

Anamorphic chaetosphaeriaceous fungi from China

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Abstract

Chaetosphaeriaceae is one of the largest families in Sordariomycetes with its members commonly found on decaying leaf, fruit, branch, bark and wood in both terrestrial and submerged environment in nature. This paper reports our research result of diversity, taxonomy and phylogeny of anamorphic Chaetosphaeriaceae in China, which is based on a systematic study with an integrated approach of morphological observation and phylogenetic analysis for a large collection (>1300 herbarium specimens and 1100 living strains). The family Chaetosphaeriaceae is expanded to accommodate 89 accepted genera, including 22 new genera and 10 newly assigned genera. Most of these genera (except for Chaetosphaeria and several other relatively large genera) are delimitated as monophyletic genera with well-defined diagnostic characters in morphology. The phylogenetic connection of non-phialidic Sporidesmium-like fungi is further confirmed and expanded to 10 different genera. The polyphyletic Codinaea/Dictyochaeta/Tainosphaeria complex is further resolved with a taxonomic framework of 28 monophyletic genera by redelimitation of Codinaea and Dictyochaeta with narrower concept, acceptance of the 16 established genera, and finally introduction of 10 new genera. *Chloridium* is phylogenetically redefined as monophyletic genus with narrower concept as typified by the type species, but a systematic review in both generic and species level is still needed. For biodiversity of chaetosphaeriaceous fungi, a total of 369 species in 76 genera, including 119 new species, 47 new combinations, and one new name, are documented. The identification keys are provided for most genera, especially the large genera such as Codinaea s. str., Codinaeella, Stilbochaeta, Cryptophiale, Thozetella, Dinemasporium and Pseudolachnella. In addition, ten known species were excluded from the family and reclassified. Systematic revision of several relatively large polyphyletic genera should be conducted in future studies, including Bahusutrabeeja, Ellisembia, Stanjehughesia, Cacumisporium, Chaetosphaeria, Chloridium, Craspedodidymum, Cryptophiale, Cryptophialoidea, Dictyochaetopsis, Minimidochium, and many published species of *Codinaea* and *Dictyochaeta*.

Keywords Chaetosphaeriaceae · Anamorphs · Diversity · Taxonomy · Phylogeny · China

Table of contents

Introduction Materials and methods Results and discussion Molecular phylogeny Morphology Taxonomy Hyphomycetes genera with non phialidic anamorphs

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¹ R&D Center, Novozymes China, No. 14 Xin Xi Lu, Shangdi Zone, Haidian District, Beijing 100085, People's Republic of China Key to genera Aunstrupia W.P. Wu & Y.Z. Diao Ellisembia Subram. Linkosia A. Hern. Gut. & B. Sutton Lomaantha Subram. Morrisiella Saikia & A.K. Sarbhoy Riisgaardia W.P. Wu & Y.Z. Diao Stanjehughesia Subram. Falholtia W.P. Wu & Y.Z. Diao Hyphomycetes with phialidic anamorph Key to genera Codinaea, Dictyochaeta and related genera Dictyochaeta and related genera with asetulate conidia Aciculadictyochaeta W.P. Wu & Y.Z. Diao Anacraspedodidymum C.R. Silva, R.F. Castañeda & Gusmão Brachydictyochaeta W.P. Wu & Y.Z. Diao

Curvichaeta W.P. Wu & Y.Z. Diao Dictyochaeta Speg. Kylindrochaeta W.P. Wu & Y.Z. Diao Lunatochaeta W.P. Wu & Y.Z. Diao Phialogeniculata Matsush. Phialoturbella Réblová & Hern.-Restr. Codinaea and related genera with setulate conidia Calceisporiella W.P. Wu & Y.Z. Diao Codinaea Maire Codinaeella Réblová & Hern.-Restr. Menispora Pers. Multiguttulispora C.G. Lin & J.K. Liu Neotainosphaeria W.P. Wu & Y.Z. Diao Nimesporella Réblová & Hern.-Restr. Oxenbollia W.P. Wu & Y.Z. Diao Paracodinaea W.P. Wu & Y.Z. Diao Parabahusutrabeeja W.P. Wu & Y.Z. Diao Stilbochaeta Réblová & Hern.-Restr. Tainosphaeria F.A. Fernández & Huhndorf Xyladelphia Réblová A.N. Mill. & & Hern.-Restr. Doubtful and excluded species of Codinaea and Dictvochaeta Chloridium, Catenularia and related genera Chloridium Link Catenularia Grove Chaetosphaeria Tul. & C. Tul. Craspedodidymum Hol.-Jech Einerjensenia W.P. Wu & Y.Z. Diao Fusichloridium W.P. Wu & Y.Z. Diao Fuscocatenula Réblová & A.N. Mill. Nawawia Marvanová Paragaeumannomyces Matsush. Cryptophiale and related genera Cryptophiale Piroz. Cryptophialoidea Kuthub. & Nawawi Paracryptophiale Kuthub. & Nawawi Paraceratocladium R.F. Castañeda Paraceratocladiella W.P. Wu & Y.Z. Diao Zanclospora S. Hughes & W.B. Kendr. Zanclosporiella W.P. Wu & Y.Z. Diao Kionochaeta P.M. Kirk & B. Sutton Kionochaetiella W.P. Wu & Y.Z. Diao Phaeostalagmus W. Gams Sporendocladia Arnaud ex Nag Raj & W.B. Kendr. Sporoschisma and related genera Anacacumisporium Y.R. Ma & X.G. Zhang Cacumisporium Preuss Exserticlava S. Hughes Monosporoschisma W.P. Wu & Y.Z. Diao Phaeodischloridium W.P. Wu & Y.Z. Diao Sporoschisma Berk. & Broome Stephembruneria R.F. Castañeda

Genera with synnematous conidiomata Arcuatospora Réblová & Hern.-Restr. Menisporopsis S. Hughes Phialoarthrobotryum Matsush. Phialosporostilbe Mercado & J. Mena Genera with sporodochial conidiomata Eucalyptostroma Crous & M.J. Wingf. Eucalyptostromiella W.P. Wu & Y.Z. Diao Minimidochium B. Sutton Pseudothozetella W.P. Wu & Y.Z. Diao Rattania Prabhug. & Bhat Thozetella Kuntze Verhulstia Hern.-Restr. Phialidic coelomycetous genera Key to genera Dinemasporium Lév. Brunneodinemasporium Crous & R.F. Castañeda Pseudodinemasporium A. Hashim. & Kaz. Tanaka Neopseudolachnella A. Hashim. & Kaz. Tanaka Pseudolachnea Ranoj. Pseudolachnella Teng Conicomyces R.C. Sinclair, Eicker & Morgan-Jones Hoehneliella Bress. & Sacc. Doubtful and excluded species Parasporendocladia W.P. Wu & Y.Z. Diao Phaeochloridium W.P. Wu & Y.Z. Diao Sinochloridium W.P. Wu & Y.Z. Diao Tubulicolla Réblová Xyladictyochaeta Hern.-Restr., R.F. Castañeda & Gené Xylolentia Réblová Pseudofuscophialis Sivan. & H.S. Chang Stratiphoromyces Goh & K.D. Hyde Discussion A list of new fungal names References

Introduction

The family Chaetosphaeriaceae was originally introduced by Locquin (1984) for *Chaetosphaeria* Tul. & C. Tul., *Loramyces* W. Weson, *Niesslia* Auersw., *Rhagadostoma* Körb., and *Zignoëlla* Sacc. It was validated by Réblová et al. (1999) to accommodate several wood-inhibiting ascomycetous genera including *Ascocodinaea* Samuels, Cand. & Magni, *Chaetosphaeria* Tul. & C. Tul., *Melanochaeta* E. Müll., Harr & Sulmont, *Melanopsammella* Höhn., *Porosphaerella* E. Müll. & Samuels, *Porosphaerellopsis* Samuels & E. Müll. and *Striatosphaeria* Samuels & E. Müll. Based on LSU sequence data, Huhndorf et al. (2004) placed the family in Chaetosphaeriales. Apart from their sexual morphology, members of these genera often reproduce by asexual stages or anamorphic stages, which are some well-known non-phialidic *Sporidesmium*-like fungi, phialidic coelomycetous genera such as *Dinemasporium* Lév. and *Pseudolachnella* Teng, and many phialidic hyphomycetous genera such as *Chloridium* Link, *Cryptophiale* Piroz., *Codinaea* Maire, *Dictyochaeta* Speg., *Kionochaeta* P.M. Kirk & B. Sutton *Sporidesmium*-like, and *Sporoschisma* Berk. & Broome (Borowska 1986; Dennis 1986; Constantinescu et al. 1995; Heredia-Abarca et al. 1995, 1997a, b; Okada et al. 1997; Réblová et al. 1999; Réblová 1998a, b, 1999a, b, 2000, 2004; Réblová and Gams 2000; Réblová and Winka 2000; Gruenig et al. 2002; Réblová and Seifert 2003; Réblová et al. 2011a, b, 2020, 2021a, b, c, d, e; Seifert et al. 2011; Hyde et al. 2016a, b; Lin et al. 2019; Luo et al. 2019; Dayarathne et al. 2020; Hyde et al. 2020).

Recent molecular phylogenetic analysis has allowed a better taxonomic and phylogenetic understanding of both sexually and asexually typified genera, which resulted in continuously adjustment in the concept and number of asexually typified genera under Chaetosphaeriaceae (Réblová et al. 1999, 2020, 2021a, b, c, d; Shenoy et al. 2006, 2007; Hyde et al. 2011; Crous et al. 2012, 2013, 2014, 2015, 2016, 2017, 2018a, b, 2019, 2020; Ma et al. 2016; Wijayawardene et al. 2012, 2017, 2018; Jayasiri et al. 2015; Maharachchikumbura et al. 2016; Yang et al. 2018a, b; Hyde et al. 2019; Lin et al. 2019; Luo et al. 2019; Hyde et al. 2020). For example, under the family Chaetosphaeriaceae, Réblová et al. (1999) accepted seven genera with asexual states in 13 asexually typified genera; Maharachchikumbura et al. (2016) and Wijayawardene et al. (2018) included 38 genera, some of them are asexually typified; Lin et al. (2019) further expanded it to accommodate 49 genera, including 5 sexually typified genera, 35 hyphomycetous genera and nine coelomycetous genera; Hyde et al. (2020) listed 39 genera, including both asexually and sexually typified genera. Réblová et al. (2020, 2021a, b, c, d, e) in their systematic review of some polyphyletic genera established several new genera under the family. It is expected that, with more effort on molecular phylogenetic analysis and exploration of fungal biodiversity in tropical and subtropical area, more anamorphic stated genera and species will be discovered and assigned to the family in future (Ma and Zhang 2015; Crous et al. 2016, 2017, 2018a, b, 2019, 2020; Li et al. 2016; Hsieh et al. 2021; Réblová et al. 2021a, b, c, d, e).

In recent years, a major change effecting the nomenclature of anamorphic fungi is the new ruling in Article 59.1 of International Code of Nomenclature for Algae, Fungi, and Plants (ICN; Melbourne Code) (Hawksworth, 2011; Hawksworth et al. 2017). The change, known as "one fungus, one name", has resulted in the implementation of a single name for one fungus, where formerly separate names were allowed for both asexual and sexual states of the same fungus. Based on this ruling, several papers have been published with recommendations for use or protection of competing generic names in Sordariomycetes (Rossman et al. 2013, 2015; Réblová et al. 2016). Molecular phylogeny has been a main enabler for implementation of "one fungus, one name" in both generic and species level under Chaetosphaeriaceae. This has leaded to several changes in taxonomy of chaetosphaeriaceous fungi: (a) accommodation of many asexually typified genera in the family, such as Codinaea, Craspedodidymum Hol.-Jech., Cryptophiale, Dictyochaeta Speg., Dinemasporium Lév., Menisporopsis S. Hughes, Nawawia Marvanová, Pseudolachnella Teng; (b). connection of anamorphs and teleomorphs in both generic and species level; (c). inclusion of species with only anamorphs known under the sexually typified genera such as Chaetosphaeria and Tainosphaeria F.A. Fernández & Huhndorf (Booth 1957; Gams and Holubová-Jechová 1976; Constantinescu et al. 1995; Fernández et al. 1999; Réblová 1998a, b, 1999a, b, 2000, 2004; Réblová and Winka 2000; Sivichai et al. 2000; Huhndorf and Fernández 2005; Réblová et al. 2006, 2020, 2021a, b, c, d, e; Shenoy et al. 2006; Fernández et al. 2006; Atkinson et al. 2007; Réblová and Seifert 2003, 2008; Liu et al. 2016; Lin et al. 2019; Luo et al. 2019). However, classification of several closely related polyphyletic genera in the family Chaetosphaeriaceae has not been solved. these genera include Codinaea, Dictyochaeta, Chloridium, Chaetosphaeria, Cryptophiale and Kionochaeta. Systematic study with inclusion of the type species for all genera is a prerequisite to build a nature classification and nomenclature system for the Chaetosphaeriaceous fungi.

In nature the chaetosphaeriaceous fungi are ascomycetes seen with superficial ascomata, or conidiomata of coelomycetes or hairy-like effuse colony as their anamorphic state on decaying plant material including leaf, stem, bark, rotten wood, and fruits. They have a cosmopolitan distribution and are known in both temperature and tropical climates, from herbaceous to woody plants, and in both terrestrial and freshwater (Gams and Holubová-Jechová 1976; McKenzie 1982, 1991a, b, 1992, 1993a, 1993b, 2008; McKenzie et al. 1992, 2000, 2004; McKenzie and Hyde, 1996; McKenzie and Kuthubutheen 1993; Goh and Hyde 1996a; Goh 1997; Hyde and Goh 1997, 1998, 1999; Marvanova 1997; Réblová et al. 1999, 2020, 2021a, b, c, d; McKenzie et al. 2000, 2004; Ho et al. 2002; Réblová 2004; Fernández and Huhndorf 2005; Fernández et al. 2006; Maharachchikumbura et al. 2015, 2016; Xia 2017; Lin et al. 2019; Luo et al. 2016, 2019; Hyde et al. 2020).

The family Chaetosphaeriaceae have not been systematically studied in China. Only few genera and species were reported in various publications (Teng 1963; Tai 1979; Tseng and Chen 1987; Guo 1989, 1992, 1997; Zhuang 2001; Xu and Zhang 2012; Lin et al. 2019; Luo et al. 2019; Hyde et al. 2020). In our study of microfungi from China during last 25 years, more than 1300 specimens bearing asexual fungi belonging to Chaetosphaeriaceae were collected from different localities in China. From these specimens, more than 1100 living strains were obtained and preserved for further study. The herbarium specimens, together with the obtained strains, were studied systematically for their biodiversity, taxonomy, and phylogeny, which forms the foundation for the current publication. Based on morphological study and phylogenetic analysis of fresh specimens and strains obtained from China, Japan and UK, we further expand the Chaetosphaeriaceae to accommodate 89 genera with 22 new genera and 10 already known asexually typified genera. For the species diversity, we record the anamorphic Chaetosphaeriaceous fungi with 369 species in 76 genera mainly from China, including 119 new species. All new species are fully described and illustrated, and the identification keys for most of the genera are provided. DNA barcodes (ITS and LSU) were generated for all studied genera and species with pure cultures successfully obtained from the fresh specimens. In a revision of these fungi, we proposed 55 new combinations (47 in Chaetosphaeriaceae, 8 in other families).

Materials and methods

Collection of chaetosphaeriaceous fungi

Fresh specimens of dead plant material including leaf litter, dead branches, bark, rotten wood, and fruits from a variety of plants in various environments including forest, botanical garden and agriculture field were collected in many localities in different part of China (Figs. 1 and 2). Samples were taken to the laboratory in Zip–lock plastic or paper bags for examination; some of these specimens were also incubated in sterile moist chambers in the laboratory to induce more diversity of chaetosphaeriaceous fungi. Type specimens were preserved in the Mycological Herbarium, Institute of Microbiology, Chinese Academy of Science, Beijing (HMAS). Ex-type strains were preserved in the Chinese General Microbiological Culture Collection (CGMCC), Beijing.

Morphological study and description

Morphological study is based on examinations of microscopic preparations made from both fresh specimens



Fig. 1 In nature the anamorphic chaetosphaeriaceous fungi can be found on decaying leaves, branches, bark and rotten wood of various plants in different geographic areas, thought more diversity can be found from subtropical and tropical areas. Submerged wood in

streams usually provide interesting diversity of chaetosphaeriaceous fungi. Here plant litter samples were collected from Moganshan, Zhejiang (**a**), Haituoshan, Hebei (**b**), and Northeast China (**c**), many new or interesting species were discovered from them



Fig. 2 The anamorphic chaetosphaeriaceous fungi can be discovered on various plant litters, including decaying leaves, branches, bark, wood, fruit and seeds of various plants

collected by the author and living cultures isolated from some of these specimens. For microscopic preparation and identification, the fresh material was mounted in distilled water. This is extremely important for proper identification of those species with appendages, especially the apical mucilaginous sheath, since this character might disappear quickly in preparations made in lactophenol or cotton blue. However, semi-permanent slide preparations were also made by mounting the specimens in cotton blue or lactophenol and sealing with nail vanish, for observation of conidiogenous cells and conidia (Sutton 1980b; Nag Raj 1993). Micro-morphological characters (conidiomata, conidiophores, conidiogenous cells, conidia) were examined using a Nikon ECLIPSE 80i and 90i compound microscope and photographed with a Canon 550 D and 600 D digital camera fitted to the microscope. Measurements of morphological structures were made with the Tarosoft (R) Image Frame Work program v.0.9.7. Photographic plates were edited and combined using Adobe Photoshop CS6 Extended version 13.0.1 software (Adobe Systems, USA).

For description of genera and species, the terms used were based on *Dictionary of the Fungi* (Kirk et al. 2001). The citation of authors for fungal names follows *Authors of Fungal Names*: A list of authors of scientific names of fungi by Kirk and Ansell (1992). For description of new fungal genera and species, we followed the recommendation in "How to publish a new fungal species, or name, version 3.0" (IMA Fungus 12:11, 2021). MycoBank was used for registering all new fungal taxon.

Fungal strains, growth, and preservation

Pure cultures were obtained from freshly collected specimens by single spore isolation method. Germinated spores were observed with a stereomicroscope and transferred to potato dextrose agar (PDA) for examination of culture characteristics, sporulation, extraction of DNA and preservation. Colony color was determined according to the color charts of Rayner (1970). The cultures were grown on potato-dextrose agar for morphological study and preservation. All 1176 living strains were preserved in 15% glycerin under – 80 °C. The presentation data of all holotype specimen and ex-type strains for new taxa are listed in Table 1. The presentation data for all studied strains are listed in Supplementary Table 1.

Genomic DNA extraction from the fungal strains

DNA extraction was performed from fresh fungal mycelia. Isolates were grown on PDA at 25 °C under dark condition for 7–14 days, or until the colony with enough mycelium for DNA extraction. The mycelium was scraped off and collected in a 1.5 ml micro-centrifuge tube. Mycelium was ground to a fine powder in liquid nitrogen and genomic DNA was extracted using the Fungal gDNA Kit (BioMIGA, USA) according to the manufacturer's instructions. The DNA products were kept at 4 °C for use in regular work and duplicated at -20 °C for long-term storage. For ITS sequence amplification, total genomic DNA was successfully extracted for

Table 1 New taxa, specimen, isolate information and GenBank accession numbers for new sequences determined for this study

Species	Substrate	Geographical location	Specimen number	Holotype specimen in HMAS	Ex-type strains in CGMCC	Type status	GenBank accession number	-
							ITS	LSU
Arcuatospora ellisii	Cinnamomum sp., dead leaf	China, Guangdong	17147a	351957	3.20745	Т	OL628394	
Arcuatospora hughesii	Leaf litter	China, Guangdong	12237	351958	3.20646	Т	OL627740	OL655098
Arcuatospora lunata	Leaf litter	China, Guangdong	17248	351959	3.20750	Т	OL628450	
Arcuatospora septata	Leaf litter	China, Hunan	6039c	351960	3.20644	Т	OL627664	
Arcuatospora sinensis	Cinnamomum sp., dead leaf	China, Zhejiang	13025	351961	3.20653	Т	OL627845	
Arcuatospora suttonii	Leaf litter	China, Hainan	17630	351962	3.20674	Т	OL628653	
Arcuatospora yun- nanensis	Quercus sp., decaying fruit	China, Yunnan	7244B	351963	3.20642	Т	OL627671	OL655067
Brachydictyochaeta bul- liformis	Leaf litter	China, Guangdong	17533a	351964	3.20759	Т	OL628591	
Brunneodinemasporium sinense	Quercus serrata, leaf litter	China, Zhejiang	13294a	351965	3.20659	Т	OL627952	
Calceisporiella sinensis	Dead branch	China, Guangdong	1900a	351966	3.20635	Т	OL627627	OL655035
Catenularia elegans	Dead branches	China, Hunan	6078	351967		Т		
Chloridium crousii	Dead branch	China, Guangxi	1328b	351968	3.20701	Т	OL627543	OL655003
Chloridium culmicola	Bamboo, decaying culm	China, Yunnan	2606b	351969	3.20639	Т	OL627650	OL655054
Chloridium cylin- drosporellum	Bamboo, rotten leaf	China, Sichuan	13210	351970	3.20719	Т	OL627899	
Chloridium jilinense	Rotten wood	China, Jilin	5039	351971	3.20640	Т	OL627659	OL655058
Chloridium kirkii	Rotten wood	China, Guangxi	1459b	351972	3.20703	Т	OL627588	OL655020
Chloridium proliferatum	Entada phaseo- loides, decaying fruit	China, Hainan	17684b	351973	3.20766	Т	OL628678	
Chloridium setosum	Pinus sp., rotten cone	China, Zhejiang	17032a	351974	3.20741	Т	OL628345	
Chloridium shangsiense	Dead branch	China, Guangxi	1285b	351975	3.20632	Т	OL627574	OL655016
Chloridium sinense	Leguminosae, rot- ten seed	China, Zhejiang	17056a	351976	3.20743	Т	OL628375	
Chloridium tropicale	Leaf litter	China, Yunnan	YN004	351977	3.20725	Т	OL628018	OL655153
Chloridium xishuang- banense	Leaf litter	China, Yunnan	YN13a	351978	3.20723	Т	OL628006	OL655149
Codinaea clavatophora	Leaf litter	China, Yunnan	8015	351979	3.20792	Т	OL627680	
Codinaea dinghushan- ensis	Smilax sp, leaf litter	China, Guangdong	12155	351980	3.20647	Т	OL627723	
Codinaea fanglanii	Leaf litter	China, Zhejiang	13345	351981	3.20658	Т	OL627950	OL655146
Codinaea kendrickii	Bamboo, rotten leaf	China, Sichuan	13208	351982	3.20718	Т	OL627885	
Codinaea latispora	Bamboo, rotten leaf	China, Zhejiang	17038	351983	3.20739	Т	OL628329	
Codinaea minima	Arundo donax, dead culm	China, Guangdong	1942b	351984		Т		
Codinaea oxenbolliae	Leaf litter	China, Sichuan	17179	351985	3.20747	Т	OL628418	
Codinaea pyriformis	Leaf litter	China, Yunnan	2746b1	351987	3.20707	Т	OL627653	OL655056
Codinaea simaoensis	Leaf litter	China, Yunnan	15214	351988	3.20800	Т	OL628033	
Codinaea tengii	Palm, dead stem	China, Nanning	1645c	351989		Т		
Codinaea trisetula	Dead branch	China, Guangdong	1930c	351990	3.20636	Т	OL627631	OL655039
Codinaeella brevissima	Leaf litter	China, Sichuan	17241	351991	3.20804	Т	OL628427	
Codinaeella cannonii	Leaf litter	China, Yunnan	15206a	351992	3.20728	Т	OL628027	
Codinaeella cinnamomi	Cinnamomum sp., dead leaf	China, Sichuan	13202	351993	3.20717	Т	OL627883	

Table 1 (continued)

Species	Substrate	Geographical location	Specimen number	Holotype specimen in HMAS	Ex-type strains in CGMCC	Type status	GenBank acces- sion number	
							ITS	LSU
Codinaeella kuthubutheenii	Dead branch	China, Guangdong	17529	351994	3.20758	Т	OL628585	
Codinaeella latispora	Leaf litter	China, Hunan	6015	351995	3.20789	Т	OL627661	
Codinaeella multisporu- loca	Quercus dentata, decaying fruit	China, Hebei	17413a	351996	3.20754	Т	OL628541	
Dinemasporium beijin- gense	Grass, decaying culm	China, Beijing	15095	351998	3.20650	Т	OL627785	OL655115
Dinemasporium fang- lanii	Grass, decaying leaf	China, Guangdong	16730a	351999	3.20668	Т	OL628233	
Dinemasporium long- isporum	Bothriochloa sp., Dead culm	USA, Texas	IMI1238583	352000		Т		
Dinemasporium multi- setulum	Grass, decaying culm	China, Beijing	15100	352001	3.20651	Т	OL627790	OL655117
Dinemasporium suttonii	Bamboo, dead leaf	China, Zhejiang	16993	352002	3.20802	Т	OL628308	OL655220
Dinemasporium tubakii	Grass, decaying leaf	China, Jiangsu	13446a	352003	3.20798	Т	OL627994	
Dinemasporium yongnianii	Grass, decaying culm	China, Shan'xi	16535	352004	3.20734	Т	OL628210	
Ellisembia reblovae	Bamboo, dead culm	China, Guangdong	1913b	352005	3.20705	Т	OL627632	OL655040
Eucalyptostroma hon- gluosiense	<i>Cyclobalanopsis</i> sp., rotten fruit	China, Jiangsu	16890a	352006	3.20669	Т	OL628282	
Eucalyptostroma oxen- bolliae	Leaf litter	China, Guangdong	16273	352007	3.20664	Т	OL628120	OL655183
Eucalyptostromiella beijingensis	Quercus sp., decaying leaf	China, Beijing	17319b	352008	3.20753	Т	OL628500	
Fuscocatenula bambu- sicola	Bamboo, dead culm	China, Ningxia	1182b	352009		Т		
Kionochaeta beijingensis	Quercus sp., decaying fruit	China, Beijing	17342a	352010	3.20752	Т	OL628478	OL655246
Linkosia filiformis	Rodeen wood	China, Hubei	8227	352012	3.20793	Т	OL627687	OL655075
Linkosia gelatinosa	Rotten wood	China, Hubei	8228c	352013	3.20709	Т	OL627688	OL655076
Linkosia multiseptum	Bamboo, dead culm	China, Guangxi	1374b	352014	3.20786	Т	OL627557	OL655008
Linkosia rostrata	Bamboo, dead culm	China, Hunan	6030b	352015	3.20790	Т	OL627662	OL655059
Lunatochaeta shenzhen- ensis	Leaf litter	China, Guangdong	17504a	352016	3.20757	Т	OL628577	OL655258
Menispora paraciliata	Pinus sp., dead cone	China, Zhejiang	17033b	352017	3.20742	Т	OL628367	
Menispora paratortuosa	Platanus occiden- talis, decaying fruit	China, Zhejiang	17005a	352018	3.20748	Т	OL628428	OL655236
Menisporopsis biformis	Palm, decaying petiole	China, Guangdong	17473	352019	3.20805	Т	OL628559	OL655255
Menisporopsis din- emasporioides	Leaf litter	China, Guangdong	12102	352020	3.20711	Т	OL627718	OL655089
Menisporopsis dush- anensis	Fagus sp., dead leaf	China, Guangdong	12183	352021	3.20795		OL627730	OL655091
Menisporopsis macros- pora	Leaf litter	China, Sichuan	17184a	352022	3.20673	Т	OL628398	OL655231
Minimidochium dicty- ochaeta	Leaf litter	China, Yunnan	15158	352023	3.20660	Т	OL628010	OL655150
Minimidochium tri- septata	<i>Smilax</i> sp., leaf litter	China, Guangdong	2083p	352024		Т		

Table 1 (continued)

Species	Substrate	Geographical location	Specimen number	Holotype specimen in HMAS	Ex-type strains in CGMCC	Type status	GenBank acces- sion number	
							ITS	LSU
Monosporoschisma elegans	Palm, dead petiole	China, Hainan	5520	352025		Т		
Morrisiella reblovae	Dead branches	China, Yunnan	9002	352026		Т		
Multiguttulispora para- triseptata	Dead branch	China, Guangdong	12457	352027	3.20796	Т	OL627820	OL655127
Neopseudolachnea microosperma	Grass, decaying culm	China, Hebei	15057	352028	3.20649	Т	OL627783	OL655113
Neotainosphaeria micro- sperma	Dead branch	China, Guangdong	1928a	352030	3.20788	Т	OL627633	OL655041
Nimesporella aunstrupii	Leaf litter	China, Guangdong	12202	352031	3.20648	Т	OL627752	OL655105
Nimesporella riisgaardii	Palm, dead petiole	China, Zhejiang	13349a	352032	3.20797	Т	OL627965	
Oxenbollia lunatospora	Leaf litter	China, Hunan	6065	352033	3.20641	Т	OL627663	OL655060
Parabahusutrabeeja minima	Cinnamomum sp., dead leaf	China, Guangxi	1559a	352034	3.20654	Т	OL627597	
Paracodinaea japonica	Dead fruit of tree	Japan, Tsu	16913	352035	3.20663	Т	OL628342	
Paracryptophiale pirozynskii	Dead branch	China, Guangdong	2008	352036	3.20706	Т	OL627641	OL655047
Paragaeumannomyces asetulus	Dead bark	China, Guangdong	12131	352037		Т		
Paragaeumannomyces nawawii	Plam, rotten mate- rial	China, Guangdong	12655	352038		Т		
Phaeochloridium gamsii	Banana, leaf	China, Guangdong	17434a	352039	3.20755	Т	OL628548	
Phaeostalagmus minimus	Leaf litter	China, Guangdong	12182	352040		Т		
Pseudodinemasporium elegans	Dead branches	China, Guangdong	12464	352041	3.20655	Т	OL627829	OL655131
Pseudodinemasporium minimum	Cinnamomum sp., decaying leaf	China, Guangxi	1382i	352042	3.20702	Т	OL627572	OL655015
Pseudolachnea mac- rospora	Sarothaumus scoparius	UK, Petit Port	IMI134705	352043		Т		
Pseudolachnella minima	Bamboo, decaying culm	China, Guangdong	12378	352044	3.20714	Т	OL627799	
Pseudolachnella tengii	Bamboo, decaying culm	China, Yunnan	7544	352045	3.20791	Т	OL627679	OL655070
Pseudolachnella yun- nanensis	Bamboo, decaying culm, big species	China, Yunnan	12902	352046	3.20720	Т	OL627929	
Pseudothozetella lunata	Leaf litter	China, Yunnan	15207	352047	3.20661	Т	OL628034	OL655157
Rattania falcata	Leaf litter	China, Guangdong	16324	352048	3.20731	Т	OL628131	
Rattania intermedia	Dead branches	China, Guangdong	1998d	352049	3.20638	Т	OL627646	OL655050
Rhopalophora hainan- ensis	Bauhinia purpu- rea, seed pod	China, Hainan	17643	352050	3.20807	Т	OL628666	
Riisgaardia longispora	Rotten wood	China, Hubei	8333	352051	3.20794	Т	OL627701	OL655085
Riisgaardia obclavata	Bamboo, dead culm	China, Guangxi	1266a	352052	3.20787	Т	OL627568	OL655013
Sinochloridium bambu- sicola	Bamboo, dead culm	China, Guangdong	16678a	352053	3.20735	Т	OL628215	
Sporendocladia beijin- gensis	<i>Quercus</i> sp., decaying fruit	China, Beijing	BJ19-3	352054	3.20738	Т	OL628290	OL655217
Stephembruneria micro- sperma	Bamboo, dead	China, Guangxi	1318a	352055	NN43126	Т	OL627563	
Stilbochaeta ejneri	Dead branch	China, Sichuan	13224A	352056	3.20716	Т	OL627877	OL655138
stilbochaeta minteri	Leaf litter	China, Guangdong	16270	352059	3.20732	Т	OL628135	OL655188
Stilbochaeta sinensis	Leaf litter	China, Guangdong	12195	352060	3.20713	Т	OL627747	

Table 1 (continued)

Species	Substrate	Geographical location	Specimen number	Holotype specimen in HMAS	Ex-type strains in CGMCC	Type status	GenBank acces sion number	
							ITS	LSU
Tainosphaeria cupulata	Acacia sp., decay- ing seed pod	China, Guangdong	17579	352061	3.20761	Т	OL628617	
Tainosphaeria micros- perma	Pinus sp., rotten cone	China, Zhejiang	16152a	352062	3.20730	Т	OL628074	OL655170
Tainosphaeria phialo- geniculata	Leaf litter	China, Yunnan	15202	352063	3.20799	Т	OL628025	
Tainosphaeria verru- cophora	Leaf litter	China, Hainan	17647b1	352064	3.20765	Т	OL628677	
Tainosphaeriella sivane- sanii	Acacia sp., decaying fruit	China, Guangdong	17575	352065	3.20767	Т	OL628636	
Thozetella asetula	Dead seed	China, Guangdong	12089	352066	3.20645	Т	OL627735	OL655094
Thozetella aunstrupii	Leaf litter	China, Guangdong	17144a	352067	3.20744	Т	OL628392	
Thozetella fanglanii	Rotten wood	China, Beijing	15230	352068	3.20662	Т	OL628043	OL655159
Thozetella guozhongii	Palm, decaying leaf	China, Guangdong	16696a	352069	3.20667	Т	OL628217	OL655204
Thozetella hunanensis	Leaf litter	China, Hunan	11044c	352070	3.20671	Т	OL627706	OL655087
Thozetella japonica	Rotten fruit of unidentified tree	Japan, Tsu	16900a	352071	3.20670	Т	OL628292	OL655218
Thozetella lunata	Palm, decaying leaf	China, Guangdong	12701a	352073	3.20657	Т	OL627903	OL655141
Thozetella moganshan- ensis	Platanus occiden- talis, decaying bark	China, Zhejiang	17016a	352075	3.20671	Т	OL628327	OL655223
Thozetella palmicola	Palm, decaying seed	China, Hainan	17612	352076	3.20763	Т	OL628651	
Thozetella paragiganitea	Leaf litter	China, Yunnan	15205a	352077	3.20727	Т	OL628026	
Thozetella pseudotock- laiensis	<i>Delonix regia</i> , decaying seed pod	China, Hainan	17596a	352078	3.20762	Т	OL628638	
Thozetella guozhongii	Palm, decaying petiole	China, Guangdong	17454a	352079	3.20756	Т	OL628553	
Thozetella suttonii	Dead branches	China, Guangdong	1940b	352080	3.20637	Т	OL627636	OL655043
Thozetella wenyingiae	Leaf litter	China, Yunnan	15209a	352082	3.20729	Т	OL628030	OL655156
Verhulstia biformis	Rubus sp., dead leaf	China, Sichuan	17175	352083	3.20749	Т	OL628435	
Verhulstia elegans	Leaf litter	China, Sichuan	17163a	352084	3.20803	Т	OL628414	OL655233
Verhulstia minima	Leaf litter	China, Sichuan	17227a	352085	3.20674	Т	OL628454	
Xyladelphia parapul- chriseta	Dead branch	China, Guangdong	17090a	352086	3.20751	Т	OL628464	OL655245
Xyladelphia sinensis	Plam, dead petiole	China, Guangdong	17453b	352087	3.20760	Т	OL628598	OL655261

A complete list of all studied strains can be found in Supplementary Table 1

HMAS The Mycological Herbarium, Institute of Microbiology, Chinese Academy of Science, Beijing, China, CGMCC The Chinese General Microbiological Culture Collection (CGMCC), Beijing, China

all strains from fresh mycelia following a modified protocol of Doyle and Doyle (1987).

DNA amplification and sequencing

DNA amplification was performed by polymerase chain reaction (PCR). Primers pairs NS1 (5'-GTA GTC ATA TGC TTG TCT C-3') & NS4 (5'-CTT CCG TCA ATT CCT TTA AG-3') as defined by White et al. (1990) were used to amplify a region spanning approximately 1100 nucleotides from the small subunit of the rDNA (18S rDNA). LROR (5'-ACCCGCTGAACT TAAGC-3') and LR5 (5'-TCCTGAGGGAAACT TCG-3') primer pairs as defined by Vilgalys and Hester (1990) were used to amplify a segment of the large subunit 28S rDNA (approx. 850 nucleotides). ITS1 (5'-TCCGTAGGTGAACCT GCGG-3') or ITS5 (5'-GGAAGTAAAAGTCGTAACAAGG-3') and ITS4 (5'-TCCTCCGCTTATTGATATGC-3') primer pairs as defined by White et al. (1990) were used to amplify a segment of the ITS1, 5.8S and ITS2 regions. The amplification was performed in a 50 μ l reaction volume as follows: 1×PCR buffer, 0.2 mM d'NTP, 0.3 μ M of each primer; 1.5 mM MgCl₂, 0.8 units Taq Polymerase and 5–10 ng DNA. The PCR products were checked on 1% agarose electrophoresis gels stained GelRed[®] Nucleic Acid Gel Stain (41003).

PCR products were then purified using minicolumns, purification resin and buffer according to the manufacturer's protocols (Amersham product code: 27-9602-01). DNA sequencing was performed using the primers mentioned above in an Applied Biosystem 3730 DNA Analyzer by SinoGenoMax Company Limited. For each fungal strain, sequences obtained for the respective primers (LROR & LR5, NS1 & NS4, ITS1, ITS5 and ITS2) were manually aligned to obtain an assembled sequence using one of the following programs, VectorNTI, Bioedit (Hall 1999) or SnapGene.

Sequence alignment and phylogenetic analysis

Original sequences were checked using various bioinformatics program including Vector NTIO, BioEdit, SnapGene, along with reference sequences originated from previous publications. The relevant homogenous sequences were obtained by BLAST searches from GenBank. All sequences generated in this study are listed in Table 1 and Supplementary Table 1. All public sequences used in this study are listed in Supplementary Table 2. Alignments for each locus were done in MAFFT v7.307 online version (Katoh and Standley 2016) and manually verified in MEGA v.7 (Tamura et al. 2013; Kumar et al. 2016) to allow maximum alignment and minimize gaps. The files for Bayesian inference analyses and maximum likelihood analyses were formatted with Mesquite v3.04 (http://mesqu iteproject.org). Phylogenetic analyses were performed using Bayesian Inference (BI) and Maximum-Likelihood (ML) approaches with the CIPRES Science Gateway portal (https:// www.phylo.org/; Miller et al. 2012) using MrBayes v. 3.2.6 (Ronquist et al. 2012), and PhyML v. 3.0 (Thompson et al. 1997; Guindon et al. 2010), respectively. For Bayesian inference analysis, the best evolutionary model for each locus was determined using MrModelTest v. 2.3 (Nylander, 2004). Posterior probabilities (PP) (Rannala and Yang 1996; Zhaxybayer and Gogarten 2002) were calculated by Markov Chain Monte Carlo sampling (MCMC), using the estimated evolutionary models. Two analyses of four MCMC chains were run from random trees for 120,000,000 generations and sampled every 1000 generations. The first 25% of trees were discarded as the burn-in phase of each analysis and posterior probabilities determined from the remaining trees. For the ML analysis, the general time reversible model was applied with an invariable gamma-distributed rate variation (GTR + I + G). Phylogenetic trees were drawn with Figtree v1.4.3 (http://tree.bio.ed.ac.uk/ software/figtree). All the sequences generated were deposited in GenBank (Table 1), novel taxonomic descriptions in Myco-Bank (https://www.mycobank.org), and the multi-locus alignments and trees in TreeBASE (Submission Number: 29086).

Results and discussion

Molecular phylogeny

Both ITS and LSU sequences were successfully obtained from 259 living strains of chaetosphaeriaceous fungi (hyphomycetes and coelomycetes) collected from China, Japan, and UK, and the final concatenated alignment consisting of 1734 characters. Based on the phylogenic analysis by using the integrated data set of ITS and LSU sequences, these strains were assigned to the monophyletic groups. One to several representative ITS and LSU sequences from each species were used in the phylogenetic analysis. The ML and BI analyses based on combined LSU and ITS sequence data provided similar tree topologies. The ML tree is shown in Fig. 3. Furthermore, single-locus phylogenetic analyses using ITS and LSU were also constructed, respectively and shown in the Supplementary Figs. 1 and 2.

In the phylogenetic tree (Fig. 3) from the integrated ITS and LSU dataset, the 508 strains (including 270 fresh isolates) of Chaetosphaeriaceae included in the analysis distributed in 31 clades with more than 100 lineages representing genera or natural groups of species with strong support. The similar results are obtained from the phylogenetic trees (Supplementary Fig. 1 and 2) generated from the single gene data set.

Clade 1 represents the asexually typified genera Calvolachnella, Codinaeella and Rattania. Codinaeella is segregated from Codinaea s. lat. and Dictyochaeta s. lat. Morphologically it is characterized by the conidiophores in two layers (the morphotype CA1) or setiform with lateral fertile (the morphotype CA2), mono- or polyphialidic conidiogenous cells extending through percurrent and sympodial proliferation and bearing flared, funnel-shaped collarettes, and aseptate falcate, cylindrical-fusiform, curved and slightly asymmetrical conidia inserted with one simple setula at each end (Réblová et al. 2021c). None of these species has been known with teleomorph. This strongly supported clade (100/1) includes seven known species (C. coryli, C. filamentosa, C. lambertiae, C. mimusopis, C. minuta, C. pini, C. sinensis, C. yunnanensis) and six undescribed species such as C. brevissima, C. paralambertiae, C. multisporuloca, C. sinensis and two unnamed species).

Rattania, characterized by sporodochial conidiomata, monophialidic conidiogenous cells, and hyaline, aseptate or septate conidia with setulae at both ends. No teleomorph is known in this genus. None of the four accepted species in this genus is known with teleomorph. *Rattania falcata* and *R. intermedia* are introduced as new species.

Calvolachnella, a monotypic and asexually typified genus, is characterized by cupulate acervular conidiomata, pale brown conidiophores, monophialidic conidiogenous, and fusiform, hyaline to pale brown conidia bearing setulae at both ends (Hernández-Restrepo et al. 2016).

Clade 2 represents the genera *Flectospora*, *Oxenbol*lia, Paracodinaea, Phialoturbella and Phialogeniculata. According to Réblová et al. (2021b), the genus Tainosphaeriella also belongs to this clade. Morphologically these genera share the similar characters such as absence of setae, solitary or aggregated conidiophores, mono- or polyphialidic conidiogenous cells extending by percurrent and sympodial proliferation and bearing flared funnel-shaped collarettes. However, the morphology of conidia varies a lot in shape (falcate, cylindrical-fusiform, cylindrical, ellipsoidal to obovoid, obclavate), color (hyaline or pale brown), septation (aseptate or septate) and setulae (setulate or asetulate), and are used to define the genera. In Oxenbollia, Paracodinaea, Tainosphaeriella and two new species included in this clade, the conidia are with setulae, while in other genera the conidia are asetulate. The teleomorphs are known in two of these genera, i.e., Flectospora and Phialoturbella, and with hyaline, aseptate or septate, ellipsoidal, ellipsoidal-fusiform ascospores (Réblová et al. 2021b, c).

Clade 3 represents the genera *Calceisporiella*, *Parabahusutrabeeja* and *Tainosphaeria*. Morphologically the genera in this clade are characterized by absence of setae, well-defined conidiophores, mono- or polyphialidic conidiogenous cells extending by percurrent or sympodial proliferation, and hyaline, aseptate, falcate, cylindrical-fusiform conidia bearing setulae. *Tainosphaeria* is a holomorphic genus characterized by perithecial ascomata, unitunicate asci, hyaline, transversely septate ascospores. The other two genera, *Calceisporiella* and *Parabahusutrabeeja*, are asexually typified monotypic genera and no teleomorph is known. Combining with morphological and phylogenetic analysis, these genera can be well defined as monophyletic genera with reasonable diagnosis characters (Lin et al. 2019; Réblová et al. 2021b).

Clade 4 represents the monophyletic and asexually typified genus *Anacacumisporium*. This asexually defined genus morphologically resembles *Cacumisporium* in well-developed conidiophores, monophialidic conidiogenous cells bearing flared and broadly funnel-shaped collarettes, and ellipsoidal, septate and versicolorous conidia, but differs from it by the setulae conidia (Ma et al. 2016).

Clade 5 represents the asexually typified genus *Thoze-tella* and *Anacraspedodidymum submersum*. All studied species of *Thozetella* are grouped together as a monophyletic clade with strong support value in all analyses (Figs. 3, S1, S2). Morphologically, *Thozetella* is also unique in forming

sporodochial and/or synnematal conidiomata, microawns and setulate conidia (Seifert et al. 2011). *Chaetosphaeria rivularia*, originally described with both teleomorph and *Thozetella* anamorph on wood submerged in freshwater in southern France, is phylogenetically closely related to other species of the genus, while distinct from other *Chaetosphaeria* species (Ariyawansa et al. 2015). Inclusion of *Anacraspedodidymum submersum* in this monophyletic clade is doubtful since this fungus is morphologically very different from the members of *Thozetella*. In *Anacraspedodidymum submersum*, the conidiophores are solitary and terminated with a monophialidic conidiogenous cells with a funnelshaped collarettes, and the conidia are hyaline, aseptate, asetulate, globose or subglobose and with a slightly papillate base (Zheng et al. 2021).

The asexually typified genus *Phialoarthrobotryum* is clustered together with *Thozetella* but as a distinct linkage. It is a newly assigned genus to Chaetosphaeriaceae, based on the phylogenetic analysis of the DNA sequences from the ex-type material of the type species, *Phialoarthrobotryum triseptatum*. The genus is well-defined by synnematous conidiomata, monophialidic conidiogenous cells, and brown, septate, cylindrical conidia (Matsushima 1975).

Clade 6 represents the asexually typified genera *Menisporopsis* s. str. and *Phialosporostilbe*. All species of *Menisporopsis*, including *M. breviseta*, *M. anisospora*, *M. dushanensis*, *M. pandanicola*, *M. pirozynskii*, *M. theobromae* (the type species of the genus), and several undescribed species, are resolved as a monophyletic clade with strong support value in all analysis (Figs. 3, S1 and S2). These species are distinctly related to the species of *Arcuatospora*, a recently established genus segregated from *Menisporopsis* (Réblová et al. 2021b). Morphologically both genera are similar in producing synnematous conidioma, terminal mono- or polyphialidic conidiogenous cells, and hyaline, aseptate conidia bearing setulae, but differs in conidial shape. No teleomorph has been known for any known species of the two genera.

Clade 7 represents the asexually typified genus *Infundibulomyces*. The genus is unique in producing the cupulate and nidulariaceous conidiomata with lateral excipulum consisting of textura prismatica with a single cell layer, monophialidic conidiogenous cells, and hyaline, septate, cylindrical to fusiform conidia bearing setulae at both ends (Plaingam et al. 2003; Somrithipol et al. 2008). No teleomorph is known for the genus.

The asexually typified genus *Minimidochium* is clustered together with Clades 1–6 but as a distinct linkage. The genus is tentatively placed in Chaetosphaeriaceae based on morphology and phylogenetic analysis, and needs to be further validated by phylogenetic analysis with inclusion of the type species.

Clade 8 represents the asexually typified genus *Din*emasporium. A total of 23 species, including 18 known



Fig.3 Maximum likelihood (ML) tree based on ITS and 28S rDNA sequence data for the *Chaetosphaeriaceae*. Bootstrap support values $\geq 60\%$, Bayesian posterior probability values ≥ 0.92 are shown at the nodes. *Tracylla eucalypti* CPC 31777 and *Tracylla aristata* CPC

Dinemasporium species with DNA sequences available and five new species are included in this clade and formed a monophyletic group with strong support value. New ITS and LSU sequences were also generated from fresh material for two species, *D. ligongense* and *D. sinensis*, previously published by one of us but without DNA bar code.

Clade 9 represents two different monophyletic genera, *Arcuatospora* and *Menispora*. All species of the asexually typified genus *Arcuatospora*, including *A. novae-zelandiae*, *A. seorsa* and several undescribed species, are clustered together with strong support value (100/1), which further supports the segregation of *Arcuatospora* from *Menisporopsis* (Réblová et al. 2021b). Morphologically the 1-septate conidia and synnematous conidiomata surrounding the seta becoming unilateral towards their apices are the characteristics of these species, and clearly differs from the closely related genus *Menisporopsis* (aseptate conidia, setae centrally located in synnemata). *Menispora* is a holomorphic genus characterized by perithecial ascomata, unitunicate asci, 25,500 was chosen as the outgroup. Ex-type strains are indicated with "T" in the end of the taxa labels. The newly generated sequences in the current study are in bold. Latin names and ex-type strain numbers of the new species described in the current study are shown in blue font

hyaline, transversely septate ascospore in teleomorph; and presence of setae or setiform conidiophores, monophialidic conidiogenous cells with inconspicuous collarettes which are sometimes strongly incurved, and hyaline, aseptate or septate, setulate or asetulate conidia in the anamorph (Réblová et al. 2006, 2021c; Réblová and Seifert 2008).

Clade 10 represents the phialidic genus *Stilbochaeta* and one non-phialidic species *Stanjehughesia kaohsiungensis*. The species of *Stilbochaeta* are distantly related to linkages where other *Codinaea* s. lat. and *Dictyochaeta* s. lat. species are included. Morphologically *Stilbochaeta* is a holomorphic genus which is well-delimited and characterized by arrangement of sterile or fertile setae and conidiophores in bundles, mono- or polyphialidic conidiogenous cells extending by percurrent or sympodial proliferation and bearing flared, funnel-shaped collarette, and hyaline, septate, falcate, oblong-falcate, ellipsoidal-fusiform conidia with unbranched or branched setulae at both ends (Réblová et al. 2021c). The teleomorph is known from *S. brevisetula* and characterized



Fig. 3 (continued)

by perithecial ascomata with setae, unitunicate asci, hyaline, transversely septate ascospore without gelatinous sheath or appendage. *Stanjehughesia kaohsiungensis* is distantly related to *Stanjehughesia hormiscioides* (the type species of *Stanjehughesia*) and other *Sporidesmium*-like fungi, the new genus *Falholtia* is created for this fungus.

Clade 11 represents the asexually typified *Codinaea* s. str. and *Nimesporella*. Both genera produce solitary or grouped conidiophores, mono- or polyphialidic conidiogenous cells extending by percurrent and sympodial proliferation and bearing flared, funnel-shaped collarettes, and hyaline and aseptate conidia with setulae. Under the genus *Codinaea*, four different morphotypes in arrangement of setae, conidiophores and conidiogenous cells were recognized by Réblová et al. (2021c). No teleomorph has been known for any species of these two genera. Clade 12 represents the asexually typified genera *Polynema*, *Pseudolachnea* and *Pseudolachnella*. *Polynema* is a synnematous genus, while other two genera are with cupulate to acervuloid conidiomata. This clade is a sister clade of the Clade 13 and 14 but unrelated to the Clade 8 containing *Dinemasporium* species, which shares mostly similarity on morphology with *Pseudolachnea* and *Pseudolachnella*. No teleomorph has been known for any species of these three genera.

Clade 13 represents the asexually typified genera Brunneodinemasporium, Dendrophoma Neopseudolachnella and Pseudodinemasprium. These genera are Dinemasporium-like or Pseudolachnea-like fungi characterized produce acervular or acervuloid, or stromatic conidiomata, monophialidic conidiogenous cells with inconspicuous collarettes, and hyaline conidia with setulae at both ends.



Fig. 3 (continued)

Neopseudolachnella is most similar to *Pseudolachnea* and *Pseudolachnella* in having hyaline, cylindrical, uni- to multiseptate conidia with bipolar setulae, but clearly separated from the latter two genera by the acervuloid conidiomata lacking a peridial wall (Hashimoto et al. 2015b). *Brunneodinemasporium* and *Pseudodinemasporium* are *Dinemasporium*-like in producing setose conidiomata and aseptate conidia with one setula at each end, but differs in basal stroma of conidiomata, color of conidiophores, and septation of conidial appendage (Crous et al. 2012; Hashimoto et al. 2015a, b). No teleomorph has been known for any species of these three genera. *Dendrophoma* is a holomorphic genus characterized by perithecial and papillate ascomata, unitunicate and 8-spored asci, and hyaline, fusiform, 1-septate ascospore in teleomorph, and stromatic then cupulate and

asetose conidiomata, monophialidic conidiogenous cells with inconspicuous collarettes, and hyaline, aseptate, naviculate to botuliform conidia with short setulae at both ends (Crous et al. 2012; Réblová et al. 2020).

Clade 14 represents the holomorphic genus *Striato-sphaeria*. The genus is morphologically and phylogenetically well-delimitated and characterized by perithecial and papillate ascomata, unitunicate asci with 8 uniseriate or obliquely uniseriate spores, and dark brown, uniseptate, ellipsoidal-fusiform ascospore as teleomorph, and solitary conidiophores, monophialidic conidiogenous cells with funnel-shaped collarettes, and brown, uniseptate, reniform to ellipsoidal, asymmetrical conidia with a setula at each end (Samuels and Müller 1978; Réblová et al. 2020).



Fig. 3 (continued)

The asexually typified genus *Hoehniliella* is clustered together with Clade 1–16 but as a distinct linkage and is a newly assigned genus to the family Chaetosphaeriaceae. The genus is placed in Chaetosphaeriaceae based on both morphologic and phylogenetic analysis. Morphologically this genus is well-delimitated and characterized by cornute to cupulate, uniloculate, setose conidiomata, monophialidic conidiogenous cells with inconspicuous collarettes, and pale brown, septate, cylindrical, fusiform or ellipsoidal conidia bearing branched or unbranched setulae at both ends (Nag Raj 1993).

Clade 15 represents the asexually typified genus *Multi-guttulispora*. This is a recently established genus, which is morphologically and phylogenetically well-delimitated (Lin et al. 2019; Réblová et al. 2021b). In this genus, the solitary or grouped conidiophores are with terminal mono- or

polyphialidic conidiogenous cells extending sympodially over a short distance and bearing funnel-shaped collarettes, and hyaline, ellipsoidal to oblong, to ellipsoidal-fusiform, multiguttulate and 3-septate conidia with one setula at each end. No teleomorph is known for any species of the genus.

Clade 16 represents the genera Adautomilanezia, Chloridium s. str. and Sporoschisma. Chloridium and Sporoschisma are not resolved in the phylogenetic tree from the integrated LSU and ITS data set, but well resolved as monophialidic genera in the phylogenetic tree generated from ITS sequences (Fig. S1) and other studies (Lin et al. 2019; Luo et al. 2019; Réblová et al. 2021a, b, c, d). Sporoschisma is a holomorphic and well-delimitated genus with subcylindrical to urceolate phialides consisting of venters and cylindrical collarettes, and endogenous, brown, septate, cylindrical



Fig. 3 (continued)

conidia with flattened or rounded end and formed in false chain. Adautomilanezia is clustered together with Sporoschisma as a strongly supported subclade (99/1), and this genus is also morphologically well-defined by the sporodochial conidiomata with sterile setae, sessile and globose conidiogenous cells with funnel-shaped collarettes, and ellipsoidal, brown and 3-septate conidia. Majority of other species included in this clade are the Chloridium-like fungi, and belong to the narrowly defined Chloridium s. str. The narrowly defined Chloridium s. str. as typified by the type species C. virescens is characterized by presence of setae, simple or branched conidiophores, terminal or lateral monophialidic conidiogenous cells bearing funnel-shaped collarettes with uni- or multisporulating loci, and hyaline or very pale brown, aseptate, globose, ellipsoid to cylindrical conidia in cirrhi or slimy heads. Two species of Chloridium s. str., C. virescens and C. caesium, are known with teleomorphs characterized by perithecial ascomata, unitunicate asci with 8 uniseriate or obliquely uniseriate spores, and hyaline, uniseptate, fusiform ascospore (Gams and Holubová-Jechová 1976).

Clade 17 represents the genera *Ellisembia* and *Lomaantha*. *Lecythothecium duriligni* and *Pyrigemmula aurantiaca*, the type species of the two genera (*Lecythothecium* and *Pyrigemmula*) are clustered together with other *Ellisembia* as a strongly supported linkage, thus the two genera are merged with *Ellisembia*. Morphologically all these species are *Sporidesmium*-like fungi (Réblová and Winka 2001; Wu and Zhuang 2005; Magyar et al. 2011). The teleomorphs were reported for two species, *E. aurea* and *L. duriligni*, both are with fusiform to ellipsoid, multiseptate and versicolored ascospores (Réblová and Winka 2001; Magyar et al. 2011).

Clade 18 represents the genera Fuscocatenula and Chaetosphaeria s. str., Chaetosphaeria mangrovei, and one unnamed fungus with Chloridium-like morphology. The asexually typified Fuscocatenula resembles Catenularia



Fig. 3 (continued)

but differs in having obclavate conidia without corners. *Chaetosphaeria innumera*, the type species of the genus *Chaetosphaeria*, is clustered together with its *Chloridium botryoideum* anamorph in *Chloridium* section *Psilobotrys* (Gams and Holubová-Jechová 1976). The teleomorphs in *C. innumera* and *C. mangrovei* (no anamorph known) are with fusiform, ovoid-fusiform, hyaline, septate ascospore without mucilaginous sheath or appendage (Gams and Holubová-Jechová 1976; Hyde et al. 2018).

Clade 19 represents the genus *Verhulstia*, an asexually typified genus with sporodochial conidiomata. Three new species, *V. biformis*, *V. elegans* and *V. minima* are introduced.

Clade 20 represents *Chaetosphaeria lentomita*, *Chloridium lignicola* and *Chloridium pini*. The teleomorph, known only in *C. lentomita*, is with fusiform, hyaline and uniseptate ascospores with finely roughened wall. The anamorphs of these three species are *Chloridium* section *Gongromeriza* (Gams & Holubová-Jechová 1976).

Clade 21 represent the genera Lunatochaeta, Phaeostalagmus, Sporendocladia, and three species of Chaetosphaeria s. lat. The new genus Ejnerjensenia is introduced for C. *myriocarpa* (anamorph known as *Chloridium clavaeforme*) and Chaetosphaeria pygmaea (anamorph known as Phialophora phaeophora), both with anamorphs producing monophialidic conidiogenous cells with flaring or vase- or funnelshaped collarettes, and hyaline, aseptate and short cuneate or dacryoid conidia in Chloridium section Gongromeriza (Gams & Holubová-Jechová 1976). Lunatochaeta is introduced for a fungus which is morphologically similar to Dictvochaeta s. str. but phylogenetically distinct. Chaetosphaeria guttulata is unique in producing polyblastic and non-phialidic conidiogenous cells bearing many tiny protuberant conidiogenous loci and hyaline septate conidia (Luo et al. 2019).

Clade 22 represents two strains of *Chloridium botryoideum* var. *minutum*. Their taxonomic position needs to be further studied.



Fig. 3 (continued)

Clade 23 represents thirteen species of Achrochaeta, Craspedodidymum, Chaetosphaeria s. lat., Kionochaeta, and two new genera, Brachydictyochaeta and Neotainosphaeria. The ITS and LSU sequences were for the first time generated for the type species of *Craspedodidymum*, C. elatum, and the genus is phylogenetically assigned to the family Chaetosphaeriaceae. New genera are established for two strongly supported linkages, Brachydictyochaeta for two species of Dictyochaeta-like fungi but producing sterile setae with swollen apex, and phialides directly formed from setae or superficial hyphae; Neotainosphaeria for an unnamed fungus with solitary conidiophores, terminal monophialidic conidiogenous cells bearing cylindrical collarette, and hyaline, globose, aseptate conidia with one short setulae. Two species of Chaetosphaeria s. lat., C. dilabens and C. hebetiseta, both with Chloridium-like anamorph and hyaline, fusiform and septate ascospores, probably represent two different genera (Réblová and Gams 2000). Achrochaeta is a holomorphic genus with ellipsoidal to ellipsoidal-fusiform and transversely septate ascospore and Dictyochaetalike anamorph but without setae (Réblová et al. 2020). Brachydictyochaeta, Craspedodidymum, Kionochaeta and *Neotainosphaeria* are asexually typified genera, and no teleomorph has been known.

Clade 24 represents the genus *Dictyochaeta* s. str. as emended by Réblová et al. (2021c). Morphologically the genus is characterized by presence of sterile or fertile setae, short but well-developed conidiophores in small group and associated with setae at the base, terminal phialidic conidiogenous cells with funnel- or cylindrical-collarettes, and hyaline, falcate, clavate to fusiform, usually asymmetrical conidia bearing no setulae.

Clade 25 represents the genera *Eucalyptostroma* and *Paliphora*. These two genera are morphologically very different, i.e., sporodochial conidiomata, phialidic conidiogenous cells, and hyaline, aseptate, fusiform conidia in *Eucalyptostroma*, and solitary and setiform conidiophores, intercalary conidiogenous cells with sporulating pore, and hyaline, septate, cylindrical to fusiform conidia in *Paliphora*. Both genera are asexually typified, and no teleomorph has been known.

Clade 26 represents two new sporodochial genera, *Eucalyptostromiella* and *Pseudothozetella*. *Eucalyptostromiella* is characterized by fresh-yellow colored sporodochia,



Fig. 3 (continued)

flask-shaped phialidic conidiogenous cells, and hyaline, aseptate, falcate or lunate conidia in slimy and fresh-yellow mass. *Pseudothozetella* is characterized by dark brown sporodochia with white slimy spore mass, cylindrical phialidic conidiogenous cells, and hyaline, aseptate, falcate or lunate conidia in. Both genera are asexually typified and monotypic.

Clade 27 represents the genus *Xyladelphia* and *Dicty-ochaeta brevis*. *Xyladelphia* is phylogenetically and morphologically well-delimitated holomorphic genus characterized by setose perithecial ascomata, and hyaline, aseptate or transversely septate, broadly fusiform to ellipsoidal ascospore without gelatinous sheath or appendage as teleomorph; and presence of sterile setae with darker ultimate or penultimate cells, several shorter conidiophores associated with setae at base, terminal mono- or poly-phialidic conidiogenous cells bearing funnel-shaped collarettes, and hyaline, aseptate, falcate, multiguttulate, asymmetrical or symmetrical conidia with or without setulae as anamorph. *Dictyochaeta brevis* differs from the species of *Xyladelphia* in lacking versicolored setae and eguttulate conidia (Lin et al. 2019).

Clade 28 represents the genera Aunstrupia, Linkosia, Morrisiella, Riisgaardia and Kionochaetiella. Except for Kionochaetiella, they are Sporidesmium-like fungi and welldefined genera in both morphology and phylogeny. Aunstrupia and Riisgaardia are introduced as two new genera. None of these genera are with known teleomorph. Kionochaetiella is introduced as a new genus for Kionochaeta ivoriensis, which is morphologically similar to but phylogenetically distinct from other Kionochaeta species (Kirk and Sutton 1985).

Clade 29 represents the genera *Cryptophiale*, *Cryptophialoidea*, *Paracryptophiale* and *Paraceratocladium* s. str. Morphologically these genera are similar in producing setae or setiform conidiophores, lateral or intercalary conidiogenous cells, and hyaline, usually falcate, obclavate, aseptate or septate conidia with or without apical appendage and produced in slimy mass, but differs in arrangement of conidiophores and conidiogenous cells, and conidial septation. Phylogenetically *Cryptophiale* and *Cryptophialoidea* were not resolved as monophyletic genera and remains to be studied by inclusion of additional marker genes and more species. No teleomorph is known for these genera.

Paraceratocladium polysetosum forms an independent linkage unrelated to the type species *P. silvestre* of the genus and other fungi with lateral phialides. The new genus *Paraceratocladiella* is introduced for *P. polysetosum* which morphologically also differs from *Paraceratocladium* in branched setae, hyphae-like conidiophores adhering and twining around the setae and bearing intercalary conidiogenous cells and spike-like structure, and hyaline, uniseptate, cylindrical conidia.

Clade 30 represents the genera *Nawawia* and *Zanclospora*. They are morphologically well-delimitated genera in conidiophores, conidiogenous cells and conidia. The monophyletic genus *Zanclospora* was recently emended and revised by Réblová et al. (2021a). *Nawawia* is an asexually typified genus. *Zanclospora* is a well-defined holomorphic genus characterized by fusiform, or broadly ellipsoidal, hyaline, septate ascospore, and setiform conidiophores bearing lateral phialides, and hyaline, aseptate, falcate, almost houseshoe-shaped, obovoid, occasionally bacilliform conidia formed a slimy mass.

The holomorphic fungus *Chaetosphaeria minuta* is clustered together with *Zanclospora* but not strongly supported in the phylogenetic analysis. Morphologically it is similar to *Zanclospora* in setiform conidiophores, lateral phialides, and hyaline, aseptate conidia, but differs in unilateral phialides produced along the midsection and aseptate ascospores. The new genus *Zanclosporiella* is created for this fungus.

Chaetosphaeria luquillensis, another holomorphic fungus with unique morphology, is clustered together with clade 19 to 30 but as unrelated linkages. Morphologically this fungus is unique in producing hyaline, fusiform, one-septate, sometimes two or three-septate ascospore covered with a gelatinous sheath, and *Dictyochaeta* s. str.-like anamorph but with obclavate and septate conidia (Fernández and Huhndorf 2005). Combined morphological and phylogenetic analysis, a new genera *Aciculadictyochaeta* is introduced for this fungus.

Clade 31 includes all species of *Cacumisporium*, *Catenularia*, *Ericiosphaeria*, *Exserticlava*, *Paragaeumannomyces* (include *Obeliospora minima*), *Stanjehughesia*, *Stephembruneria*, and some diversified *Chaetosphaeria* species. Several strongly supported subclades and linkages are formed within this clade, each probably represents a different genus.

One of the strongly supported subclades represents all known species of *Paragaeumannomyces*, *Obeliospora minima*, *Chaetosphaeria chalaroides* and the recently established monotypic genus *Ericiosphaeria*. The monophyletic genus *Paragaeumannomyces* was recently emended and revised with 12 accepted species known as *Chaetosphaeria* species with scolecospore ascospore (Huhndorf and Fernández, 2005; Réblová et al. 2020, 2021a). The genus is characterized by the scolecospore ascospore, and unique anamorphs if present characterized by the reduced conidiophores, bulb-shaped conidiogenous cells with flared funnel-shaped collarettes, and hyaline, aseptate, cuneiform-shaped conidia with 3–4 corners from top view, and sometime each corner bearing one simple setulae. One isolate of *Obeliospora minima* is included in the analysis and it is clearly grouped together with all other species of *Paragaeumannomy-ces* in the same clade, thus it is transferred to the genus *Paragaeumannomyces*.

Another strongly supported sub-clade includes five species of *Exserticlava*, *Stephembruneria* and *Stanjehughesia* s. str. The anamorphs of these fungi are with colored and septate conidia from terminal phialidic conidiogenous cells of the conidiophores (Réblová and Seifert 2003; Fernández and Huhndorf, 2005). Except for *Stephembruneria*, the teleomorph and anamorph connections have been established for all included species in *Exserticlava* and *Stanjehughesia hormiscioides*, and the ascospore are fusiform, septate and versicolorous for all of them. The type species of *Stanjehughesia*, *S. hormiscioides* (= *Chaetosphaeria caesariata*), is a member of this clade and unrelated to other *Sporidesmium*-like fungi.

The holomorphic fungus *Chaetosphaeria fusiformis*, characterized by the fusiform, hyaline, 3-septate ascospores and the *Chloridium cylindrosporum* anamorph, forms an independent linkage. Based on its unique morphological characters and phylogeny, the new genus *Fusichloridium* is created. The *Chloridium cylindrosporum* anamorph is characterized by the presence of fertile setae with terminal conidiogenous cells, the grouped conidiophores in association with setae at the base, discrete polyphialidic conidiogenous cells with percurrent proliferation and funnel-shaped collarettes, and hyaline, aseptate, cylindrical conidia usually centrally constricted (Gams and Holubová-Jechová 1976; Réblová and Gams 1999).

The asexually typified fungus *Chaetosphaeria aquatica* also forms a separate linkage in this clade. The new genus *Phaeodischloridium* is established and characterized by producing solitary conidiophores, terminal mono-phialidic conidiogenous cells extending percurrently and with broad sporulating loci and inconspicuous collarettes, and ellipsoid, cylindrical, 3-septate, versicolorous conidia.

Two *Chaetosphaeria* species, *C. catenulata* and *C. cubensis*, both with colored, aseptate and cuneiform conidia with 3–5 corners from top view, are grouped together as a strongly supported subclade unrelated to the type species of *Chaetosphaeria*. The anamorphic name *Catenularia* was adapted as generic name, and emending and revision of the genus was provided by Réblová et al. (2021d). *Chalarodes* also belongs to this subclade.

Several other species of *Chaetosphaeria*, including *C. fennica*, *C. lignomollis*, *C. metallicans*, *C. curvispora*, *C. cylindrospora* and *C. conirostris*, also form different leakages unrelated to the type species of *Chaetosphaeria*.

Morphologically they are diverse, and revision is needed to determine their taxonomic positions. Here two new genera, *Curvichaeta* and *Kylindrochaeta* are created for *Chaetosphaeria curvispora* and *C. lignomollis* respectively.

Finally, *Neonawawia malaysiana* seems to be unique in Chaetosphaeriaceae and forms an independent linkage unrelated to any other clades in the family Chaetosphaeriaceae. Morphologically it is similar to *Nawawia*, with reduced conidiophores, monophialidic conidiogenous cells with broad collarettes, and hyaline, aseptate, cuneiform-shaped conidia bearing one setulae at each of corner on top of the conidia.

Morphology of non-phialidic chaetosphaeriaceous fungi

Among the known anamorphs of chaetosphaeriaceous fungi, only a few genera and species are known with non-phialidic conidiogenous cell and holoblastic conidia. All these anamorphs are *Sporidesmium*-like fungi, except for *Paliphora* Sivan. & B. Sutton, and their teleomorphs, if known, are with multiseptate and versicolor ascospores (Shoemaker and White 1985; Subramanian 1992, 1995; Réblová 1999a; Réblová and Winka 2001; Magyar et al. 2011; Seifert et al. 2011; Hyde et al. 2019; Luo et al. 2018, 2019; Hsieh et al. 2021; Réblová et al. 2021b).

For the Sporidesmium-like anamorph, they are diverse in conidiomata, conidiophores and conidia, and the detailed description and discussion can be found in previous publications (Ellis 1971, 1976; Wu and Zhuang 2005; Seifert et al. 2011; Réblová et al. 2021b). The synnematous conidiomata are only found from Morrisiella Saikia & A.K. Sarbhoy and Falholtia W.P. Wu & Y.Z. Diao, while the conidiophores in most other genera are solitary or in groups. The conidiophores can be well-developed, or reduced to sessile conidiogenous cells (Fig. 4). The pigmented conidia are various in shape, being cylindrical, sub-cylindrical, fusiform, ellipsoidal, obclavate, rostrate; their septation can be euseptate or distoseptate (Fig. 5). In some species, the conidia are with germinating pore. The morphology of conidiophores and conidia are used for distinguishing different species.

Paliphora is very special among the chaetosphaeriaceous anamorphs in producing solitary, unbranched setiform conidiophores with sterile apex and intercalary conidiogenous cells bearing sporulating pores, from which the cylindrical to fusiform conidia are produced (Sivanesan and Sutton 1985; Kuthubutheen 1987c; Alcorn 1996; Gusmão et al. 2008; Goh et al. 2014b; Malosso et al. 2017).

Chaetosphaeria guttulata is also unique among the chaetosphaeriaceous fungi in producing non-phialidic conidiogenous cells bearing many tiny protuberant conidiogenous loci and hyaline septate conidia (Luo et al. 2019).

Morphology of phialidic chaetosphaeriaceous fungi

Most of the anamorphic chaetosphaeriaceous fungi with phialidic conidiogenous cells are hyphomycetes, however 8 coelomycetous genera are also assigned to the family (Lin et al. 2019; Luo et al. 2019). Morphological characters of conidiomata, conidiophores, conidiogenous cells, and conidia are important in identification of these fungi (Sutton 1980a, b; Nag Raj 1993; Réblová et al. 1999; Réblová and Winka 2000; Fernández et al. 2006; Seifert et al. 2011; Hashimoto et al. 2015a, b; Liu et al. 2016; Wijayawardene et al. 2016; Lin et al. 2019; Luo et al. 2019).

Conidiomata

The conidiomata of anamorphic chaetosphaeriaceous fungi are diverse and vary in form from acervuloid to cupulate, sporodochial and synnematous, and solitary or grouped conidiophores (Kendrick 1980; Sutton 1980a, b; Nag Raj 1993; Seifert et al. 2011; Hashimoto et al. 2015a, b; Lin et al. 2019; Luo et al. 2019).

Acervuloid to cupulate conidiomata (Fig. 6), usually superficial, globose to navicular, unilocular, with variable excipular development and adorned with sterile hyphae or setae, are formed from most known coelomycetous genera of chaetosphaeriaceous fungi, including Brunnepdinemasporium Crous & R.F. Castañeda, Calvolachnella Marinc., T.A. Duong & M.J. Wingf., Dendrophoma Sacc., Dinemasporium Lév., Infundibulomyces Plaingam, Somrith. & E.B.G. Jones, Neopseudolachnella A. Hashim. & Kaz. Tanaka, Pseudodinemasporium A. Hashim. & Kaz. Tanaka, Pseudolachnea Ranoj. and Pseudolachnella Teng (Sutton 1980a, b; Nag Raj 1993; Plaingam et al. 2003; Somrithipol et al. 2008; Crous et al. 2012; Hashimoto et al. 2015a, b; Hernández-Restrepo et al. 2016). Basal stroma of these cupulate conidiomata are usually well-developed, of textura angularis or epidermoidea, cells thick-walled, brown, pale brown or subhyaline, cells bordering the lateral wall becoming darker and thicker; lateral excipulum hardly exist or well-developed and usually consisting of cells of textura porrecta, cells thin- or thick-walled, pale brown to brown, marginal cells becoming darker (Sutton 1980a, b; Nag Raj 1993; Hashimoto et al. 2015a, b). In Infundibulomyces, the basal stroma is poorly developed and lateral excipulum consisting of textura prismatica with a single cell layer, appearing nidulariaceous (Plaingam et al. 2003; Somrithipol et al. 2008). In Brunnepdinemasporium, Dendrophoma, Dinemasporium, Neopseudolachnella, Pseudolachnea and Pseudolachnella, the conidiomata are usually associated with setae, which are dark brown, septate, with acute or obtuse tips, and restricted to the basal part of the lateral walls. While in Calvolachnella and Infundibulomyces, no setae are formed in conidiomata.

Sporodochial conidiomata (Fig. 7), with superficial pulvinate stroma supporting conidiophores or conidiogenous cells on its upper surface and not covered by the substrate, usually with a basal stroma, were found from several genera, including Adautomilanezia, Eucalyptostroma, Minimidochium, Rattania, Pseudothozetella, Thozetella and Verhulstia (Sutton 1980a, b; Nag Raj 1993; Seifert et al. 2011; Crous et al. 2016; Hernández-Restrepo et al. 2016). In *Minimidochium*, Rattania and Verhulstia, the sporodochia are usually associated with setae, which are dark brown, septate, with acute or obtuse tips, and arising from basal stroma (Sutton, 1969; Prabhugaonkar and Bhat 2009). In Thozetella, the sterile element microawns in various shapes is produced from conidiogenous cells in most species (Pirozynski and Hodges 1973; Sutton and Cole 1983; Monteiro et al. 2016, 2019). In all these genera, the conidia are embedded in wet spore mass covering the upper part of sporodochia.

Synnematous conidiomata (Fig. 7), consisting of a compacted group of erect and fused hyphae, the apices and occasionally intercalary cells of which function as conidiophores and conidiogenous cells, is the characteristics of several genera, including Conicomyces, Hoehniliella, Hyphopolynema, Menisporopsis, Phialoarthrobotryum, Phialosporostilbe, and some species of Codinaea, Dictyochaeta, and Thozetella (Hughes and Kendrick 1968; Kuthubutheen 1987a; Mercado Sierra and Mena Portales 1985; Kuthubutheen and Nawawi 1991a, b; Shirouzu and Harada 2004; Seifert et al. 2011; Granados et al. 2014; Lin et al. 2019). Among these genera, Conicomyces, Hyphopolynema, Menisporopsis, Arcuatospora and Phialosporostilbe produce synnemata with setae, which are formed from out layers or basal stroma of the synnemata, same as the conidiophores. The synnematous conidiomata in Conicomyces and Hoehneliella are cupulate, and for this reason, these two genera have also been treated as coelomycetes (Illman and White 1985a, b; Okada and Tubaki 1986; Nag Raj 1993).

Setae and microawns

The sterile or fertile setae are commonly found in some genera and species among the anamorphic chaetosphaeriaceous fungi (Seifert et al. 2011). These setae are pale to dark brown in color, septate, and thin- or thick-walled, simple, or branched, and formed from hyphae or stroma. In most cases, the conidiophores and/or conidiogenous cells are associated with setae in different approaches, including in cluster, as branches, or directly from setae. The setae can be used for delimitation of genera and species (Figs. 7, 8, 9). In *Catenularia, Conicomyces, Dinemasporium, Hoehneliella, Menisporopsis, Minimidochium, Neopseudolachnea, Obeliospora, Paraceratocladium, Pseudodinemasporium, Pseudolachnea, Pseudolachnella, Rattania, Sporoschisma, and some species of <i>Chloridium* and *Dictyochaeta*, the setae are always sterile; while in *Cryptophiale*, *Cryptophialoidea*, *Dictyochaetopsis*, *Gonytrichum*, *Kionochaeta*, *Menispora*, *Paracryptophiale*, *Phialosporostilbe*, *Zanclospora*, and some species of *Chloridium*, *Codinaea* and *Dictyochaeta*, the setae are fertile as setiform conidiophores (Seifert et al. 2011; Luo et al. 2016).

Morphology of setae, including color, septation, location of fertile region, appearance of apex, varies a lot and in some cases, they can be used as one of the characters to define genus or species. For example, all species of *Sporoschisma* produce sterile setae usually called capitate hyphae with rounded apex covered by a mucilaginous sheath; the very characteristic structures of fertile region, including how the conidiophores and conidiogenous cells produced and arranged, can be used to distinguish *Kionochaeta*, *Cryptophiale*, *Cryptophialoidea*, *Paracryptophiale* and *Zanclospora* from other genera. This was further confirmed by our phylogenetic analysis and redelimitation of *Codinaea* s. lat. and *Dictyochaeta* s. lat.

Microawns, another type of sterile element, are the characteristics for the genus Thozetella (Agnihothrudu 1958; Pirozynski and Hodges 1973; Sutton and Cole 1983). The term microawn was proposed by Pirozynski and Hodges (1973) while reviewing *Thozetella* species, because these cells were described as awn-shaped cells in the descriptions of T. cristata, T. nivea, T. radicata and T. tocklaiensis (Pirozynski and Hodges 1973). They are cells produced by the conidiogenous cells, mixed and immersed in the conidial mass, hyaline, aseptate or septate, thin- or thick-walled, smooth or verruculose, and with different shapes, which are important for distinguishing the genus from others and also delimiting species within the genus (Sutton and Cole 1983; Sliva and Grandi 2013; Monteiro et al., 2016). New species described afterward were found to have many other forms of microawns including vermiform, clavate with coronate projections, Y-shaped, L-shaped, sigmoid-shaped (Barbosa et al. 2011; Sliva and Grandi 2013; Monteiro et al., 2016, 2016) (Fig. 10). The origin of microawns from the conidiogenous cells was confirmed in T. effusa and T. canadensis by Sutton and Cole (1983). They did not consider microawns to be reproductive structures and described these cells as arising from phialides. Speculations of microawn function include carrying the conidia for dispersal and acting as an obstacle for the animals that feed on conidia (Pirozynski and Hodges 1973; Waipara et al. 1996; Paulus et al. 2004).

Conidiophores

In all coelomycetous genera and some sporodochial hyphomycetous genera (Fig. 8), the conidiophores are pale brown to brown, branched or unbranched, arising from inner layer cells of cavity, terminated with 1 to several hyaline to very pale brown conidiogenous cells (Sutton 1980a, b; Nag Raj 1993; Luo et al. 2019).

23



Fig. 4 Conidiomata, conidiophores and conidiogenous cells of nonphialidic chaetosphaeriaceous fungi. **a** Synnemata of *Falholtia kaohsiungensis*. **b** Synnemata of *Morrisiella indica*. **c** Conidiogenous cells of *Stanjehughesia hormiscioides*. **d** Conidiogenous cells of *Riisgaardia longispora*. **e** Conidiophores and conidiogenous cells of *Ellisembia reblovae*. **f** Conidiogenous cells of *Linkosia gelatinosa*.

g Conidiophores and conidiogenous cells of Aunstrupia nodipes. h Conidiogenous cells of Morrisiella fusiformis. i Conidiophores and conidiogenous cell of Lomaantha pooga. j Conidiophores and conidiogenous cells of Falholtia kaohsiungensis. k Conidiogenous cells of Morrisiella indica. Scale bar: a, b 40 µm, c-g, i-k 10 µm, h 5 µm

In hyphomycetous genera with synnemata (Figs. 8, 9), the conidiophores are closely compacted group of erect and fused hyphae, the apices and occasionally intercalary cells of which function as conidiophores and conidiogenous cells. In some genera and species such as *Phialosporostilbe*, *Menisporopsis*, and some species of *Dictyochaeta* Speg. and *Codinaea* Maire the upper parts of the conidiophores are separated from each other; while in other species or genera such as some species of *Menisporopsis*, *Arcuatospora* and *Hyphopolynema*, they are always closely packed together.

In most other hyphomycetous genera (Figs. 8, 9), the conidiophores are macronematous or mononematous, brown, septate, straight, or slightly flexuous, solitary, or formed in clusters and arising directly from hyphae or basal stroma composed of dark brown and thick-walled cell. In many genera including Anacacumisporium, Bahusutrabeeja, Cacumisporium, Catenularia, Chloridium, Codinaea, Craspedodidymum, Dictyochaeta, Exserticlava, Multiguttulispora, Nawawia and Stephembruneria, the conidiophore are simple, unbranched, septate, cylindrical, brown and becoming paler towards the apex and terminated with apical conidiogenous cells (Figs. 11, 12). In Dictyochaetopsis, Menispora and Phaeostalagmus, the setiform conidiophores are with lateral conidiogenous cells forming directly from cell



Fig. 5 Conidia of non-phialidic chaetosphaeriaceous fungi. a Linkosia longispora. b Linkosia multiseptum. c Stanjehughesia larvata. d Stanjehughesia polypora. e Stanjehughesia hormiscioides. f Falholtia

sia hormiscioides. f Falholtia Ellisembia l

kaohsiungensis. g Linkosia fusiformis. h Linkosia gelatinosa. i Stanjehughesia curviapicis. j Ellisembia reblovae. k Aunstrupia nodipes. l Ellisembia brachypus. Scale bar: 10 µm for all



Fig. 6 Conidiomata of Dinemasporium, Pseudolachnea and Pseudolachnella. a Dinemasporium fusiformis. b Pseudolachnella tengii. c Dinemasporium longisporum. d Pseudolachnea macrospora. e D. ligongense. f D. sinensis. Scale bar: 20 µm

of conidiophores or lateral branches from which the terminal conidiogenous cells are formed (Réblová et al. 2006; Réblová and Seifert 2008). In some other genera, including *Cryptophiale, Cryptophialoidea, Kionochaeta, Paracryptophiale* and *Zanclospora*, the setiform conidiophores are simple or branched, and the closely packed conidiogenous cells forming the fertile regions in special part of the setiform conidiophores. In *Sporoschisma*, the conidiophores are solitary, each composed of a bulbous base, a cylindrical stipe, and a swollen venter, like those found in *Chalara*-like fungi. In *Paraceratocladium* and *Paraceratocladiella* the conidiophores are hyphae-like, the simple or branched setae are covered by anastomosing superficial hyphae functioned as conidiophores, which are smooth, septate, thin-walled, and bearing intercalary conidiogenous cells.

Conidiogenous cells and conidiogenesis

The conidiogenous cells are phialidic in majority of known anamorphic chaetosphaeriaceous fungi (Cole 1986; Sutton 1986; Magyar et al. 2011; Seifert et al. 2011; Lin et al. 2019; Luo et al. 2019; Hyde et al. 2020). Only a few genera are with other types, the conidiogenous cell with a solitary terminal pore in *Pyrigemmula* (Magyar et al. 2011), intercalary conidiogenous cells with pore in *Paliphora* (Sivanesan and Sutton 1985; Kuthubutheen 1987c; Alcorn 1996; Gusmão et al. 2008; Goh et al. 2014b; Malosso et al. 2017); and terminal holoblastic in *Ellisembia* and *Lecythothecium* (Hughes 1953, 1958; Réblová and Winka 2000; Seifert et al. 2011; Lin et al. 2019).

Same as in other fungi with phialidic conidiogenous cells (for examples *Colletotrichum*, *Aspergillus*, *Fusarium*, *Penicillium*, *Trichoderma*), the phialidic anamorphic chaetosphaeriaceous fungi produce conidia by inside wall building and in rapid basipetal succession from the open end of special conidiogenous cells called phialides (Fig. 12). The phialidic conidiogenous cells can be terminal (*Anacacumisporium*, *Cacumisporium*, *Chloridium*, *Dictyochaeta*, *Sporoschisma* and many other genera), intercalary (*Paraceratocladium*, *Paliphora*) or lateral (*Cryptophiale*, *Cryptophialoidea*, *Dictyochaetopsis*, *Zanclospora*) (Fig. 12).

Shapes of phialides are ampulliform, cylindrical, lageniform or ellipsoidal. They are straight, except for some species of *Menispora* and *Menisporopsis*, where the apex of phialide curved strongly downwards towards the main stipe



Fig. 7 Conidiomata of phialidic chaetosphaeriaceous fungi. a-c Sporodochial conidiomata in *Thozetella asetulata* (Wu12089, a), *Menisporopsis dinemasporium* (Wu12102, b) and *Adautomilanezia*

caesalpiniae (Crous et al. 2016, c). **d–f** Synnemata of *Phialosporostilbe setosa* (Wu12420, **d**), *Arcuatospora sinensis* (Wu12237, **e**), *Menisporopsis elegans* (Wu12183, **f**)

(Huhndorf and Fernández 2005; Réblová et al. 2006). They can be hyaline, pale brown to dark brown, thin- or thick-walled, smooth- or rough-walled with different decoration on the cell wall. These characters together with others are also used for distinguishing taxa in genera and species.

The phialide can be monophialidic with a single apical collarette or polyphialidic with several collarettes. The open end of the phialides can be rather simple, seen as a narrow or wide opening without collarette, or being well-developed collarette in funnel shapes. The funnel-shaped collarettes in some species, especially those with several collarettes in the same phialide, easily break out and are carried away by conidia, this left the conidiogenous cells as non-phialidic and sympodial appearance as seen in *Multiguttulispora*, and some *Dictyochaeta* species with big spore. The phialides in *Sporoschisma* and *Sporendocladia* are somewhat special, where they are subcylindrical to urceolate, composed of a subcylindrical to ellipsoidal venter and a narrower, cylindrical or more or less tubular, open ended collarette, and the

conidia are endogenous inside the tubular collarettes and extruded in phase chain (Nag Raj and Kendrick 1975; Minter et al. 1983; Huhndorf and Fernández 2005; Fernández, et al. 2006). In most genera and species, the phialides don't change in length while producing many successive conidia, though many wall layers build up inside the open end of the cell. However, in some species of *Anacacumisporium*, *Bahusutrabeeja*, *Cacumisporium*, *Chloridium* and *Exserticlava*, signification elongation of the sporulating region happens during the sporulating process to form thin-walled extension structures (Goos 1969a, b; Bhat 1994; Réblová 2000; Tsui et al. 2001b; Fernández et al. 2006). In most of these cases, multisporulating loci are connected. Annellidic extension was also observed in some species of *Chloridium*.

Sympodial extension of conidiogenous cells also happens in many species of the chaetosphaeriaceous fungi, this is because the accumulation of wall layers after rapid basipetal succession may eventually plug the opening, and in phialides to which this happens there is a tendency to produce



Fig. 8 Conidiomata of phialidic chaetosphaeriaceous fungi. a Conidiophores formed in cluster from basal stroma in *Catenularia elegans* (Wu6078). b Conidiophores and capitate setae with mucilaginous apex from basal stroma in *Sporoschisma phaeocentron* (Luo et al. 2016). c Conidiophores and setae in clusters from basal stroma in *Stilbochaeta lunata*. d Single conidiophores with percurrent proliferation in *Catenularia cubensis*. e Conidiophores adhering and twining around the setae in *Paraceratocladium silvestre*. f Setiform conidi-

sympodial extensions that develop new fertile apertures. Such phialides are called polyphialides since they have more than one conidiogenous locus.

In all coelomycetous genera and some sporodochial hyphomycetous genera, the conidiophores are mainly hyaline to pale brown, branched or unbranched, arising from inner layer cells of cavity, terminated with one to several hyaline to very pale brown conidiogenous cells (Sutton 1980a, b; Minter et al. 1983; Nag Raj 1993; Li et al. 2020).

Ultrastructural studies on conidial anatomy and conidiogenesis were studied for a few phialidic chaetosphaeriaceous fungi by electron microscopy, and these species, including *Chloridium chlamydosporium, Cacumisporium capitulatum, Codinaea setosa, Gonytrichum macrocladum, Phialocephala humicola* and *Sporoschisma nigroseptatum*, represented different conidium ontogenies (Hammill 1972; Gams and Holubová-Jechová 1976; Onofri et al. 1994; Ho et al. 1998). Conidium ontogeny has been used for phylogenetic analysis among genera of the family and also used for delimitation of genera, subgenera and species within the family (Gams and Holubová-Jechová 1976; Réblová and Winka 2000; Fernández et al. 2006). ophores with dichotomously branched towards the apex and generally above the fertile region, consisting of two rows of phialides one on each side of the conidiophore with each cell narrowly ellipsoid, covered by sterile shield cells in *Cryptophiale udagawae*. **g** Setiform conidiophores with fertile region restricted to middle part and conidiogenous cells adpressed to the fertile region, formed just below the distal septa of cells, and arranged in verticils in *Zanclospora brevispora*

In Chloridium chlamydosporium, a collarette is formed by rupture of an electron-dense, outer wall layer of tip of phialides. An electron-transparent inner wall layer blow out into a conidium initial which after expansion is delimited by a septum. Then a new conidium develops to one side of the previously delimited conidium. Conidia are therefore not produced concurrently from within the collarette, but are produced sequentially and sympodially (Hammill 1972). Scanning electron and interference contrast microscopy of conidiogenesis in Phialocephala humicola (now transferred into Chloridium in this work) revealed a replacement wall building development type with a peculiar disposition of conidia at the apex of the conidiogenous cell, a pattern of conidiogenesis similar to the one described for Chloridium chlamydosporum, was proposed by Onofri et al. (1994). In Sporoschisma nigroseptatum (Ho et al. 1998), the development of the conidial chain involves endogenous conidial ontogeny, apical wall-building, and retrogressive conidial delimitation followed by cessation of apical wall-building, then replacement ring wall-building of additional retrogressively delimited conidia, and extrusion of the true conidial chain through the terminal aperture of the conidiogenous



Fig. 9 Conidiomata of anamorphic chaetosphaeriaceous fungi. **a** Setiform conidiophores with sterile apex and fertile region in *Kionochaeta beijingensis*. **b** Setiform conidiophores with secondary branches bearing conidiogenous cells in *Gonytrichum macrocladum*. **c** Setiform conidiophores with lateral branches bearing conidiogenous

cell. Maturation of conidia involves deposition of two inner wall layers and formation of five distosepta. Conidial chains secede schizolytically. No proliferation of the conidiogenous cell occurs and the conidium is delimited by a cross wall that is discontinuous with the periclinal wall. Each conidium has polar plug- and socket-like structures that are interlocked between adjacent conidia along the conidial chain. Similar plug- and socket-like structures are also seen in other *Sporoschisma* species.

Conidia

Conidia of anamorphic chaetosphaeriaceous fungi display the greatest variation in shape, color, septation and appendage, and are useful characters for identification of genera and species. The different types of conidia encountered in these fungi are illustrated in Figs. 13 and 14.

In conidial shape and septation, large variation, from amerosporous, didymosporous, phragmosporous, dictyosporous (only in *Paracryptophiale*) or scolecosporous, can be found from different genera and even among species within same genus (Sutton 1980a, b; Kuthubutheen and Nawawi 1991a, b, c, d, e; Nag Raj 1993; Whitton et al. 2000, 2001; Seifert et al. 2011). The distoseptate conidia is only found in *Exserclavata*, while all other genera are aseptate or euseptate conidia (Seifert et al. 2011). Many different conidial shapes can be found among

cells in *Menispora* sp. **d** Conidiophores with branches and conidiophores at the apex in *Sporendocladia beijingensis*. **e** Capitate hyphae in *Monosporoschisma elegans*. **f** Capitate hyphae and conidiophores in *Sporoschisma mirable*. g. Sterile setae in *Xyladelphia parapulchriseta*

the chaetosphaeriaceous fungi, including globose, ellipsoid, cuneiform, pyramidal, fusiform, falcate, cylindrical, filamentous, star-shaped. For some genera, especially most monotypic genera, the conidial shape and septation are used as one of diagnosis characters of the genus. For example, all species of Catenularia have aseptate and cuneiform-shaped conidia; all species of Phialosporostilbe have aseptate and round-tetrahedral to pyramidal conidia with 3 protuberant corners each corner furnished with one setula and base slightly truncate to rounded with one setula. On the other hand, in most of other genera including Codinaea, Dictyochaeta, Chloridium, Craspedodidymum, Cryptophiale, and Pseudolachnella, the conidial shapes and septation vary a lot among different species in the same genus. For example, the conidial shapes in Dictyochaeta can be falcate, fusiform, globose, and ellipsoidal; the conidial septation can be aseptate, uniseptate, to multiseptate. In conidial septation, euseptate conidia are found from almost all species with septate conidia, except for Exserticlava with distoseptate conidia (Hughes 1978; Seifert et al. 2011).

Majority of the known genera in the family produces hyaline spores in various shape and septation, including Bahusutrabeeja, Brunneodinemasporium, Chloridium, Codinaea, Conicomyces, Cryptophiale, Cryptophialoidea, Dendrophoma, Dictyochaeta (except for a few species), Dictyochaetopsis, Dinemasporium, Eucalyptostroma, Hyphopolynema, Infundibulomyces, Kinochaeta, Menispora,



Fig. 10 Morphology of microawns in *Thozetella* species. **a** *T. acerosa.* **b** *T. hunanensis.* **c** *T. fabacearum.* **d** *T. asetula.* **e, f** *T. fanglanii.* **g** *T. guozhongii.* **h, j** *T. japonica.* **i** *T. longispora.* Scale bar: 5 μ m

Menisporopsis, Multiguttulispora, Nawawia, Neopseudolachnella, Paraceraclodium, Paracryptophiale, Phaeostalagmus, Pseudodinemasporium, Pseudolachnea, Pseudolachnella, Rattania, and Zanclospora. While the rest genera, including Adautomilanezia, Anacacumisporium, Calvolachnella, Catenularia, Craspedodidymum, Exserticlava, Phialoarthrobotryum and Sporoschisma, are with pigmentated conidia which can be subhyaline, pale brown to dark brown. Many species among these fungi produce conidia with tubular appendage, which can be single to multiple, branched or unbranched, bipolar and/or lateral. These genera include Anacacumisporium, Bahusutrabeeja, Brunneodinemasporium, Calvolachnella, Codinaea, Dendrophoma, Dictyochaeta, Dictyochaetopsis, Dinemasporium, Hyphopolynema, Infundibulomyces, Menispora, Menisporopsis, Multiguttulispora, Nawawia, Neopseudolachnella, Phialosporostilbe, Pseudodinemasporium, Pseudolachnea, Pseudolachnella, Rattania and



Fig. 11 Conidiogenous cells and conidiogenesis of anamorphic chaetosphaeriaceous fungi. a Sporoschisma nigroseptatum. b Catenularia elegans. c Cacumisporium capitulatum (public domain) d Catenularia cubensis. e Craspedodidymum cubense. f Phialogeniculata gua-

Thozetella. Other type of appendages is rarely found in these fungi, except for *Brunneodinemasporium jonesii* with mucilaginous balls at the conidial ends to connect the conidia in short false chains (Lu et al. 2016). These appendages are very often used as useful character to delimit genera and species.

In all the coelomycetous genera of the anamorphic chaetosphaeriaceous fungi, the conidia are produced in slimy within the conidiomata, and adhering material can be seen when making slide preparation. This is also true for all sporodochial and synnematous genera such as Conicomyces, Eucalyptostroma, Hoehneliella, Minimidochium, Phialosporostilbe, Rattania, and Thozetella. In hyphomycetous genera, it is also very common that the conidia are produced in slimy and adhering to the fertile region, as seen in Chloridium, Codinaea, Cacumisporium, Dictvochaetopsis, Gonvtrichum, Kionochaeta, Menispora, Menisporopsis, Nawawia and Paraceratocladium. In some species, the conidia are produced in false chains as seen in Sporoschisma, Sporendocladia, some species of Chloridium, Catenularia. For those species with dark spore or hyaline spore in big size, such as Anacacumisporium, Catenularia, Craspedodidymum, Stephembruneria, the conidia are usually not produced in slimy.

dalcanalensis (Luo et al. 2019). **g** Tainosphaeria cupulata. **h** Tainosphaeria phialogeniculata. **i** Stephembruneria elegans. **j** Catenularia sp. **k** Xyladelphia sinensis. **l** Chloridium jinghongense. **m** Chloridium culmicola. **n** Parabahusutrabeeja minima

Production of microconidia were reported in several genera and species, especially in pure culture (Fernández and Huhndorf 2005; Fernández et al. 2006; Crous et al. 2011; Hashimoto et al. 2015b). For example, Fernández and Huhndorf (2005) described both macroconidia and microconidia in *Chaetosphaeria longiseta* and *Tainosphaeria crassiparis*; Hashimoto et al. (2015b) reported the production of microconidia on natural substrate in *Neopseudolachnella unseptata*, *Pseudolachnea fraxini*, *Pseudolachnella asymmetrica* and *Pseudolachnella longiciliata*. In our study, we also observed the microconidia production in *Menisporopsis* sp., *Phialosporostilbe setosa* and *Pseudolachnella minima* on natural substrates.

Pure culture

Conidia or ascospores of many chaetosphaeriaceous fungi are usually easy to germinate and pure culture can be obtained. Those with hyaline spore such as *Codinaea*, *Dictyochaeta*, *Chloridium*, *Menisporopsis*, *Dinemasporium* and *Pseudolachnea* are usually easy to be cultivated and grow relatively fast on PDA. We also observed that spores of some



Fig. 12 Conidiogenous cells and conidiogenesis of anamorphic chaetosphaeriaceous fungi. a Arcuatospora sinensis. b Multiguttulispora dimorpha. c Adautomilanezia caesalpiniae (Crous et al. 2016). d–e Obeliospora minima. f Cryptophialoidea fasciculata. g Zanclospora

genera and species were difficult to germinate or took long time to germinate under current condition. For example, we failed to obtain living strains from many specimens of *Catenularia*, pure cultures were obtained only from small portions of studied specimens of *Obeliospora* and *Sporoschisma*. The growth rate of these fungi are very different, some grow fast (for example, most species of *Codinaea*, *Dinemasporium*), while other grow very slow (for example, most species in *Ellisembia*, *Stanjehughesia*, *Sporoschisma*).

Colony of these fungi on artificial media, including growth rate, superficial hyphae, pigmentation etc., varies a lot among different species within a genus and among different genera in the family (Figs. 16–17). They have some value in distinguishing different species within a genus. Sporulation often occurs on laboratory media from freshly obtained strains, and broader variations on conidiomata, conidiophores and conidia were seen within the species.

Anamorph and teleomorph connection in Chaetosphaeriaceae

Among the 89 accepted genera in Chaetosphaeriaceae, only 17 genera are with teleomorph and anamorph connection established for at least one species within the genus, while a large number of genera are known with only anamorphs

iberica (Hernandez-Restrepo et al. 2017). **h** *Cryptophiale fruticetum.* **i** *Gonytrichum mirable.* **j** *Menispora paraciliata.* **k** *Paraceratocladium silvestre.* **l** *Phaeostalagmus minimus.* **m** *Sporendocladia beijingensis*

(Borowska 1986; Dennis 1986; Constantinescu et al., 1995; Heredia-Abarca et al. 1995, 1997a, b; Okada et al. 1997; Réblová 1998a, b, 1999a, b, 2000, 2004, 2014; Réblová et al. 1999, 2000, 2011a, b, 2020, 2021a, b, c; Rébolvá and Gams 2000; Réblová and Winka 2000; Gruenig et al. 2002; Réblová and Seifert 2003; Hyde et al. 2016a, b, 2020; Lin et al. 2019; Luo et al. 2019).

The genera with both anamorph and teleomorph connection established for at least one species include Cacumisporium, Catenularia, Chaetosphaeria, Morrisiella, Chloridium, Dictyochaeta, Exserticlava, Lecythothecium, Menispora, Paragaeumannomyces, Pyrigemmula, Sporoschisma, Striatosphaeria, Tainosphaeria, Thozetella and Zanclospora. These connections were confirmed by both pure culture study and phylogenetic analysis. The anamorphic stage within a specific genus is usually well defined and can be morphologically distinguished from others, which provides a useful character to define these genera (Constantinescu et al., 1995; Réblová 1998a, b, 1999a, 1999b, 2000, 2004; Rébolvá and Gams 2000; Réblová and Winka 2000; Réblová and Seifert 2003; Fernández and Huhndorf 2005; Réblová et al. 2011a, b). However, the anamorphs for Chaetosphaeria and Tainosphaeria are diverse and morphologically very different on conidiophores, conidiogenous cells, conidiogenesis and conidia (Hyde et al. 2016a, 2020; Lin et al. 2019; Luo et al. 2019).



Fig. 13 Conidial morphology of phialidic chaetosphaeriaceous fungi with hyaline spores. a *Kionochaeta ramifera*. b *Zanclospora brevispora*. c *Chloridium culmicola*. d *Fuscocatenula variegata*. e *Parabahusutrabeeja minima*. f *Nawawia oviformis* (Peng et al. 2016). g *Cryptophiale guadalcanalensis*. h *Cryptophiale fruticetum*. i *Ejner*-

Biodiversity of anamorphic chaetosphaeriaceous fungi

Anamorphic chaetosphaeriaceous fungi are geographically widespread and found in different habitats from temperate, subtropical to tropical regions, the diversity is richer in subtropical and tropical areas (Agnihothrudu 1962/1963a, 1963b; Ellis 1971, 1976; Holubová-Jechová 1972, 1973a, b, 1982, 1984, 1987a, b, 1988a, b; Kirk 1981a, b, 1982a, b, 1983a, b, 1985, 1986, 1992; Castañeda-Ruiz 1984, 1985a, b, 1985c, 1986a, b, 1987, 1988; Castañeda-Ruiz 1984, 1985a, b, 1985c, 1986a, b, 1987, 1988; Castañeda-Ruiz 1986; Holubová-Jechová and Mercado Sierra 1984, 1986; Holubová-Jechová and Revay 1987; Sutton 1980a, b; Subramanian 1986; Bhat and Kendrick 1993; Nag Raj 1993; Ellis and Ellis 1997; Réblová et al. 1999, 2020, 2021a, b, c, d; Prabhugaonkar and Bhat 2009; Bhat 2010; Hashimoto et al. 2015a,

leomaiae (Barbosa et al. 2016). I Phialogeniculata guadalcanalensis (Luo et al. 2019). m Brachydictyochaeta bulliformis. n Zanclospora novae-zelandiae. o Dinemasporium americana. p Arcuatospora ellisii. q Menisporopsis pirozynskii. r Paragaeumannomyces nawawii

jensonia parapulchriseta. j Cryptophiale udagawae. k Codinaea

b; Castañeda-Ruiz et al. 2016; Hyde et al. 1999, 2016a, b; Maharachchikumbura et al. 2016; Lin et al. 2019; Luo et al. 2019). Most of them are found as saprobes in leaf litter, decaying branches and bark, decaying fruit and seeds, rotten wood etc., that recycle carbon and other nutrient elements. In nature they grow on broad plant species including monocotyledons (such as bamboo, palms, grasses, banana) and dicotyledonous plant in natural forest and gardens (Goh and Hyde 1996a; Whitton et al. 2012; Liu et al. 2016; Luo et al. 2016, 2019; Dai et al. 2017; Perera et al. 2020). Apart from commonly known on terrestrial occurrence, many species in the family Chaetosphaeriaceae are found from submerged woods in stream. So far, approximately 17 genera in this family have been reported from fresh water (Schoenlein-Crusius and Grandi 2003; Seifert et al. 2011; Liu et al. 2016; Lin et al. 2019; Luo et al. 2019; Zheng et al. 2020; Zhang



Fig. 14 Conidial morphology of phialidic chaetosphaeriaceous fungi with pigmented spores. a *Chloridium proliferatum*. b *Chloridium* gonytrichii. c Hoehneliella perplexa. d Catenularia catenulata. e Catenularia cubensis; f Catenularia elegans. g Craspedodidymum

et al. 2022). Seeds and fruits of various tree, especially wild seeds and fruits also provided a good substrate for rich chaetosphaeriaceous fungi (Perera et al. 2020, 2020).

Among the many known genera under the Chaetosphaeriaceae, some of them are monotypic genus or with only few species; while several genera, such as *Dictyochaeta*, *Dinemasporium*, *Pseudolachnella*, *Chloridium* and *Thozetella* are with many known species and new species are constantly being described. For examples, more than 120 species names under *Dictyochaeta* have been registered in Mycobank. Number of new species described under Chaetosphaeriaceae are rapidly increasing during last 10 years, partly contributed by sorting out the species complex with DNA sequencing and phylogenetic analysis, and also more dedicated researching effort from subtropical or tropical areas (Liu et al. 2016; Luo et al. 2016, 2019).

elatum. **h** Phaeodischloridium inaequiseptatum. **i** Adautomilanezia caesalpiniae (Crous et al. 2016). **j** Exserticlava vasiformis; **k** Monosporoschisma elegans. **l** Sporoschisma hemipsilum. **m** Sporoschisma mirabile. **n** Sporoschisma parcicuneatum. o Stephembruneria elegans

Although not so many species of *Chaetosphaeriaceae* have been reported in China, our research demonstrated great diversity of these fungi and a total of with 304 species in 70 genera were recorded from China, including 110 new species, and 117 new recorded species.

Taxonomy

Chaetosphaeriaceae Réblová, M.E. Barr & Samuels, Sydowia 51: 56, 1999.

Teleomorph: Stroma absent or restricted to a thin sometimes subiculate crust. Ascomata perithecial, superficial, often aggregated, black, globose to conical, usually rather thin walled but often carbonaceous, glabrous or setose the ostiole papillate, periphysate. Interascal tissue of copious persistent true paraphyses. Asci cylindrical, persistent, thinwalled, not fissitunicate, with a well-developed refractive

No.	Generic name	No.	Generic name
1	Achrochaeta Réblová & HernRestr. (S & H)*	46	Minimidochium B. Sutton (H)**
2	Aciculadictyochaeta W.P. Wu & Y.Z. Diao (S & H)*	47	Monosporoschisma W.P. Wu & Y.Z. Diao (H)**
3	Adautomilanezia Gusmão, S.S. Silva, Fluza, L.A. Costa & T.A.B. Santos (H)*	48	Morrisium Saikia & A.K. Sarbhoy (H)
4	Anacacumisporium Y.R. Ma & X.G. Zhang (H)	49	Multiguttulispora C.G. Lin & J.K. Liu (H)
5	Anacraspedodidymum C.R. Silva, R.F. Castañeda & Gusmão (H)**	50	Nawawia Marvanová (H)
6	Arcuatospora Réblová & HernRestr. (H)	51	Neonawawia J. Yang, K.D. Hyde & J.K. Liu (H)*
7	Aunstrupia W.P. Wu & Y.Z. Diao (H)	52	Neopseudolachnella A. Hashim. & Kaz. Tanaka (C)
8	Brachydictyochaeta W.P. Wu & Y.Z. Diao (H)	53	Neotainosphaeria W.P. Wu & Y.Z Diao (H)
9	Brunneodinemasporium Crous & R.F. Castañeda (C)	54	Nimesporella Réblová & HernRestr. (H)
10	Cacumisporium Preuss (S & H)	55	Oxenbollia W.P. Wu & Y.Z. Diao (H)
11	Calceisporiella W.P. Wu & Y.Z. Diao (H)	56	Paliphora Sivan. & B. Sutton (H)*
12	Calvolachnella Marinc., T.A. Duong & M.J. Wingf. (C)*	57	Parabahusutrabeeja W.P. Wu & Y.Z. Diao (H)
13	Catenularia Grove (S & H)	58	Paraceratocladium R.F. Castañeda (H)
14	Chaetosphaeria Tul. & C. Tul. (S & H)	59	Paraceratocladiella W.P. Wu & Y.Z. Diao (H)
15	Chalarodes McKenzie (S & H)*	60	Paracodinaea W.P. Wu & Y.Z. Diao (H)
16	Chloridium Link (S & H)	61	Paracryptophiale Kubuth. & Nawawi 1994 (H)
17	Codinaea Maire (H)	62	Paragaeumannomyces Matsush. (S & H)
18	Codinaeella Réblová & HernRestr. (H)	63	Phaeodischloridium W.P. Wu & Y.Z. Diao (H)
19	Conicomyces R.C. Sinclair, Eicker & Morgan-Jones (H)	64	Phaeonawawia Goh (H)*
20	Craspedodidymum HolJech. (H)	65	Phaeostalagmus W. Gams (H)
21	Cryptophiale Piroz. (H)	66	Phialoarthrobotryum Matsush. (H)*
22	Cryptophialoidea Kuthub. & Nawawi (H)	67	Phialogeniculata Matsush(H)
23	Dendrophoma Sacc. (C)*	68	Phialosporostilbe Mercado & J. Mena (H)
24	Dictyochaeta Speg. (S & H)	69	Phialoturbella Réblová & HernRestr. (S & H)
25	Dictyochaetopsis Aramb. & Cabello (H)***	70	Polynema Lév. (C)*
26	Dinemasporium Lév. (C)	71	Pseudodinemasporium A. Hashim. & Kaz. Tanaka (C)
27	Ejnerjensenia W.P. Wu & Y.Z. Diao (H)	72	Pseudolachnea Ranoj. (C)
28	Ellisembia Subram. (H & S) **	73	Pseudolachnella Teng (C)
29	Ericiosphaeria Réblová & HernRestr. (S & H)*	74	Pseudothozetella W.P. Wu & Y.Z. Diao (H)
30	Eucalyptostroma Crous & M.J. Wingf. (H)	75	Rattania Prabhug. & Bhat (H)
31	Eucalyptostromiella W.P. Wu & Y.Z. Diao (H)	76	Riisgaardia W.P. Wu & Y.Z. Diao (H)
32	Exserticlava S. Hughes (S & H)	77	Stilbochaeta Réblová & HernRestr. (S & H)
33	Falholtia W.P. Wu & Y.Z. Diao (H)	78	Sporendocladia Arnaud ex Nag Raj & W.B. Kendr. (H)
34	Flectospora Réblová & HernRestr. (S & H)*	79	Sporoschisma Berk. & Broome (S & H)
35	Fusichloridium W.P. Wu & Y.Z. Diao (S & H)*	80	Stanjehughesia Subram. (S & H)
36	Fuscocatenula Réblová & A.N. Mill	81	Stephembruneria R.F. Castañeda (H)
37	Hoehneliella Bress. & Sacc. (C)	82	Striatosphaeria Samuels & E. Müll. (S & H)*
38	Infundibulomyces Plaingam, Somrith. & E.B.G. Jones (C)*	83	Tainosphaeria F.A. Fernández & Huhndorf (S & H)
39	Kionochaeta P.M. Kirk & B. Sutton (H)	84	Tainosphaeriella Réblová & HernRestr. (H)*
40	Kionochaetiella W.P. Wu & Y.Z. Diao (H)*	85	<i>Thozetella</i> Kuntze (S & H)
41	Linkosia A. Hern. Gut. & B. Sutton (H)	86	Verhulstia HernRestr. (H)
42	Lomaantha Subram. (H)	87	Xyladelphia Réblová, A.N. Mill. & HernRestr. (S & H)
43	Lunatochaeta W.P. Wu & Y.Z. Diao	88	Zanclospora S. Hughes & W.B. Kendr. (S & H)
44	Menispora Pers. (S & H)	89	Zanclosporiella W.P. Wu & Y.Z. Diao*
15	Manian anongia S. Hughas (H)		-

 Table 2
 A list of all accepted genera in the family Chaetosphaeriaceae (*genera not found from China; **genera tentatively assigned to the family, due to no DNA sequence available from the type specie; H hyphomycetes, C coelomycetes, S sexual morph)

J-apical ring. Ascospores ellipsoidal to fusiform, transversely septate, sometimes fragmenting at the septa, hyaline to brown. Anamorphs hyphomycetous, coelomycetous, varied, with pigmented conidiophores and percurrently proliferating conidiogenous cells often with widely flared collarettes, conidia very varied in form but mostly small and hyaline.

Type genus: Chaetosphaeria Tul. & C. Tul.

Ecology/Substrate/host: Saprobes on decaying leaves, fruits, branches, stems, barks and wood of herbaceous or woody plants, terrestrial or submersed.

Distribution: Cosmopolitan, very frequent in temperate, subtropical, and tropical climates.

Notes: Based on phylogenetic analysis, the family Chaetosphaeriaceae is expanded with 89 accepted genera, including 22 new genera and 10 newly assigned genera (Table 2). All these genera (except for Monosporoschisma) are assigned with support from phylogenetic analysis by using integrated ITS and LSU data. Most of these accepted genera (except for Chaetosphaeria and several others) are delimitated as monophyletic generic concept with well-defined morphological diagnosis characters. Among these genera, only 12 genera (Brunneodinemasporium, Calvolachnella, Conicomyces, Dendrophoma, Dinemasporium, Hoehneliella, Infundibulomyces, Neopseudolachnella, Polynema, Pseudodinemasporium, Pseudolachnea, Pseudolachnella) are with coelomycetous anamorphs, while all other genera are with dematiaceous hyphomycetous anamorphs. In conidiogenesis, majority of these genera are with phialidic conidiogenous cells, and only 10 genera (Aunstrupia, Ellisembia, Falholtia, Linkosia, Lomaantha, Morrisiella, Paliphora, Riisgaardia, Stanjehughesia and Zanclospora) are with non-phialidic condiogenous cells. The genus Chaetosphaeria is still a polyphyletic genus and revision is under way for monophyletic generic concept. The identification keys for both hyphomycetous and coelomycetous genera are provided as well under each session.

The 22 new genera are Aciculadictyochaeta W.P. Wu & Y.Z. Diao, Aunstrupia W.P. Wu & Y.Z. Diao, Brachydictyochaeta W.P. Wu & Y.Z. Diao, Calceisporiella W.P. Wu & Y.Z. Diao, Curvichaeta W.P. Wu & Y.Z. Diao, Ejnerjensenia W.P. Wu & Y.Z. Diao, Eucalyptostromiella W.P. Wu & Y.Z. Diao, Falholtia W.P. Wu & Y.Z. Diao, Fusichloridium W.P. Wu & Y.Z. Diao, Kionochaetiella W.P. Wu & Y.Z. Diao, Lunatochaeta W.P. Wu & Y.Z. Diao, Kylindrochaeta W.P. Wu & Y.Z. Diao, Monosporoschisma W.P. Wu & Y.Z. Diao, Neotainosphaeria W.P. Wu & Y.Z. Diao, Oxenbollia W.P. Wu & Y.Z. Diao, Paracodinaea W.P. Wu & Y.Z. Diao, Parabahusutrabeeja W.P. Wu & Y.Z. Diao, Paraceratocladiella W.P. Wu & Y.Z. Diao, Phaeodischloridium W.P. Wu & Y.Z. Diao, Pseudothozetella W.P. Wu & Y.Z. Diao, Riisgaardia W.P. Wu & Y.Z. Diao and Zanclosporiella W.P. Wu & Y.Z. Diao. The ten newly assigned asexually typified genera based on the ITS and LSU sequences generated from fresh specimens are Hoehneliella, Linkosia, Lomaantha, Minimidochium, Morrisiella, Paraceratocladium, Paracryptophiale, Phialoarthrobotryum, Sporendocladia and Stephembruneria. Concepts of some polyphyletic genera such as Chloridium, Codinaea, Dictyochaeta, Ellisembia Subram., Menisporopsis, Paraceratocladium are future defined and emended.

It is expected that number of genera in family Chaetosphaeriaceae will be further expanded through revision of *Chaetosphaeria*, molecular phylogenetic analysis of relevant genera when DNA sequence data are available (for example: *Hyphopolynema*, *Morrisographium*, *Polybulbophiale*, *Stratiphoromyces*), and exploration of fungal biodiversity in tropical and subtropical area, more asexually typified genera and species will be discovered and assigned to the family in future (Morelet 1968; Subramanian 1971; Illman and White 1984, 1985b; McKenzie 1991a, b; Marvanova, 1997; Goh and Hyde 1998a, b; Marincowitz et al. 2008; Seifert et al. 2011; Ma and Zhang 2015; Crous et al. 2016, 2017, 2018a, b, 2019, 2020; Li et al. 2016; Luo et al. 2019; Hyde et al. 2020; Hsieh et al. 2021; Réblová et al. 2020, 2021a, b, c, d; Zheng et al. 2020, 2021).

For biodiversity of the chaetosphaeriaceous fungi, a total of 369 species in 76 genera, including 119 new species and 47 new combinations or new name, are documented in this paper. Among them, 304 species in 70 genera are reported from China, and majority of these genera and species are reported from our own studies of specimens and living strains. All these species are described and illustrated, and the identification keys for most of the genera are also provided. DNA barcodes (ITS and LSU) were generated for all studied genera and species with pure cultures successfully obtained from the fresh specimens. A list of new genera, new species and new combination is found in the Appendix.

In addition, eight already described species are excluded from the Chaetosphaeriaceae and re-assigned to other fungal family, and subsequently 3 new genera, 3 new species, 1 new name and 7 new combinations are made. The three new genera are: Parasporendocladia W.P. Wu & Y.Z. Diao gen. nov., Phaeochloridium W.P. Wu & Y.Z. Diao gen. nov. and Sinochloridium W.P. Wu & Y.Z. Diao gen. nov.; the new species, new name and new combinations are: Lareunionomyces foliicola (P.M. Kirk) W.P. Wu & Y.Z. Diao comb. nov. (= Phialocephala foliicola P.M. Kirk, \equiv Sporendocladia folliicola (P.M. Kirk) M.J. Wingf.), Lareunionomyces kionochaetoides (B. Sutton) W.P. Wu & Y.Z. Diao comb. nov. (≡ Sporendocladia kionochaetoides B. Sutton), Parasporendocladia bactrospora (W.B. Kendr.) W.P. Wu & Y.Z. Diao comb. nov. (≡ Phialocephala bactrospora W.B. Kendr., ≡ Sporendocladia bactrospora (W.B. Kendr.) M.J. Wingf.), Phaeochloridium gamsii W.P. Wu & Y.Z. Diao sp. nov., Phaeochloridium geniculata (Emden) W.P. Wu & Y.Z. Diao comb. nov., and



Fig. 15 Maximum likelihood (ML) tree based on ITS sequence data for the non-phialidic *Chaetosphaeriaceae*. Bootstrap support values $\geq 60\%$, Bayesian posterior probability values ≥ 0.95 are shown at the nodes. *Tracylla eucalypti* CPC31777 was chosen as the outgroup.

Ex-type strains are indicated with "T" in the end of the taxa labels. Latin names and ex-type strain numbers of the new species described in the current study are shown in font

Phaeochloridium phaeosporum (W. Gams & Hol.-Jech) W.P. Wu & Y.Z. Diao comb. nov. (\equiv Chloridium phaeosporum W. Gams & Hol.-Jech.), Rhopalophora minima W.P. Wu & Y.Z. Diao, Sinochloridium bambusicola W.P. Wu & Y.Z. Diao sp. nov., Xyladictyochaeta eucalypti (B. Sutton & Hodges) W.P. Wu & Y.Z. Diao comb. nov. (\equiv Codinaea eucalypti B. Sutton & Hodges), Xylolentia matsushimae W.P. Wu & Y.Z. Diao nom. nov. (\equiv Chloridium reniforme Matsush.) and X. palmicola W.P. Wu & Y.Z. Diao sp. nov.

Hyphomycetous genera with non-phialidic anamorphs

Among the known anamorphs of chaetosphaeriaceous fungi, only a few genera and species were reported with non-phialidic conidiogenous cell and holoblastic conidia. All these anamorphs are *Sporidesmium*-like fungi, except for *Paliphora* Sivan. & B. Sutton and *Chaetosphaeria guttulata*, and their teleomorphs are with multiseptate and versicolor ascospores (Shoemaker and White 1985; Subramanian 1992a, b; Réblová 1999a; Réblová and Winka 2001; Magyar et al. 2011; Seifert et al. 2011; Hyde et al. 2019; Luo et al. 2018, 2019; Hsieh et al. 2021; Réblová et al. 2021a). *Paliphora* is very special among the chaetosphaeriaceous anamorphs in producing solitary, unbranched setiform conidiophores with sterile apex and intercalary conidiogenous cells bearing sporulating pores from which the cylindrical to fusiform conidia are produced (Sivanesan and Sutton 1985; Kuthubutheen 1987c; Alcorn 1996; Gusmão et al. 2008; Goh et al. 2014b; Malosso et al. 2017). *Chaetosphaeria guttulata* is also unique among the chaetosphaeriaceous fungi in producing non-phialidic conidiogenous cells bearing many tiny protuberant conidiogenous loci and hyaline septate conidia (Luo et al. 2019).

Based on our phylogenetic analysis (Figs. 4 and 15), ten monophyletic genera including three new genera are accepted for *Sporidesmium*-like fungi under the Chaetosphaeriaceae. They are *Aunstrupia*, *Ellisembia*, *Falholtia*, *Linkosia*, *Lomaantha*, *Morrisiella*, *Riisgaardia*, *Stanjehughesia* and *Zanclospora*. Two generic names, *Lecythothecium* Réblová & Winka and *Pyrigemmula*, are treated as synonyms of *Ellisembia*.


Fig. 16 Colony of non-phialidic anamorphs of chaetosphaeriaceous fungi on PDA after 20 days at 25 °C. **a**, **b** *Aunstrupia nodipes* (**a** 43149, **b** 44694). **c** *Ellisembia brachypus* (50,658). **d** *Ellisembia reblovae* (ex-type strain 44776). **e**, **f** *L*. *multiseptum* (**e** ex-type strain 42961, **e** 43190); **g** *L*. *rostrata* (ex-type strain NN47479). **h**,

i Lomaantha pooga (h 42977, i 43946). j, k Morrisiella indica (j 42908, k 44,710). l Falholtia kaohsiungensis (50,711). m Stanjehughesia polypora (47796). n, o Riisgaardia longispora (n ex-type strain 50731, o 50687). p R. vermiculata (42,952)

Among these known species with non-phialidic conidiogenous cells, only three species have both anamorph and teleomorph found and also phylogenetically supported, including *Chaetosphaeria caesariata* with *Sporidesmium hormiscioides* as anamorph, *Lecythothecium duriligni* with *Sporidesmium folliculatum* as anamorph, and *Ellisembia* *aurea* with both anamorph and teleomorph described in nature.

Living strains of many studied species were also studied on PDA (Figs. 16 and 17), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.



Fig. 17 Non-phialidic anamorphs of chaetosphaeriaceous fungi on PDA after 20 days at 25°C. a, b *Ellisembia reblovae* (ex-type strain 44776). c, d *Linkosia filiformis* (ex-type strain 50606). e, f *L. gelatinosa* (ex-type strain NN50607). g, h *L. rostrata* (ex-type strain NN47479). i-r *Riisgaardia longispora* (ex-type strain 50731). k, l *R. obclavata* (ex-type strain 43163)

Key to hyphomycetous genera with non-phialidic anamorphs

1.	Conidiogenous cells intercalary; conidia produced from
	sporulating poresPaliphora
1.	Conidiogenous cells terminal; conidia not produced
	from sporulating pores2
2.	Conidia euseptate
2.	Conidia distoseptate7
3.	Conidiophores absent; conidiogenous cells directly
	formed from superficial hyphae4
3.	Conidiophores present, with conidiogenous cells termi-
	nal6
4.	Synanamorph of Zanclospora with phialides
	Zanclospora
4.	Not synanamorph of Zanclospora5
5.	Conidia obclavate, obclavate-rostrate, subcylindrical
5	Conidia cylindrical clavate or obclavate Staniehushesia
6.	Conidiophores solitary, with doliiform-shaped prolifera-
0.	tionAunstrupia
6.	Conidiophores in synnemata or in cluster, without pro-
	liferationFalholtia
7.	Conidiophores in synnemataMorrisiella
7.	Conidiophores solitary or in clusters
8.	Conidiophores absentLinkosia
8.	Conidiophores present
9.	Conidia obclavate, with branched appendage at the
	apexLomaantha
9.	Conidia fusiform to obclavate, rostrate; apical append-
	age not branched if presentEllisembia
A	nstrunia WP Wu & V7 Diao gan nov MucoPonk

Aunstrupia W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB841515 Etymology: Named after Knud Aunstrum, the former vise

Etymology: Named after Knud Aunstrup, the former vice president in Novozymes, who gave strong support for this study in early time.

Diagnosis: Similar to *Sporidesmium* on percurrently proliferated conidiophore and euseptate conidia, but phylogenetically belong to Chaetosphaeriaceae.

Type species: *Aunstrupia nodipes* (Penz. & Sacc.) W.P. Wu & Y.Z. Diao.

Saprobe on rotten leaves and petiole of palm. Colonies effuse, brown, hairy, often inconspicuous. Mycelium partly superficial, partly immersed in the substratum, composed of pale brown to brown, septate, branched hyphae, often forming network on the surface of the substrate. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, solitary or in small group, simple, cylindrical, straight or slightly flexuous, smooth, septate, dark brown. Conidiogenous cells integrated, terminal, cylindrical, lageniform, ampulliform, smooth, dark brown, with percurrent proliferations. Conidia acrogenous, solitary, dry, obclavate, rostrate, euseptate, sometimes constricted at the septa, brown to dark brown, become pale brown towards the apex, smooth, basal cell conic-truncate.

Ecology/Substrate/Host: Saprobe on decaying leaves and petioles of palm.

Geographical distribution: Tropical and subtropical areas, including China, Gabon, Indonesia, Java and Venezuela.

Notes: *Aunstrupia* is characterized by solitary conidiophores, holoblastic conidiogenous cells with doliiform or lageniform percurrent proliferations, and dark brown and euseptate conidia. Morphologically it resembles *Sporidesmium* on conidiophores, conidiogenous cells and conidia. However, phylogenetically it belongs to *Chaetosphaeriaceae*, while members of *Sporidesmium* belong to *Sporidesmiaceae* or *Distoseptosoraceae* (Ellis, 1948, 1958, 1971, 1976; Subramanian 1992a, b; Ellis and Ellis 1997; Wu and Zhuang 2005; Luo et al. 2018). The genus is monotypic. The ITS sequences were also obtained from several other similar *Sporidesmium* species producing conidiophores with doliiform or lageniform proliferations and dark brown, obclavate or subcylindrical conidia, but they phylogenetically belong to other family (unpublished).

Aunstrupia nodipes (Penz. & Sacc.) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 18, MycoBank MB841676.

 \equiv *Helminthosporium nodipes* Penz. & Sacc., Malpigia 15: 246, 1901.

 \equiv Sporidesmium nodipes (Penz. & Sacc.) S. Hughes, Can. J. Bot. 36: 809, 1958.

 \equiv *Penzigomyces nodipes* (Penz. & Sacc.) Subram., Proc. Indian Nat. Acad. Sci. B 58: 187, 1992.

Description on the natural substrate: Saprobe on decaying leaves and petiole of palm. Colonies effuse, brown, hairy, often inconspicuous. Mycelium partly superficial, partly immersed in the substratum, composed of pale brown to brown, septate, branched hyphae, 1-3 µm wide, often forming network on the surface of the substrate. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, solitary or in small group, simple, cylindrical, straight or slightly flexuous, smooth, 1-6-septate, dark brown, $20-250 \times 3-5 \mu m$, $7-10 \mu m$ at the base. Conidiogenous cells integrated, terminal, cylindrical, lageniform, ampulliform, smooth, dark brown, $10-22 \times 4-6 \mu m$, apex 2.5-4 µm wide and truncate, with up to 15 percurrent proliferations. Conidia acrogenous, solitary, dry, obclavate, rostrate, 11–14-euseptate, sometimes constricted at the septa, brown to dark brown, become pale brown towards the apex,



 Fig. 18 Aunstrupia nodipes (Wu1311a). a Hyphae. b, d, e Conidiophores and conidiogenous cells with percurrent proliferations. c, i–l Conidia. h Conidiophore with developing conidia. Scale bar: b 100 μm, c, e 20 μm, a, d, f–l 10 μm

smooth, $40-65 \times 6.5-8 \mu m$; apex acute and $1.5-4 \mu m$ wide; basal cell conic-truncate, $2.5-4 \mu m$ wide at the base.

Colonies on PDA effuse, colonies 2–3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium welldeveloped, brown or dark brown, reverse of the same color or slightly darker, with yellow pigment diffused into agar (Fig. 16a, b).

Materials examined: **China:** Guangdong Province, Dinghushan, on rotten leaves and petiole of palm, 9 October 1998, W.P. Wu (Wu1881b, Wu1892a, Wu1898, Wu1918a); Guangdong Province, Luofushan, on rotten leaves and branches of palm, 9 October 1998, W.P. Wu (Wu2057c); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of palm, 2 January 1997, W.P. Wu (Wu1311a). Living strains: 43149 (from Wu1311a) and 44694 (from Wu1881b).

Ecology/Substrate/Host: saprobe on rotten leaves and branches of palm.

Geographical distribution: China, Gabon, Indonesia, Java and Venezuela (Ellis 1976; Wu and Zhuang 2005).

Descriptions and illustrations: Ellis (1963, 1976); Wu and Zhuang (2005).

Notes: Aunstrupia nodipes can be recognized by its dark brown conidiophores, percurrently proliferated conidiogenous cells, and dark brown, 11–14-septate, obclavate conidia. This species is commonly found on dead petiole of various palm species in tropical and subtropical areas. Ellis (1963) described the pale colored hyphae around the first formed conidiophores, but this character was not seen from any collections examined here. The ITS and LSU sequences were obtained from two strains and its affinity to Chaeto-sphaeriaceae is confirmed.

Both ITS and LSU sequences were obtained from the two studied strain. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 43149 include *Cryptophialoidea fasciculata* (GenBank MG758195, 89% identity) and *Kionochaeta ivoriensis* (GenBank NR_160149, 90% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the strain 43149 include *Cryptophiale udagawae* (GenBank MH758211, 97% identity) and *Kionochaeta ivoriensis* (GenBank MH758211, 97% identity).

Ellisembia Subram., Proc. India Natn. Acad. Sci. B 58: 183, 1992.

=*Imicles* Shoemaker & Hambleton, Can. J. Bot. 79: 598, 2001.

= Lecythothecium Réblová, Mycologia 93: 481, 2001.

=*Pyrigemmula* D. Magyar & R. Shoemaker, Mycol. Prog. 10:309, 2011.

Colonies effuse, brown, hairy, often inconspicuous. Teleomorph: Perthecia immersed, flask-shaped, glabrous. Perithecial wall leathery, consisting of distinct regions. Ostiolar canal periphysate. Paraphyses persistent. Asci unitunicate, 8-spored, cylindrical; ascal apex with nonamyloid (J-), refractive apical annulus. Ascospores ellipsoidal to fusiform, transversely septate, versicolorous, central cells brown, end cells hyaline. Anamorph: Conidiophores macronematous, mononematous, solitary or aggregated, simple, cylindrical, straight or slightly flexuous, smooth, septate or aseptate, brown to dark brown. Conidiogenous cells integrated or discrete, terminal or directly from hyphae, lageniform, doliiform, cylindrical, smooth, medium brown to brown, proliferation none or percurrent. Conidial ontogeny holoblastic. Conidia acrogenous, solitary, dry, cylindrical, obclavate, rostrate, fusiform, or narrowly clavate, obovoid to broadly obovoid, truncate at the base, rounded or appendaged at the apex, smooth or verruculose, distoseptate, cell lumina reduced, pale brown to brown; apical appendage absent or present, filamentous, septate, pale brown (Adapted Réblová and Winka 2001; Wu and Zhuang 2005).

Type species: Ellisembia coronata (Fuckel) Subram.

Ecology/Substrate/Host: on wood, bamboo culm or plant remnants in terrestrial and freshwater habitats.

Geographical distribution: Broadly distributed and known from many countries.

Description and illustration: Subramanian (1992a, b); Wu and Zhuang (2005).

Notes: Ellisembia, based on E. coronata, is a segregated genus from Sporidesmium Link by Subramanian (1992a, b) to accommodate those previously described Sporidesmium without or with percurrently proliferating conidiogenous cells, and distoseptate conidia (McKenzie 1995; Goh and Hyde 1999; Wu and Zhuang 2005). The criteria used for species identification in the genus are number of proliferation in conidiogenous cells and conidial morphology such as shape, size and septation. Teleomorphs of Ellisembia were found from four species, i.e., Ellisembia adscendens with Miyoshiella triseptata (Shoemaker & White) Réblová as teleomorph; Ellisembia aurea described with both anamorph and teleomorph, Ellisembia bambusicola with Miyoshiella fusispora as teleomorph; Ellisembia folliculata with Lecythothecium duriligni as teleomorph (Shoemaker and White 1985; Réblová 1999a; Réblová and Winka 2001; Hyde et al. 2019).

Recent phylogenetic analysis shows that the genus *Ellisembia* is polyphyletic and problematic in delimitation from *Distoseptispora* and *Sporidesmium*. It comprises more than 65 species but only some of them could be positioned in the system based on DNA sequence data (Hyde et al. 2019). Members of *Ellisembia* with DNA sequences available are placed in four clades in Sordariomycetes, i.e., in Chaetosphaeriaceae under the name *Ellisembia*, Distoseptisporaceae as

Distoseptispora, Sporidesmiaceae as Sporidesmium and Xylariales as Ellisembia calyptrata (Réblová and Winka 2001; Shenoy et al. 2006; Su et al. 2016; Hyde et al. 2019). Future revision needs to include both morphological and molecular analysis of the types species (Réblová 1999a; Réblová and Winka 2001; Shoemaker and Hambleton 2001; Wu and Zhuang 2005; Shenoy et al. 2006; Mena Portales et al. 2016; Su et al. 2016; Luo et al. 2018; Yang et al. 2018b; Hyde et al. 2019; Sun et al. 2020; Hsieh et al. 2021). Among the many known species under Ellisembia, only three species, *Ellisembia aurea*, *E. brachypus* and *E.* folliculata, are assigned to Chaetosphaeriaceae (Réblová and Winka 2001; Shenoy et al. 2006; Magyar et al. 2011; Hyde et al. 2019). However, their phylogenetic relationship with the type species, E. coronata, is not known, thus placement of the genus Ellisembia in Chaetosphaeriaceae needs to be further confirmed when the DNA sequence data will be available from fresh collection of the type species. Hyde et al. (2019) recommended using the name *Ellisembia* for species grouped in a strongly supported monophyletic clade in Chaetosphaeriaceae, experimentally linked with sexual morphs having multiseptate, versicolorous ascospores in asci with a non-amyloid apical annulus, persistent paraphyses and immersed ascomata.

Species of the genus occurs as saprobes on wood, bamboo culm or plant remnants in terrestrial and freshwater habitats. Many species under the genus *Ellisembia* have been reported from China (Wu and Zhuang 2005). However, only three species, *E. aurea*, *E. brachypus* and *E. folliculata*, are phylogenetically assigned to Chaetosphaeriaceae based on available DNA data, while most other species are to be studied. Here we add a new species, *E. reblovae* to the genus.

Key to species of *Ellisembia* (*E.*) and *Lomaantha* (*L.*) species with affinity to Chaetosphaeriaceae

- 1. Conidiophores absent; conidiogenous cells directly from hyphae; conidia ellipsoid, 0-5-septate, 22.5- $24 \times 6.5 - 8 \,\mu m...$ E. aurantiaca 1. Conidiophores well-developed, septate; conidiogenous cells terminal.....2 2. Conidia cylindrical to clavate or obclavate, 5-11-septate, $28-62 \times 9-10.5 \,\mu m \dots E.$ folliculata 2. Conidia obclavate, obclavate-rostrate, fusiform, more 3. Conidia without apical extension, 10–14-septate, 60–93×11–13 μm*E. reblovae* 3. Conidia with apical hyaline to subhyaline extension......4 4. Conidia 17–19-septate, $110–135 \times 18–20 \,\mu\text{m}$; appendage branched, 45–65×1–1.5 μm.....L. pooga
- 4. Conidia less than 15-septate, apical appendage unbranched......5

- 5. Conidia 5–8-septate, 50–90×10–14 μm, apical extension up to 70 μm long*E. brachypus*
- 5. Conidia 11–13-septate, 70–97×11–16 μm, apical extension up to 20 μm*E. aurea*

Ellisembia aurantiaca (D. Magyar & R. Shoemaker) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841983.

 \equiv *Pyrigemmula aurantiaca* D. Magyar & R. Shoemaker, Mycol. Prog. 10: 310, 2011.

Teleomorph: Unknown. Anamorph: Conidiophores $3-5 \times 2-3 \mu m$, later extending to $10 \times 3 \mu m$ with a branch budding from the outside of the curvature, finally branching bifurcately to produce 4 or 5 cells. Conidiogenous cells $(9.6-)11(-14.4) \times (4.8-)5.7(-7.2) \mu m$, with one solitary terminal pore 2 μm diam. Conidia (17.6-)22.5-24 $(-27.2) \times 6.5-8 \mu m$, 0-5(-7) septate (Magyar et al. 2011).

Ecology/Substrate/Host: Saprobes on the marginal surface of the bark of living Acer saccarinum, Betula pendula, Elaeagnus angustifolia, Mespilus germanica, Quercus sp., Platanus hybrida, Pyrus communis, Vitis vinifera and on litter.

Geographical distribution: Hungary (Magyar et al. 2011). Description and illustration: Magyar et al. (2011).

Notes: *Pyrigemmula aurantiaca*, the type species of *Pyrigemmula*, is similar to species of *Linkosia* in lacking well-developed conidiophores and pseudoseptate conidia. Our phylogenetic analysis shows that *P. aurantiaca* is congeneric with other species of *Ellisembia* with Chaetosphaeriaceae affinity.

Ellisembia aurea Réblová & J. Fourn., Fungal Divers. 96: 163, 2019. Figure 19

Description on the natural substrate: Saprobic on decaying wood partly submerged in freshwater. Teleomorph: Ascomata immersed with protruding necks or becoming superficial, solitary or in small groups. Venter 550-700 µm diam., 300-380 µm high, subglobose, upright or decumbent. Neck central, 150-200 µm wide, 350-800 µm long, cylindrical, sometimes tapering towards the apex, with a distinct pore at the apex. Ostiole periphysate. Ascomatal wall leathery, 20-30 µm thick, two-layered; outer layer consisting of brown, thick-walled, polyhedral cells with opaque walls of textura angularis; towards the interior cells more flattened of textura prismatica. Inner layer consisting of several rows of thin-walled, hyaline, flattened cells. Paraphyses hyaline, branched, anastomosing, septate, 2.5-3 µm wide, tapering to 1.5–2.0 μ m. Asci 160–220 × 20–27 μ m, truncate at the apex, cylindrical to clavate, stipitate; with 8 obliquely uniseriate or biseriate ascospores; apical annulus 6.5-8 µm wide, $2.0-2.5 \mu m$ high. Ascospores $37-41.5 \times 10-11 \mu m$, ellipsoidal, sometimes inequilateral, 5-septate, not constricted at the septa, with a large globule in each cell obscuring the septa, versicolorous prior to discharge, middle cells brown



Fig. 19 *Ellisembia aurea* (Wu1786a). **a**, **b**, **d**, **e**, **g–k** Ascospores. **c** Paraphyses. **f** Apical structure of asci. Scale bar: **a**, **b**, **d–e** 20 µm, **c**, **f–k** 10 µm

to olivaceous brown with hyaline polar cells, smooth-walled, without mucilaginous sheath or appendages. Anamorph: Not observed from Chinese material, but reported in the original description (Hyde et al. 2019).

Culture characteristics: Colonies on PDA effuse, colonies 2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, brown to dark brown, reverse of the same color or slightly darker.

Materials examined: **China**, Jilin Province, Changbaishan, on dead stem of unidentified tree, 5 September 1998, Wenping Wu (Wu1786a). Living strain: 44,588 (from Wu1786a).

Ecology/substrate/host: Saprobes on dead stem of trees, including *Sambucus nigra*.

Geographical distribution: China and France (Hyde et al. 2019).

Description and illustration: Hyde et al. (2019).

Notes: The fungus is only found with teleomorph in the Chinese material. The anamorph on nature substrate was fully described by Hyde et al. (2019): the conidiophores are 92–155×6.5–7.5 µm, and the conidia are (65–)70–97(–103)×11–16(–17.5) µm, obclavate to fusiform to lanceolate, brown to reddish brown, with the darkest basal cell, paler at the apex, 11–13-distoseptate, smooth-walled, truncate at the base 4.5–5.0 µm wide, tapering apically with a terminal extension up to 26 µm long. In the phylogenic analysis by using the combined ITS-LSU sequences, *E. aurea* is positioned in a strongly supported clade together with *E. brachypus*, *E. foliiculata* and *Pyrigemmula aurantiaca*.

Besides *E. foliiculata* (Réblová and Winka 2001), *E. aurea* is another *Ellisembia* species experimentally linked with a sexual morph with versicolorous ascospores. *Ellisembia aurea* resembles *E. foliiculata* in the morphology of ascomata, size of ascospores and morphology of brown, distoseptate conidia, but the latter species differs from *E. aurea* in having flask-shaped ascomata, regularly 7-septate ascospores, and cylindrical to clavate or obclavate, shorter conidia without a rostrum or appendage at the distal end (Hyde et al. 2019). *Ellisembia aurea* morphologically resembles *E. brachypus* in having conidia with a distal rostrate end, but differs in having somewhat shorter conidia (45–90 µm) with fewer (5–8) septa (Ellis 1958; Hughes and Illman 1974b).

Ellisembia brachypus (Ellis & Everh.) Subram., Proc. Indian Natn. Acad. Sci. B 58: 183, 1992. Figure 20

 \equiv *Helminthosporium brachypus* Ellis & Everh., Publ. Field Columbian Mus. Bot. Ser. 1: 92, 1896.

 \equiv Sporidesmium brachypus (Ellis & Evert.) S. Hughes, Can. J. Bot. 36: 807, 1958.

= Sporidesmium deightonii M.B. Ellis, Mycol. Pap. 70: 26, 1958.

= Sporidesmium ceratophorum Munja & Kulshr., Indian Phytopathol. 19: 269, 1962.

Description on the natural substrate: Colonies effuse, brown, hairy, often inconspicuous. Mycelium partly superficial, partly immersed in the substratum, composed of pale brown to brown, septate, branched hyphae, 2-3 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, solitary or aggregated at the base, simple, cylindrical, straight or slightly flexuous, smooth, 2-7-septate, brown to dark brown, almost black at the lower part and septa hardly seen, $30-250 \times 5-9 \mu m$, base sometimes swollen. Conidiogenous cells integrated, terminal, lageniform, smooth, brown to dark brown, $5-10 \times 3-4.5$ µm, constricted toward the truncate apex, 2-3 µm wide at the apex. Conidia acrogenous, solitary, dry, ellipsoidal, fusiform, rostrate, 5-8-distoseptate, dark brown, become pale brown toward the apex, $50-90 \times 10-14 \mu m$; apical cell extended into hyaline, aseptate, filiform appendage of $30-74 \times 2-3$ µm; basal cell conical-truncate, darker than other cells, $3-5 \mu m$ wide at the base.

Culture characteristics: Colonies on PDA effuse, colonies 1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium not well-developed, grey to yellow brown, reverse dark brown, with red brown pigment in the medium (Fig. 16c).

Materials examined: China, Guangdong Province, Dinghushan, on dead branches of Bauhinia sp., 9 October 1998, W.P. Wu (Wu1875, Wu1997c); Guangdong Province, Luofushan, on dead branches, 12 October 1998, W.P. Wu (Wu2264, Wu2253a); Guangxi Province, Shangsi, Shiwandashan, on dead branches of Rhododendron sp., 2 January 1997, W.P. Wu (Wu1246b, Wu1259b, Wu1328a, W1598); Hubei Province, Shennongjia, on rotten wood, Sept 2004, W.P. Wu (Wu8080b); China: Jilin Province, Changbaishan, on rotten wood of Salix sp., 5 Sept 1998, W.P. Wu (Wu1769c); Hunan Province, Zhangjiajie (Wu4549); Ningxia Province, Liupanshan, Langtianxia, on rotten wood, 25 August 1997, W.P. Wu (Wu1022e); Ningxia Province, Liupanshan, Liangtianxia, on rotten bark, 24 August 1997, W.P. Wu (Wu1154i); Yunnan Province, Kunming, Shilin, on dead branches, 24 October 1999, W.P. Wu (Wu2573a); Yunnan Province, Xishuangbanna, Jinghong, Xishuangbanna, Jinghong, on rotten bark, 20 October 1999, W.P. Wu (Wu2643a); Yunnan Province, Simao, on rotten bark, 12 October 1999, W.P. Wu (Wu2696b, Wu3102c); Zhejiang Province, Huaian County, Oiandaohu, on rotten wood, 18 October 2018, W.P. Wu (Wu16078); Taiwan (Matsushima 1980). Living strains: 50658 (from Wu8080b) and 76,460 (form Wu16078).

Ecology/Substrate/Host: saprobe on dead branches, rotten bark, rotten wood of many plants, including Areca catechu, Averrhoa carambola, Bauhinia sp., Citrus aurantifolia, Citrus limetta, Dichrostachys glomerata, Freycinetia banksii,



Fig. 20 Ellisembia brachypus (Wu8080b). a, e, h, i Conidiophores and conidiogenous cells. b–g, j Conidia. Scale bar: a 20 µm, b–j 20 µm



Fig. 21 Ellisembia reblovae (Wu1913b, holotype). a-i, o-u Conidia. j-n Conidiophores and conidiogenous cells. Scale bar: 10 µm

Ocotea leucoxylon, Ocotea usambarensis, Pandanus furcatus, Petrea volubilus, Rhododendron sp., Ripogoum scandens, Roystonea regia, Salix sp. Thevetia neriifolia.

Geographical distribution: China, Cuba, India, Japan, Kenya, New Zealand, Sierra Leone and USA (Ellis 1971; Hughes and Illman 1974a; Matsushima 1975, 1980; McKenzie 1995; Wu and Zhuang 2005; Luo et al. 2019).

Descriptions and illustrations: Ellis (1958, 1971); Hughes and Illman (1974a); McKenzie (1995); Matsushima (1975); Wu and Zhuang (2005); Luo et al. (2019).

Notes: *Ellisembia bambusae* is similar to *E. brachypus*, but differs from it by producing proliferated conidiogenous cells and dark brown conidia with apical mucilaginous sheath (Ellis 1958, 1971; Hughes and Illman 1974a). The conidia of this species have a broad range of variation in

different collections examined by us, this was also shown by Ellis (1958, 1971) and Matsushima (1975). On PDA, the strain NN50658 produced abundant conidia which are morphologically similar to those found on natural substrate (Fig. 27e–k). *Ellisembia brachypus* has wide distribution and found through temperate to tropical areas. It has been recorded on rotten wood and dead branches of many plant species. Its occurrence in Taiwan was reported by Matsushima (1980).

Ellisembia reblovae W.P. Wu & Y.Z. Diao, sp. nov., Fig. 21, MycoBank MB841546.

Etymology: Named after Prof. Martina Réblová who made significant contribution to biodiversity and taxonomy of the family Chaetosphaeriaceae. Diagnosis: Similar to other chaetosphaeriaceous *Ellisembia* species, especially *E. aurea* and *E. brachypus* in conidiophores without percurrent proliferation, and obclavate to obclavate-rostrate conidia, but differs from them by conidia without apical appendage.

Typification: **China**: Guangdong Province, Dinghushan, on dead culm of bamboo, 9 October 1998, W.P. Wu, Holotype HMAS 352,005 (= Wu1913b), ex-type strain CGMCC 3.20705 (= NN44776).

Description on the natural substrate: Colonies on natural substrate effuse, brown, hairy, often inconspicuous. Mycelium partly superficial, partly immersed in the substratum, composed of pale brown to brown, septate, branched hyphae, 2–4 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, solitary or 1-2 aggregated at the base, simple, cylindrical, straight or slightly flexuous, smooth, 1-3-septate, dark brown to almost black and septa hardly seen, $40-57 \times 5.5-6.5 \,\mu\text{m}$, base sometimes swollen, apex truncate, without percurrent proliferation. Conidiogenous cells integrated, terminal, cylindrical, smooth, brown to dark brown, $18-22 \times 5-6 \mu m$, constricted toward the truncate apex, $3.5-4 \mu m$ wide at the apex. Conidia acrogenous, solitary, dry, obclavate, obclavate-rostrate, 11–14-distoseptate, brown to dark brown, become pale brown toward the apex, $60-93 \times 11-13 \mu m$; apical cell pale brown, conical, cylindrical, rounded at the apex; basal cell truncate, significantly darker than other cells, 3.5-4 µm wide at the base.

Culture characteristics: Colonies on PDA effuse, colonies 1.5–2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, while to grey, reverse brown to dark brown (Figs. 16d, 17a, b).

Ecology/Substrate/Host: Saprobe on dead culm of bamboo.

Geographical distribution: China.

Notes: *Ellisembia reblovae* is similar to *E. aurea* (conidia $(65-)70-97 \times 11-16(-17.5) \mu m$, obclavate to fusiform to lanceolate, 11-13(-15)-distoseptate, tapering apically with a terminal appendage up to 26 µm long) and *E. brachypus* (conidia ellipsoidal, fusiform, rostrate, 5-8-distoseptate, $50-90 \times 10-14 \mu m$; apical cell extended into hyaline, aseptate, apical filiform appendage of $30-74 \times 2-3 \mu m$), but differs from them by producing conidia without apical appendage. In addition, the conidia in *E. aurea* are broader than those in *E. reblovae*. Several *Ellisembia* species have been reported on bamboo, but none of them belongs to Chaetosphaeriaceae (Wu and Zhuang 2005; Yang et al. 2018b; Hyde et al. 2019).

Both ITS and LSU sequences were obtained from the ex-type strain. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 44776 include *Pyrigemmula aurantiaca* (GenBank MH864218, 87% identity), *Ellisembia folliculata* (GenBank OL654015, 88% identity),

E. brachypus (GenBank MK828633, 86% identity) and *E. aurea* (GenBank NR_170735, 87% identity).

Linkosia A. Hern. Gut. & B. Sutton, Mycol. Res. 101: 202, 1997.

Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells discrete, determinate, lageniform, ampulliform, subcylindrical, solitary or aggregated at the base, short, simple, truncate at the apex. Conidial ontogeny holoblastic, one locus per conidiogenous cell, solitary conidia, delimitated by one septum, maturation by diffuse wall-building, secession schizolytic, no proliferation. Conidia holoblastic, straight or slightly curved, narrowly obclavate to obclavate-rostrate, filiform, conical-truncate at the base, distoseptate, pale brown to brown, smooth, subhyaline at the apex (Adapted from Wu and Zhuang 2005).

Type species: *Linkosia coccothrinacis* (A. Hern. & J. Mena) A. Hern. Gut. & B. Sutton.

Ecology/Substrate/Host: Saprobes on decaying plant material, and commonly found on dead culm of bamboo.

Known distribution: Broadly distribution, especially from subtropical and tropical areas.

Description and illustration: Hernández-Gutiérrez and Sutton (1997); Wu and Zhuang (2005); Seifert et al. (2011).

Notes: Linkosia differs from Sporidesmium Link and the other segregated genera in that the conidiophores are absent, the conidiogenous cells are directly formed from superficial hyphae, and the conidia are distoseptate (Subramanian 1992a, b; Hernández-Gutiérrez and Sutton 1997). Stanjehughesia and Janetia are the two related genera to Linkosia in many respects such as absence of conidiophores, lageniform conidiogenous cells directly formed from superficial mycelium and obclavate conidia. However, the conidia in these two genera are euseptate (only one species in Janetia, J. longispora is with distoseptate conidia). In addition, all members of the genus Janetia superficially grow on leaves of various plant species (Ellis 1976; Hughes 1983; Hernández-Gutiérrez and Mena Portales 1996; Goh and Hyde 1996a, b, c). A total of 12 species are known in the genus Linkosia and they can be distinguished by shape, size and septation of conidia (Hernández-Gutiérrez and Sutton 1997; Castañeda-Ruíz et al. 2000; Wu and Zhuang 2005; Zhang et al. 2009; Ma et al. 2011b; Almeida et al. 2014; Delgado 2014; Conceição et al. 2016; Xu et al. 2017).

The ITS and LSU sequences were obtained from four species, *L. filiformia*, *Linkosia gelatinosa*, *L. multiseptum*, *L. obclavata*, and *L. rostrata*, the phylogenetic analysis showed that these four species with distoseptate conidia, *Linkosia gelatinosa*, *L. filiformia*, *L. multiseptum* and *L. rostrata*, were clustered together, while one species *L. obclavata*, with euseptate conidia, is phylogenetically closer



Fig. 22 Linkosia acutispora (Wu1315a, holotype). a-k Conidia. I-o Conidiogenous cells. Scale bar: a-l, n, o 20 µm, m 10 µm

4.

to *Stanjehughesia*. No DNA sequence is available from the type species *L. coccothrinacis*, and assignment of the genus to Chaetosphaeriaceae needs to be further confirmed when the DNA sequence data will be available from fresh collection. Ten species of *Linkosia*, including four new species, are known from China and documented here (Wu and Zhuang 2005; Zhang et al. 2009; Ma 2011; Xu et al. 2017).

Key to all known species of *Linkosia* (Modified from Conceição et al. 2016)

- Conidia with an apical appendage, navicular, 5–6-distoseptate, 28–42×9–13 μm (appendage excluded), appendage 5–12 μm long.....L. ponapensis
- 1. Conidia without apical appendage......2
- 2. Conidia not rostrate.....12
- 3. Conidia 4–7-septate, narrowly obclavate to obclavaterostrate, 43–71×7–11 μm.....L. coccothrinacis
- 3. Conidia not as above......4
- 4. Conidia less than 18-distoseptate......5
- Conidia 11–14-septate, 70–113 \times 9–10 µm, apex with 5 mucilaginous sheathL. gelatinosa 5. Conidia without apical mucilaginous sheath......6 6. Conidia fusiform, with acute apex, 10-14-distoseptate, 130–230×10–14.5 µm.....L. acutispora Conidia obclavate or obclavate-tostrate, apex obtuse 6. 7. Conidia 9-18-septate, narrowly obclavate to long obclavate rostrate, 91–158×6.5–12 µm.....L. longirostrata 7. Conidia not long and narrow rostrate......8 Conidiogenous cells 10-13 µm long; conidia 8. 11–15-distoseptate, 107–123 × 8.5–10.5 µm.....L. rostrata Conidiogenous cells 8-10 µm long; conidia 8-14-dis-8. toseptate, $110-135 \times 10-11.5 \,\mu m$L. subramanianii 9. Conidia sometimes > 20-distoseptate.....10 9. Conidia 15-20-distoseptate, obclavate to obclavaterostrate, 100–160×13–15 µm.....L. fusiformis

Conidia more than 18-distoseptate......9

10.	Conidia < 25-distoseptate, obclavate to obclavate-ros-
	trate11
10.	Conidia 27–30-distoseptate, 300–380×12–14 µm
	L. multiseptata
11.	Conidia 15–21-distoseptate, 122–177×12–16 µm
	L. mori
11.	Conidia 16-21-distoseptate, 160-210 × 7.5-9.5 µm
	L. hibisci
12.	Conidia smooth13
12.	Conidia verruculose14
13.	Conidia bacilliform, attenuated at the ends, 5-9-dis-
	toseptateL. bacilliformis
13.	Conidia cylindrical, slightly clavate, sometimes fili-
	form, 16–21 distoseptateL. aquatica
14.	Conidia 22-35-septate, filiform, long obclavate-ros-
	trate, 260–377 × 7–9.5 μm <i>L. filiformis</i>
14.	Conidia with less than 20 septa, shorter than 200 µm
	long
15.	Conidia pyriform or obpyriform to cylindrical, 1–7
	distoseptate, 16–57×5.5–9 µmL. canescens
15.	Conidia pyriform or obpyriform, 4–6-distoseptate,
	31–37×7–8 µmL. refugia

Linkosia acutispora W.P. Wu & Y.Z. Diao, sp. nov., Fig. 22, MycoBank MB843981.

Etymology: Refers to its conidia with acute apex.

Diagnosis: Conidia fusiform, 10-14-distoseptate, brown, smooth, $130-230 \times 10-14.5 \mu m$; 2-3 basal cells dark brown, with broad and truncate base (8–10 μm wide); sharply tapering toward the acute apex. Differs from all known species in the genus by its fusiform conidia with broader base and acute apex.

Typification: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead culms of *Saccharum* sp., 2 January 1997, W.P. Wu (Wu1315a, Holotype).

Description on the natural substrate: Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae, 2.5–3.5 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells determinate, monoblastic, lageniform, ampulliform, solitary, short, simple, brown to dark brown, 8–16 μ m long, 10–14 μ m wide in swollen base, 6–9 μ m wide at the truncate apex. Conidia holoblastic, straight or slightly curved, fusiform, 10–14-distoseptate, brown, smooth, 130–230×10–14.5 μ m; 2–3 basal cells dark brown, with broad and truncate base (8–10 μ m wide); sharply tapering toward the acute apex.

Materials examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead culms of *Saccharum* sp., 2 January 1997, W.P. Wu (Wu1315a, holotype).

Ecology/Substrate: saprobe on decaying culm of Saccharum.

Geographical distribution: China.

Notes: Morphologically this fungus differs from all known species in the genus by its fusiform conidia with broader base and acute apex (Conceição et al. 2016). *Linkosia coccothrinacis* resembles to *L. acutispora* in conidial shape, but it has fewer septate conidia in smaller size (4–7-septate, 43–71.5×7–11 μ m) and without acute apex (Hernández-Gutiérrez and Sutton 1997). No living strain was obtained.

Linkosia filiformis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 23, MycoBank MB841547.

Etymology: Refers to its long, multiseptate and filamentous conidia.

Diagnosis: Conidiophores absent. Conidiogenous cells lageniform, $14-19 \times 5.5-6 \mu m$, $9-12 \mu m$ at the swollen base. Conidia cylindrical, filamentous, narrowly obclavate-rostrate, 15-23-septate, $230-273 \times 10-11.5 \mu m$.

Typification: China: Hubei Province, Shennongjia, on rotten plant material, 20 September 2004, W.P. Wu, Holotype HMAS352012 (=Wu8277), ex-type strain CGMCC 3.20793 (=NN50606).

Description on the natural substrate: Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae, 2–3 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells discrete, determinate, monoblastic, lageniform, solitary or in groups, short, simple, brown to dark brown, 14–19×5.5–6 µm, 9–12 µm at the swollen base, 4–5.5 µm wide at the truncate apex. Conidia holoblastic, straight or slightly curved, cylindrical, filamentous, narrowly obclavate, (11–)15–23-euseptate, brown to dark brown, smooth, (125–) 230–273×10–11.5 µm; apical cells subhyaline, rounded, 2.5–3 µm; basal cell cylindrical, conical-truncate, 5–6.5 µm wide at the base (Figs. 17c, d).

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, brown to dark brown, reverse of the same color or slightly darker, with yellow pigment diffused into agar.

Other material examined: **China**, Hubei Province, Shennongjia, on rotten plant material, September 2004, W.P. Wu (Wu8169, Wu8204). Living strains: 50717 (from Wu8169) and 50600 (from Wu8204).

Ecology/substrate/host: Saprobe on rotten wood.

Geographical distribution: China.

Notes: *Linkosia filiformis* differs from most of other species in *Linkosia* and related genera including *Riisgaardia* and *Stanjehughesia* by its longer conidia with more septa. *Linkosia multiseptum* (conidia 27–30–distoseptate, $300-380 \times 12-14 \mu m$) also produces long conidia, but differs from *L. filiformis* by longer conidia with more septa. *Linkosia filiformis* also resembles *Riisgaardia longispora*



Fig. 23 Linkosia filiformis (Wu8277, holotype). a-j Conidia. k-m Conidiogenous cells. Scale bar: a-i, k l 10 µm, j, m 5 µm



Fig. 24 Linkosia fusiformis (Wu1326a, holotype). a–o Conidia. p–t Conidiogenous cells. Scale bar: 10 µm

and *R. vermiculata* in conidial shape, but differs from them by longer and narrower conidia with more septa (Wu and Zhuang 2005; Hsieh et al. 2021).

Both ITS and LSU sequences were obtained from the three studied strain. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 50606 include *Linkosia multiseptum* (GenBank OL627557, 97% identity) and *Kionochaeta ivoriensis* (GenBank NR_160149, 88% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the ex-type strain 50506 include *Cryptophiale udagawae* (GenBank MH758211, 95% identity) and *Kionochaeta ivoriensis* (GenBank MH872758, 96% identity).

Linkosia fusiformis W.P. Wu, *Sporidesmium*, *Endophragmiella* and related genera from China: 183, 2005. Figure 24

Description on the natural substrate: Saprobe on dead culm of bamboo. Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae, 2.5–3.5 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells discrete, determinate, monoblastic, lageniform, ampulliform, solitary or aggregated in small group, short, simple, brown to dark brown, 13–15×7–9 μ m, 4–5.5 μ m wide at the truncate apex. Conidia holoblastic, straight or slightly curved, obclavate to obclavate–rostrate, 15–20–distoseptate, pale brown to brown, smooth, 100–160×13–15 μ m; apical cells subhyaline, rounded and with a mucilaginous sheath; basal cell conical-truncate, 4–5.5 μ m wide at the base.

Material examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead culm of bamboo, 2 January 1997, W.P. Wu (Wu1326a, holotype).

Ecology/substrate: Saprobe on dead culm of bamboo. Geographical distribution: China (Wu and Zhuang 2005). Description and illustration: Wu and Zhuang (2005).

Notes: *Linkosia fusiformis* superficially resembles *L. coccothrinacis*, but can be distinguished by its much longer conidia with more septa (Hernández-Gutiérrez and Sutton 1997; Wu and Zhuang 2005). The ex-type living culture NN43150 preserved in NN is contaminated by another fungus, thus no DNA sequence is available for phylogenetic analysis. However, its affinity to *Linkosia* seems to be well-supported by morphology.

Linkosia gelatinosa W.P. Wu & Y.Z. Diao, sp. nov., Fig. 25, MycoBank MB841548.

Etymology: Refers to its conidia with gelatinous apex.

Diagnosis: Conidiophores absent. Conidiogenous cells lageniform, $9-12 \times 4-5 \mu m$, $9-11 \mu m$ at the swollen base. Conidia obclavate-rostrate, 11-14-septate, $70-113 \times 9-10 \mu m$, apex cell with mucilaginous sheath.

Typification: **China**, Hubei Province, Shennongjia, On rotten plant material, 20 September 2004, W.P. Wu, Holotype HMAS 352013 (= Wu8228c), ex-type culture CGMCC 3.20709 (= NN50607).

Description on the natural substrate: Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae, 2–3 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells discrete, determinate, monoblastic, cylindrical, lageniform, ampulliform, solitary or few in groups, short, simple, brown to dark brown, 9–12×4–5 μ m, 9–11 μ m at the swollen base, 4–5 μ m wide at the truncate apex. Conidia holoblastic, straight or slightly curved, obclavate, obclavate-rostrate, 11–14-euseptate, brown to dark brown, smooth, 70–113×9–10 μ m; apical cells subhyaline, rounded, 3–3.5 μ m; basal cell subcylindrical, conicaltruncate, 5–7 μ m wide at the base.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, grey-brown to dark brown, reverse of the same color or darker (Fig. 17e, f).

Ecology/substrate/host: Saprobe on dead branches.

Geographical distribution: China.

Notes: Linkosia gelatinosa is similar to L. coccothrinacis (conidia 4–7-septate, 43–71×7–11 µm), L. fusiformis (conidia 5–20-septate, 100–160×13–15 µm), L. obclavata (conidia 12–14-septate, 110–125×9–12 µm) and L. rostrata (conidia 11–15-septate, 107–123×8.5–10 µm) in producing obclavate to obclavate-rostrate conidia, but differs in a combination of shape, size and septation of conidia (Wu and Zhuang 2005; Conceição et al. 2016).

Both ITS and LSU sequences were obtained from the ex-type strain. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 50607 include *Linkosia multiseptum* (GenBank OL627557, 90% identity) and *Z. xylophia* (GenBank NR_172434, 88% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the strain 50607 include *Linkosia multiseptum* (GenBank OL655008, 97% identity) and *Morrisiella indica* (GenBank DQ408578, 95% identity).

Linkosia hibisci Jian Ma & X.G. Zhang, Mycotaxon 117: 249, 2011.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells discrete, determinate, monoblastic, solitary, simple, lageniform or ampulliform, brown to dark brown, smooth, $9-12 \times 4-5 \mu m$, $4-4.5 \mu m$ wide at the truncate apex. Conidia holoblastic, solitary, acrogenous, straight or curved, obclavate to obclavate-rostrate, dark brown to brown, smooth, 16–21-distoseptate, 160–210 µm long, 7.5–9.5 µm thick in the widest part, tapering to 1.5–2.5 µm near the apex; apical cells pale brown, rounded; basal cell cylindrical, truncate, 2–4.5 µm (Ma et al. 2011a, b).



Fig.25 *Linkosia gelatinosa* (Wu8118a). **a** Hyphae. **b–d** Conidiogenous cells. **e–g** Part of conidia with rough wall and germination pore. **h–o** Conidia with gelatinous apex. Scale bar: **a–g** 5 µm, **h–o** 10 µm

Typification: **China**, Hainan Province, tropical forest of Bawangling, on dead branches of *Hibiscus mutabilis*, 8 Dec 2010, J. Ma (HSAUP H5199-1, holotype; HMAS146142, isotype).

Ecology/substrate/host: Saprobe on dead branches of *Hibiscus mutabilis*.

Geographical distribution: China (Ma et al. 2011a, b).

Description and illustration: Ma et al. (2011a, b).

Notes: *Linkosia hibisci* resembles *L. obclavata* and *L. mori* on conidial shape, but differs on number of conidial septa and size of conidia (Wu and Zhuang 2005; Zhang et al. 2009; Ma et al. 2011b). No DNA sequence data are available for molecular phylogenetic analysis.

Linkosia longirostrata G. Delgado, Mycotaxon 129: 42, 2014.

Teleomorph: Unknown. Anamorph: Conidiophores absent or very reduced, uniseptate, 21–35 μ m long, 6–12.5 μ m wide at the swollen base. Conidiogenous cells 15–27×5–6 μ m, 3–4 μ m wide at the truncate apex. Conidia obclavate to obclavate-rostrate, pale brown, smooth, 10–18-distoseptate, 82–126 μ m long, 6.5–8.5 μ m wide in the broadest part, 3–3.5 μ m wide at the truncate base, apex extended into a pale brown to brown rostrum, 2–2.5 μ m wide, and invested in 1–3 spherical or subspherical, hyaline or subhyaline mucous tunicae ca 6–15 μ m diam. (Xu et al. 2017).

Ecology/substrate/host: Saprobe on dead branch and rachides of dead leaves of *Acoelorrhaphe wrightii*.

Geographical distribution: China and USA (Delgado 2014; Xu et al. 2017).

Description and illustration: Delgado (2014); Xu et al. (2017).

Notes: No specimen was examined in this study and the above description is based on the documentation provided by Xu et al. (2017). No DNA sequence data are available for molecular phylogenetic analysis.

Linkosia mori K. Zhang & X.G. Zhang, Mycotaxon 108: 123, 2009.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells lageniform or ampulliform, $13-17 \times 7-9 \mu m$, $4-5 \mu m$ wide at the truncate apex. Conidia obclavate to obclavate-rostrate, pale brown to brown, smooth, 15-21-distoseptate, $122-177 \mu m$ long, $12-16 \mu m$ thick in the widest part, apical cells subhyaline, basal cell cylindrical to conicaltruncate, $3.5-5.5 \mu m$ wide (Zhang et al. 2009).

Typification: **China**, Guangxi Province, Natural Reserve of Shiwandashan, on dead branches of *Morus alba*, 12 May 2007 (HSAUPviio, holotype; HMAS189369, isotype).

Ecology/substrate/host: Saprobes on dead branch. Geographical distribution: China (Zhang et al. 2009). Description and illustration: Zhang et al. (2009).

Notes: *Linkosia mori* resembles *L. obclavata* and *L. hibisci* on conidial shape, but differs on number of conidial septa and size of conidia (Wu and Zhuang 2005; Zhang et al. 2009; Ma et al. 2011b). No DNA sequence data are available for molecular phylogenetic analysis.

Linkosia multiseptum W.P. Wu, *Sporidesmium*, *Endophragmiella* and related genera from China: 185, 2005. Figure 26

Description on the natural substrate: Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae, 2.5–3.5 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells discrete, determinate, monoblastic, lageniform, ampulliform, solitary, short, simple, brown to dark brown, 10–12.5×9–11 μ m, 8–9 μ m wide at the truncate apex. Conidia holoblastic, straight or slightly curved, obclavate to obclavate–rostrate, 27–30-distoseptate, pale brown to brown, smooth, 300–380×12–14 μ m; apical cells subhyaline, rounded; base truncate and 8–9.5 μ m wide.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, brown to dark brown, reverse of the same color (Fig. 16e, f).

Material examined: **China**, Guangxi Province, Damingshan, on rotten bamboo culm, 18 December 1997, W.P. Wu, Holotype HMAS 352,014 (=Wu1374b). Living strain: extype strain CGMCC 3.20786 (=NN42961).

Ecology/Substrate/Host: Saprobe on rotten culm of bamboo.

Geographical distribution: China (Wu and Zhuang 2005). Description and illustration: Wu and Zhuang (2005).

Notes: *Linkosia multiseptum* differs from all other known species in the genus by its longer and wider conidia with more septa (Hernández-Gutiérrez and Sutton 1997; Conceição et al. 2016). The ITS and LSU sequences were obtained from the type specimen, and its affinity to Chaeto-sphaeriaceae was confirmed.

Linkosia rostrata W.P. Wu & Y.Z. Diao, sp. nov., Fig. 27, MycoBank MB841549.

Etymology: Refers to its rostrate conidia.

Diagnosis: Conidiophores absent. Conidiogenous cells lageniform, 10–13 μ m long, 7.5–10 μ m wide in swollen base, 4.5–5.2 μ m wide at the truncate apex. Conidia obclavate to obclavate-rostrate, 11–15–distoseptate, 107–123×8.5–10 μ m.

Typification: **China**, Hunan Province, Hengshan, on dead culm of bamboo, 10 April. 2002, W.P. Wu, Holotype HMAS 352,015 (= Wu6030b), ex-type culture CGMCC 3.20790 (= NN47479).



Fig. 26 Linkosia multiseptum (Wu1374b, holotype). a-e Conidiogenous cells bearing mature conidia. f-j Conidia. Scale bar: 10 µm

Description on the natural substrate: Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae, 2.5–4 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells discrete determinate, monoblastic, lageniform, ampulliform, solitary, short, simple, brown to dark brown, 10–13 μ m long, 7.5–10 μ m wide in swollen base, 4.5–5.2 μ m wide at the truncate apex. Conidia holoblastic, straight or slightly curved, obclavate to obclavate-rostrate, 11–15-distoseptate, brown, smooth, 107–133×8.5–10.5 μ m; basal cell dark brown, with truncate base; apical cells subhyaline, rounded.

Colonies on PDA effuse, colonies 0.5–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, brown to dark brown, reverse of the same color (Figs. 16g, 17e, f).

Ecology/Substrate: saprobe on dead culm of bamboo. Geographical distribution: China.

Notes: Linkosia rostrata is similar to L. coccothrinacis (conidia 4–7-septate, 43–71×7–11 μ m), L. fusiformis (conidia 5–20-distoseptate, 100–160×13–15 μ m) and L. obclavata (conidia 12–14-euseptate, 110–125×9–12 μ m) but differs on a combination of shape, size and septation of conidia (Wu and Zhuang 2005; Conceição et al. 2016). The ITS and LSU sequences were obtained from the type specimen, and its affinity to Chaetosphaeriaceae was confirmed.

Both ITS and LSU sequences were obtained from the ex-type strain. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 47479 include Zanclospora lateriphiala (GenBank MW144428, 88% identity) and Z. xylophia (GenBank NR_172434, 88% identity). Based on LSU blast in NCBI's GenBank, the closest matches



Fig.27 Linkosia rostrata (Wu6030b, holotype). **a–l, p–r** Conidia. **m–o** Conidiogenous cells formed from superficial hyphae. Scale bar: **a–m** 10 μm, **n–r** 5 μm





Fig. 28 Linkosia subramanianii (Wu5006, Holotype). a Setiform conidiophores. b-h Conidia. i, j Conidiogenous cells. Scale bar: 5 µm

to the strain 47479 include *Morrisiella indica* (GenBank DQ408578, 95% identity) and *Cryptophiale udagawae* (GenBank MH758211, 94% identity).

Linkosia subramanianii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 28, MycoBank MB843982.

Etymology: Named after the former mycologist C.V. Subramanian to recongnized his contribution to the anamorphic fungi. Diagnosis: Conidia obclavate to obclavate–rostrate, 8–14-distoseptate, brown, smooth, $110-135 \times 10-11.5 \mu m$; basal cell dark brown, with truncate base; apical cells subhyaline, rounded. Similar to *L. gelatinosa*, *L. longirostrata* and *L. rostrata*, but differs in shape, color, septation and size of conidia.

Typification: **China**, Sichuan Province, Qingchengshan, on rotten wood, 5 August 2000, W.P. Wu (Wu5006, Holotype).

Description on the natural substrate: Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae, 2.5–3.5 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells determinate, monoblastic, lageniform, ampulliform, solitary, short, simple, brown to dark brown, 8–10 μ m long, 6–8 μ m wide in swollen base, 4.5–5.2 μ m wide at the truncate apex. Conidia holoblastic, straight or slightly curved, obclavate to obclavate-rostrate, 8–14-distoseptate, brown, smooth, 110–135 × 10–11.5 μ m; basal cell dark brown, with truncate base; apical cells subhyaline, rounded.

Ecology/Substrate: saprobe on rotten wood.

Geographical distribution: China.

Notes: Morphologically *Linkosia subramanianii* resembles *L. gelatinosa*, *L. longirostrata* and *L. rostrata*, but differs in conidial septation and size (Conceição et al. 2016). In *L. gelatinosa*, the conidia are with the apical gelatinous sheath and slightly smaller in size $(70-113 \times 9-10 \ \mu\text{m})$ than those in *L. subramanianii*. *Linkosia longirostrata* differs from *L. subramanianii* by its narrowly obclavate to long obclavate rostrate conidia which are longer $(91-158 \times 6.5-12 \ \mu\text{m})$ and with more septate (9-18). In *Linkosia rostrata*, the conidia are lighter in color, especially towards upper part than those in *L. subramanianii*.

Lomaantha Subram., J. Indian Bot. Soc. 33: 32, 1954.

Colonies effuse, brown, hairy, often inconspicuous. Mycelium partly superficial, partly immersed in the substratum, composed of pale brown to brown, septate, branched hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, solitary, simple, cylindrical, straight or slightly flexuous, smooth, septate, brown to dark brown. Conidiogenous cells integrated, terminal, lageniform, smooth, brown to dark brown. Conidial ontogeny holoblastic, one locus per conidiogenous cell, solitary conidia, delimitated by one septum, maturation by diffuse wall-building, secession schizolytic, no proliferation. Conidia acrogenous, solitary, dry, cylindrical, obclavate, rostrate, smooth, pale brown to brown, distoseptate, cell lumina reduced; apex extended into a filamentous, branched and septate appendages (Adapted from Wu and Zhuang 2005).

Type species: Lomaantha pooga Subram.

Ecology/Substrate/Host: Saprobes on decaying plant material.

Known distribution: China and India.

Description and illustration: Subramanian (1954).

Notes: *Lomaantha*, typified by *L. pooga*, is similar to *Ellisembia* Subram., but differs by the conidia with branched appendages at the apex (Subramanian, 1954, 1992a; b). Some species of *Ellisembia* also produce appendaged conidia, but their appendages are unbranched (Ellis 1958, 1971, 1976; Matsushima 1971, 1975, 1983, 1989, 1993). The ITS and LSU sequences of the type species were obtained from the two Chinese collections (Wu1518a and Wu1357a), and the affinity of this genus to Chaetosphaeriaceae was confirmed. Both ITS and LSU sequences are with high identity with those from *Ellisembia*. We propose to maintain this genus as a separate one until the phylogenic relationship of type species of *Ellisembia, Ellisembia coronata*, is clarified. It might be adapted as a potential generic name for those *Ellisembia* species in Chaetosphaeriaceae.

Lomaantha pooga Subram., J. Indian Bot. Soc. 33: 32, 1954. Figure 29

Description on the natural substrate: Colonies effuse, brown, hairy, often inconspicuous. Mycelium partly superficial, partly immersed in the substratum, composed of pale brown to brown, septate, branched hyphae, 2-4.5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, solitary or aggregated at the base, simple, cylindrical, straight or slightly flexuous, smooth, 3-5-septate, brown to dark brown, 70-100 µm long, 7–9 µm wide, base sometimes slightly swollen up to 12 µm. Conidiogenous cells integrated, terminal, lageniform, smooth, brown, $25-30 \times 7-10 \mu m$, apex 4.5-5 μm wide. Conidia acrogenous, solitary, dry, obclavate, rostrate, 17–19-distoseptate, not constricted at the septa, dark brown, becoming pale brown toward the apex, the 2 basal cells distinctly darker than the other cells, $110-135 \times 18-20 \mu m$; apical cell extended into hyaline, aseptate, branched appendage of $45-65 \times 1-1.5 \,\mu\text{m}$; basal cell conical-truncate, darker than other cells, $4-5 \,\mu m$ wide at the base.

Culture characteristics: Colonies on PDA effuse, colonies 0.3–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium not well-developed, yellow to yellow brown, reverse of the same color or slightly darker (Fig. 16g, i).

Materials examined: **China**, Guangxi Province, Damingshan, on dead culm of *Arundo donax*, 18 December 1997, W.P. Wu (Wu1375a); Guangxi Province, Damingshan, on dead culm of *Arundo donax*, 20 December 1997, W.P. Wu (Wu1467b); Guangxi Province, Shiwandashan, on dead culms of bamboo, 29 December 1997, W.P. Wu (Wu1518a). Living strains: 43946 (from Wu1518a) and 42977 (from Wu1375a).



Fig. 29 Lomaantha pooga (**1-h** Wu1375a, **i-o** Wu1518a). **a-b**, **d-i**, **m-o** Conidia with branched or unbranched appendage at the apex. **c**, **j-l** Conidiophores and conidiogenous cells. Scale bar: 20 μm

Ecology/Substrate/Host: Saprobe on decaying plant material, including dead culm of *Arundo donax*.

Geographical distribution: China and India (Subramanian 1954; Wu and Zhuang 2005).

Description and illustration: Subramanian (1954); Wu and Zhuang (2005).

Notes: Lomaantha pooga is probably a tropical species. Except for the slightly shorter conidia ($48-62 \times 12-14 \mu m$), Sporidesmium magnibrachypus is very similar to Lomaantha pooga (Matsushima 1975).

Both ITS and LSU sequences were obtained from the studied strains. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 43946 include *Ellisembia aurea* (GenBank NR_170735, 91% identity), *E. folliculata* (GenBank OL654105, 89% identity), *Pyrigemmula aurantiaca* (GenBank MH864218, 88% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the strain 43946 include *Ellisembia aurea* (GenBank OL655028, 99% identity), *E. folliculata* (GenBank OL654162, 99% identity), *Pyrigemmula aurantiaca* (GenBank OL654162, 99% identity), *Pyrigemmula aurantiaca* (GenBank HM241692, 98% identity), *Lecythothecium duriligni* (GenBank AF261071, 98% identity) and *E. brachypus* (GenBank MBDQ408563, 97% identity).

Morrisiella Saikia & A.K. Sarbhoy, Mycologia 77: 318, 1985.

=*Hemisynnema* Subram., Nova Hedwigia 58: 224, 1994.

Colonies effuse dark brown to black, hairy. Mycelium partly immersed, partly superficially, composed of subhyaline to brown, branched, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnematous, solitary or in group, erect, cylindrical, dark brown to blackish, become narrower toward the apex, composed of closely compacted conidiophores, with a long fertile region. Conidiophores macronematous, synnematous, brown to dark brown, septate, smooth, and cylindrical. Conidiogenous cells integrated, denticulate, terminal, intercalary and lateral, monoblastic, determinate, straight, dark brown to black. Conidial ontogeny holoblastic. Conidia holoblastic, solitary, dry, obclavate-rostrate, straight or curved, pale brown to brown, distoseptate, often with reduced cell lumen, smoothwalled (Adapted from Wu and Zhuang 2005).

Type species: *Morrisiella indica* Saikia & A.K. Sarbhoy. Ecology/Substrate/Host: Saprobes on decaying plant material.

Known distribution: Broadly distributed, especially in subtropical and tropical areas.

Description and illustration: Saika and Sarbhoy (1985); Wu and Zhuang (2005).

Notes: Saikia and Sarbhoy (1985) erected the genus *Morrisiella* based on the type species *M. indica* on bamboo. The most distinctive feature of the genus is its characteristic synnematous conidiomata, lateral or terminal, ampulliform conidiogenous cells coupled with the production of distoseptate conidia. The genus is similar to *Podosporium*, but differs from the members of that genus in the production of integrated conidiogenous cells arranged laterally on

the conidiophores in synnemata and in bearing distoseptate conidia (Ellis 1971, 1976). This type of conidiogenesis and conidial morphology notably the distoseptate conidia are also characteristic of *Linkosia*, but the later genus does not form conidiophores, where the conidiogenous cells directly arising from superficial mycelium (Hernández-Gutiérrez and Sutton 1997; Wu and Zhuang 2005). The second species, *Morrisiella malayasiana* (Subram.) W.P. Wu & W.Y. Zhuang (\equiv *Hemisynnema malayasianum* Subram., Kavaka 20/21(1–2): 58, 1995 (1992/1993) was added into the genus by Wu and Zhuang (2005).

The ITS and LSU sequences of *Morrisiella inidca* were obtained from two strains and its affinity to Chaetosphaeriaceae was confirmed by the phylogenetic analysis. A new species without DNA sequence is added into the genus.

Morrisiella indica Saikia & A.K. Sarbhoy, Mycologia 77: 319, 1985. Figure 30

= Janetia synnematosa Sivan. & W.H. Hsieh, Mycol. Res. 94: 567, 1990.

Description on the natural substrate: Colonies effuse, dark brown to black, hairy. Mycelium partly immersed, partly superficially, composed of subhyaline to brown, and branched, septate hyphae, 2-5 µm wide, forming networks on the surface of substrate. Teleomorph: Unknown. Anamorph: Conidiomata synnematous, solitary or in group of 2-5, erect, cylindrical, dark brown to blackish, up to 2.5 mm high, 100-500 µm wide, become narrower toward the apex, composed of closely compacted conidiophores, with a long fertile region. Conidiophores macronematous, synnematous, brown to dark brown, multiseptate, smooth, cylindrical, 2.5-4 µm wide. Conidiogenous cells integrated, denticulate, ampulliform, terminal, intercalary and lateral, monoblastic, determinate, straight, dark brown to black, 10–15 μ m long, 4–8 μ m wide at the base, 2–3 μ m wide at the apex, truncate. Conidia holoblastic, solitary, dry, obclavate- rostrate, straight or curved, pale brown to brown, 9-22-distoseptate, often with reduced cell lumen, smooth, $80-120 \times 10-12.5 \,\mu\text{m}$, basal cell conical, truncate, darker than other cells, dark brown to black, apex obtuse, pale brown.

Culture characteristics: Colonies on PDA effuse, colonies 1 cm diameter in 14 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, brown to dark brown, reverse of the same color (Fig. 16j, k).

Materials examined: **China**, Guangdong Province, Dinghushan, on dead culm of bamboo, 9 October 1998, W.P. Wu (1913a); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead culms of *Arundo donax*, 2 January 1997, W.P. Wu (Wu1258a); Guangxi Province, Shiwandashan, on dead culm of bamboo, 29 December 1997, W.P. Wu (1527a).



Fig. 30 Morrisiella indica (Wu1913a). a, b Synnemata. c-f Conidiogenous cells arising laterally on synnemata. g-n Conidia. Scale bar: a, b 50 μm, c 20 μm, d-n 10 μm

Living strains: 42908 (from Wu1258a) and 44,710 (from Wu1913a).

Ecology/substrate/host: Saprobes on decaying plant material, including *Arundo donax* and bamboo.

Geographical distribution: China and India (Saikia and Sarbhoy 1985; Sivanesan and Hsien 1990; Wu and Zhuang 2005).

Descriptions and illustrations: Saikia and Sarbhoy (1985); Sivanesan and Hsien (1990); Wu and Zhuang (2005).

Notes: *Morrisiella indica* has been known on dead stem of grasses including *Bambusa tulda*, *Miscanthus floridulus*, *Schizostachyum dumetorum* and *Thysanolaena macima* from tropical areas and probably it has much wider distribution. Its occurrence in China including Taiwan and Hoog Kong has been reported (Sivanesan & Hsien 1990; Wu and Zhuang 2005). Both ITS and LSU sequences were obtained from the two studied strains. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 44710 include *Cryptophialoidea fasciculata* (GenBank MH758195, 92% identity) and *Eucalyptostroma eucalypti* (GenBank NR_154027, 86% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the strain 44710 include *Morrisiella indica* (GenBank DQ408578, 100% identity), *Kionochaetia ivoriensis* (GenBank MH872758, 95% identity) and *Cryptophiale udagawae* (GenBank MH758211, 95% identity).

Morrisiella malayasiana (Subram.) W.P. Wu & W.Y. Zhuang, *Sporidesmium, Endophragmiella* and related genera from China: 189, 2005.

 \equiv Hemisynnema malayasianum Subram., Kavaka 20/21(1-2): 58, 1995 (1992/1993).

Ecology/substrate/host: Saprobes on decaying plant material.



Fig. 31 *Morrisiella reblovae* (Wu9002, holotype). **a**, **b** Synnemata and conidia. **c**–**e** Part of the synnemata bearing conidiophores and conidiogenous cells. **f**–**j** Part of the synnemata, showing the terminal and intercalary conidiogenous cells. **k**–**o** Conidia. Scale bar: **a**, **b** 50 µm, **c**–**o** 10 µm

Geographical distribution: India (Subramanian 1995). Descriptions and illustrations: Subramanian (1994).

Notes: The new combination was made by Wu and Zhuang (2005).

Morrisiella reblovae W.P. Wu & Y.Z. Diao, sp. nov., Fig. 31, MycoBank MB841550.

Etymology: Named after the mycologist Martina Réblová, who made significant contribution for taxonomy of Chaetosphaeriaceae.

Diagnosis: Similar to *Morrisiella indica* in producing synnematous conidiomata, integrated conidiogenous cells and distoseptate conidia, but differs in fusiform-shaped conidia in smaller size $(50-79 \times 8.5-10 \ \mu\text{m})$ and with a narrower base $(1.8-2 \ \mu\text{m}$ wide).

Typification: **China**, Yunnan Province, Jinghong, Xishuangbanna, on dead branches of unidentified broad leaf tree, March 2000, W.P. Wu, Holotype HMAS 352026 (=Wu9002).

Description on the natural substrate: Colonies effuse, dark brown to black, hairy. Mycelium partly immersed, partly superficially, composed of subhyaline to brown, and branched, septate hyphae, 2-4 µm wide, forming networks on the surface of substrate. Teleomorph: Unknown. Anamorph: Conidiomata synnematous, solitary or in group from superficial mycelium network, erect, cylindrical, dark brown to blackish, 500-753 µm high, 10-17 µm wide, basal part up to 30 µm wide, becoming slightly narrower toward the apex, composed of one central setae and closely compacted conidiophores, with a long fertile region from base to apex; central setae cylindrical, dark brown, multiseptate, completely covered by conidiophores and hyphae, 6-8 µm wide, apex rounded. Conidiophores macronematous, brown to dark brown, multiseptate, smooth, cylindrical, 1–1.5 µm wide. Conidiogenous cells integrated, denticulate, ampulliform, intercalary and lateral, monoblastic, determinate, straight, brown to dark brown; basal part pale brown, thin-walled, 13–16 µm wide; upper part cylindrical, becoming darker towards the apex, smooth, 5–6 µm wide, with truncate apex up to 2 µm wide. Conidia holoblastic, solitary, dry, fusiform, obclavate-rostrate, straight or slightly curved, brown to dark brown, 8–9–distoseptate, often with reduced cell lumen, smooth, $50-79 \times 8.5-10 \,\mu\text{m}$; basal cell conical, truncate, darker than other cells; apical cell conical with obtuse apex, pale brown, sometime with short extension.

Ecology/Substrate/Host: Saprobe on dead branches of unidentified broad leaf tree.

Geographical distribution: China.

Notes: *Morrisiella reblovae* resembles *M. indica*, the type species of the genus, but differs in shorter and narrower synnemata, pale brown conidiogenous cells, and fusiform, fewer septate conidia in smaller size (Wu and

Zhuang 2005; Seifert et al. 2011). Unfortunately, no living culture was obtained, its affinity to the genus is still in doubtful.

Stanjehughesia Subram., Proc. India Natn. Acad. Sci. B 58: 184, 1992.

Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae. Teleomorph: See Réblová (1999a, b). Anamorph: Conidiophores absent. Conidiogenous cells discrete, determinate, lageniform, ampulliform, solitary, short, simple, truncate at the apex. Conidial ontogeny holoblastic, 1 locus per conidiogenous cell, solitary conidia, delimitated by one septum, maturation by diffuse wall-building, secession schizolytic, no proliferation. Conidia holoblastic, straight or slightly curved, narrowly obclavate to obclavate-rostrate, conicaltruncate at the base, euseptate, pale brown to brown, smooth, subhyaline at the apex (Aapted from Wu and Zhuang 2005).

Type species: *Stanjehughesia hormiscioides* (Corda) Subram.

Ecology/Substrate/Host: Saprobes on decaying plant material.

Known distribution: Broadly distributed, especially in subtropical and tropical areas.

Description and illustration: Subramanian (1992a, b); Wu and Zhuang (2005).

Notes: *Stanjehughesia* Subram. is a relatively small genus segregated from *Sporidesmium* (Subramanian, 1992a, b). It is characteristic of absence of conidiophores, discrete conidiogenous cells, and euseptate, obclavate conidia. Morphologically *Stanjehughesia* resembles *Linkosia* and *Janetia*, but can be distinguished from *Linkosia* by its euseptate conidia, from *Janetia* by its monoblastic conidiogenous cells and lignicolous habitat (Ellis 1976; Hughes 1983; Swart 1985; Subramanian 1992a, b; Hernández-Gutiérrez and Mena Portales 1996; Goh and Hyde 1996c; Hernández-Gutiérrez and Sutton 1997; Wu and Zhuang 2005; Hsieh et al. 2021). *Pseudostanjehughesia*, typified by *P. aquitropica*, is also similar to *Stanjehughesia* on absence of conidiophores and euseptate conidia, but phylogenetically distinct and belongs to different family (Yang et al. 2018b).

Twenty species are known under the genus and they can be distinguished by conidial size and septation (Subramanian 1992a, b; McKenzie 1995; Wu and Zhuang 2005; Delgado 2008; Marincowitz et al., 2008; Ma et al. 2011b; Almeida et al. 2014; Ma 2016; Mena Portales et al. 2016; Heuchert et al. 2018; Hsieh et al. 2021).

Teleomorph of *Stanjehughesia* was found from 2 species: *Stanjehughesia hormiscioides* (as *Sporidesmium hormiscioides*) has *Umbrinosphaeria caesariata* (=*Lasiosphaeria caesariata*) as the teleomorph, which was confirmed by single spore isolation method (Réblová and Winka 2001); *Stanjehughesia larvata* (Cooke) Subram. (as *Sporidesmium larvata*) has *Miyoshiella larvata* as the teleomorph (Réblová 1999a; Réblová and Winka 2001). In both species, the teleomorphs are with fusiform, multiseptate and versicolorous ascospores.

Our phylogenetic analysis shows that the genus Stanjehughesia is polyphyletic, and species with available ITS/ LSU sequences are grouped into 5 different clades in the phylogenetic tree (Fig. 3). Among them, three species belong to Chaetosphaeriaceae: the type species of the genus Stanjehughesia, S. hormiscioides (= Chaetosphaeria caesariata; = Umbrinosphaeria caesariata), is clustered together with Exserticlava and represents a separate genus in Chaetosphaeriaceae; S. vermiculata is clustered together with several other Sporidesmium-like fungi; and S. kaohsiungensis is clustered together with Codinaea-like fungi with septate conidia, and belongs to an independent genus; two species should be excluded from the family, S. polypora belongs to Xylariales. Further phylogenetic analysis is needed with more DNA sequences available to clarify their phylogenetic relationship and revision of the genus (Réblová 1999a; Réblová and Winka 2001; Shenoy et al. 2006; Hyde et al. 2019; Réblová et al. 2020, 2021a; Hsieh et al. 2021).

Despite the immature phylogeny-based taxonomy at this stage, Hsieh et al. (2021) recognized 18 species of *Stanje-hughesia* based on morphology and a detailed morphological comparison, with a taxonomic key to ease species identification. Some of the taxonomic issues were also discussed. A total of ten species of *Stanjehughesia* have been reported from China (Wu and Zhuang 2005; Ma et al. 2011a, b; Ma 2016; Hsieh et al. 2021).

Key to all species of *Riisgaardia* (*R*.), *Stanjehughesia* (*S*.) and *Falholtia* (*F*.) (Revised after Hsieh et al. 2021)

1. Conidia with both eusepta and distosepta......2 1. 2. Conidia obclavate, apex rostrate, curved or coiled, 65–140×5.5–7.5 μm.....S. curviapicis 2. Conidia cylindrical to clavate, apex broadly rounded, 60-7×8-12 μm.....S. clavata 3. Conidia obclavate, apex conical or rostrate......4 3. Conidia cylindrical, cylindro-clavate, vermiform, fusiform, ellipsoidal, apex obtuse or rounded......14 4. 4. Conidial wall smooth.....7 Conidia 90–170 (–200) \times 12–17 µm, apex rostrate and 5. with a mucilaginous sheath.....S. decorosa 5. Conidia obclavate or fusiform, $60-118 \times 7-11 \mu m$, 6. 9-15-septate, apex subhyaline and with a broken outer wall.....S. fasciculata

6.	6.Conidia obclavate or ventricose, $100-140 \times 10.5-14.5 \mu m$, 19–27-septate, apex not as above
-	F. kaohsiungensis
7.	Conidia $/-9 \mu\text{m}$ wide
7.	Conidia $10-20 \mu\text{m}$ wide
8.	Conidia 130–190×7–9 μ m, 13–19-septate, with 0–2
	lateral branches at upper partS. micheliae
8.	Conidia $65-85 \times 7-8 \ \mu\text{m}$, $6-8$ -septate, apical regions
	lacking lateral branchesS. fusiformis
9.	Conidiogenous cells 3.5–4.5 µm wide at the truncated apex; conidia typically obclavate10
9.	Conidiogenous cells $4-7 \mu m$ wide at the truncated
	apex; conidia ventricose, cylindro-obclavate, elongate-
	fusiform or vermiform11
10.	Conidia 12–14-septate, 110–125×9–12 μm
10.	Conidia 11–14-septate, 80–120×10–12 µm
11.	Conidia ventricose. 15–20 um wide
	S. ventricosa
11.	Conidia cylindro-obclavate, elongate-fusiform to ver-
	miform $10-15 \text{ µm}$ wide 12
12	Conidia 7–16-septate 52 5–145 µm long
12.	S obclavorostrata
12	Conidia with more than 16 sents longer than
12.	150 µm 13
13	Conidia $120-270 \times 12-15$ µm $12-26$ -sentate
15.	<i>R</i> vermiculata
13	Conidia $230-273 \times 10-115$ µm $15-23$ -sentate
10.	R longispora
14	Conidia $32-50(-79)$ µm long $5-15$ -septate 15
14.	Conidia $65-214$ µm long $8-36$ -sentate 17
15	Conidiophores absent or short 1–2 septate: conidia
15.	$40-79 \times 9-12$ µm $10-15$ -sentate S larvata
15	Conidiophores absent: conidia $34-48 \times 6-10$ µm
15.	5-9-septate
16.	Conidia cylindro-obclavate. 6–7 um wide
	S. floridensis
16.	Conidia fusiform or ellipsoidal, 8.5–10 um wide
10.	S minima
17	Conidia vermiform broader and distinctly darker at
17.	the middle portion $130-214 \times 10-12$ µm $23-36$ -sep-
	tate S nigroga
17	Conidia cylindrical to cylindro-fusoid apex broadly
17.	rounded uniform in color $9-17$ µm wide $8-20$ -sep-
	total total 12
18	Conidiogenous cells in fascicles: conidia
10.	$65_{150} \times 13_{17} \times 17$ µm 8 20 sentete
	03-130 × 13-17 μm, 0-20-septate
18	Conidiogenous cells solitery: conidio 00, 205 y
10.	$9_{14}5 \text{ um } 8_{20}\text{ sentate}$
	γ 1 1.5 μm, 0 20 septate

Stanjehughesia curviapicis (Goh & K.D. Hyde) D.A.C. Almeida & Gusmão, Nova Hedwigia 98: 438, 2014.

≡ Janetia curviapicis Goh & K.D. Hyde, Mycologia 88: 1015, 1997.

= *Stanjehughesia hamatiella* W.P. Wu, *Sporidesmium*, *Endophragmiella* and related genera from China: 94, 2005.

Materials examined: **China**, Guangdong Province, Dinghushan, on dead culm of bamboo, 9 October 1998, W.P. Wu (Wu1911b, holotype of *Stanjehughesia hamatiella*).

Ecology/substrate/host: Saprobes on decaying plant material.

Geographical distribution: Australia (Goh and Hyde 1997) and China (Wu and Zhuang 2005).

Description and illustration: Goh and Hyde (1997); Wu and Zhuang (2005).

Notes: The hamate conidia in *Stanjehughesia curviapicis* is characteristic and make it easily being distinguished from all other known species in the genus (Ellis 1958, 1959, 1961, 1976; Subramanian 1992a, b; Wu and Zhuang 2005). No living strain was obtained for molecular phylogenetic study, its affinity to Chaetosphaeriaceae remains to be confirmed.

Stanjehughesia fasciculata J. Mena, Delgado & Guarro, Mycologia 93: 754, 2001.

Materials examined: **China**, Hainan Province, on dead petiole of palm, 20 December 2000, W.P. Wu and Yan Huang (Wu5502); Hainan Province, on dead petiole of palm, 20 December 2000, W.P. Wu and Yan Huang (Wu5508, Wu5519a).

Ecology/substrate/host: Saprobes on rotten petiole of palm.

Geographical distributions: China (Wu and Zhuang 2005) and Cuba (Mena Portales et al. 2001).

Descriptions and illustrations: Mena Portales et al. (2001); Wu and Zhuang (2005).

Notes: *Stanjehughesia fasciculata* differs from other species in the genus by its verruculose, dark brown to black conidia with apical mucilaginous appendage (Subramanian 1992a, b; Mena Portales et al. 2001). No living strain was obtained for molecular phylogenetic study, its affinity to Chaetosphaeriaceae remains to be confirmed.

Stanjehughesia fusiformis W.P. Wu, *Sporidesmium*, *Endophragmiella* and related genera from China: 92, 2005.

Materials examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on decaying culm of bamboo, 2 January 1997, W.P. Wu (Wu2095, holotype).

Ecology/substrate/host: Saprobe on dead culm of bamboo.

Geographical distribution: China (Wu and Zhuang 2005). Description and illustration: Wu and Zhuang (2005).

Notes: Among the known species in the genus, *Stanje-hughesia caespitulosa* (., *S. hormiscioides*, *S. larvata* and

S. nigroaca produce cylindrical to subcylindrical conidia, thus can be easily distinguished from S. fusiformis which has obclavate to fusiform conidia (Ellis 1958, 1971, 1976). The conidia in S. and S. vermiculata are also obclavate to fusiform but are much longer and with more septa than S. obclavata (Conidia 16–26-septate and 120–270×10–15 μ m in S. vermiculata; 10–14-septate and 170–200×12–17 μ m in S. decorosa).

Stanjehughesia hormiscioides (Corda) Subram., Proc. Indian natn Sci. Acad., Part B. Biol. Sci. 58(4): 184, 1992. Figure 32

 \equiv Sporidesmium hormiscioides Corda, Icon. Fung. (Prague) 2: 6, 1838.

 \equiv Helminthosporium hormiscioides (Corda) Sacc. (as 'Helmisporium'), Michelia 1 (no. 1): 85, 1877.

≡ *Clasterosporium hormiscioides* (Corda) Sacc., Syll. Fung. (Abellini) 4: 383, 1886.

=*Lasiosphaeria caesariata* (Clinton & Peck) Sacc., Syll. Fung. (Abellini) 2: 192, 1883.

= *Phaeotrichosphaeria caesariata* (Clinton & Peck) M.E. Barr, in Barr, Rogerson, Smith & Haines, Bull. N.Y. St. Mus. 459: 12, 1986.

= Umbrinosphaeria caesariata (Clinton & Peck) Réblová, Mycotaxon 71: 18, 1999.

= Chaetosphaeria caesariata (Clinton & Peck) F.A. Fernández & Huhndorf, Fungal Divers. 18: 49, 2005.

= *Sphaeria caesariata* Clinton & Peck, in Peck, Ann. Rep. N.Y. St. Mus. Nat. Hist. 29: 60, 1878 (1876).

Description on the natural substrate: Mycelium superficial. Teleomorph: Not observed. Anamorph: Conidiophores absent. Conidiogenous cells discrete, determinate, solitary or rarely in clusters on the substrate surface, short, dark brown, smooth and thick-walled, ampulliform, mostly $14-16 \times 5-5.5 \mu m$, with a bulbous base $13-15 \mu m$ wide, rounded at the distal end, apical cell subhyaline, truncate at the proximal end and $4.7-5 \mu m$ wide at the base. Conidia holoblastic, terminal and single at the conidiophore apex, dark brown, with basal cell, or cells, darker, smooth, thick-walled, obclavate, cylindrical, straight with rounded apex and slight tapering toward a narrower truncated base, 10-12-septate, $85-100 \times 14-16 \mu m$.

Materials examined: China, Hubei Province, Shengnongjia, on rotten wood, September 2004, W.P. Wu (Wu8263).

Ecology/substrate/host: Saprobes on dead branch and rotten wood of many trees.

Geographical distribution: China, Italy, New Zealand and USA (Ellis 1958, 1971; Hughes and Illman 1974a, b; Shoemaker and White 1985; Réblová, 1999a, b; Hsieh et al. 2021).

Description and illustration: Ellis (1958, 1971); Hughes and Illman (1974a, b); Shoemaker and White (1985); Réblová (1999a, b); Hsieh et al. (2021).



Fig. 32 Stanjehughesia hormiscioides (Wu8263). a-i Conidia. j-m Developing conidia. n-s Conidiogenous cells. Scale bar: 10 µm

Notes: Among the known species of *Stanjehughesia*, *S. caespitulosa*, *S. hormiscioides*, *S. clavata*, and *S. nigroaca* produce clavate to cylindrical conidia with rounded apex and they can be distinguished by size and septation of conidia (Ellis 1958, 1971, 1976; Shoemaker and White 1985; Sutton 1989; Almeida et al. 2014; Hsieh et al. 2021). *Stanjehughesia hormiscioides* was fully described and illustrated in several publications. The fungus from the single Chinese

specimen has shorter conidia with fewer septa, otherwise it is very similar to those described in literatures. Attempt to get the pure culture was failed due to no germination of spore.

Stanjehughesia jiangxiensis Jian Ma, Mycotaxon 131: 585, 2016.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores reduced to conidiogenous cells. Conidiogenous cells discrete, monoblastic, determinate, solitary or grouped, cylindrical or ampulliform, brown to dark brown, smooth, $9.5-22 \times 3.5-4 \mu m$. Conidia acrogenous, straight or curved, obclavate to obclavate-rostrate, brown, smooth, 11-14-euseptate, $82-120 \mu m$ long, $10-12 \mu m$ thick in the broadest part, tapering to $2.5-3 \mu m$ near the apex, $3.5-4 \mu m$ wide at the truncate base (Ma 2016).

Ecology/substrate/host: Saprobes on dead branches.

Geographical distribution: China (Ma 2016).

Description and illustration: Ma (2016).

Notes: Stanjehughesia jiangxiensis is characterized by absence of conidiophores, aggregated conidiogenous cells, and 11-14-septate, obclavate-rostrate conidia of $82-120 \times 10-12 \mu m$ conidia (Ma 2016). No living strain is available for molecular phylogenetic study and the above description is based on the original publication, its affinity to the genus is doubtful.

Stanjehughesia larvata (Cooke & Ellis) Subram., Proc. Indian Natn. Acad. Sci. B 58: 184, 1992.

 \equiv Sporidesmium larvatum Cooke & Ellis, Grevillea 6: 86, 1878.

≡ Clasterosporium larvatum (Cooke & Ellis) Sacc., Syll. Fung. 4: 385, 1886.

Materials examined: **China**. Guangdong Province, Dinghushan, on dead branches of *Eucalyptus* sp., 10 October 1998, W.P. Wu (Wu1958); Yunnan, Kunming Botanical Garden, on dead bark, 22 October 1999, W.P. Wu and Yan Huang (Wu2528).

Ecology/substrate/host: Saprobes on dead branches of tree, including *Eucalyptus* sp.

Geographical distributions: Canada, China, Japan, Pakistan, UK, USA and USSR (Ellis 1958, 1971; Matsushima 1975).

Descriptions and illustrations: Ellis (1958, 1971); Matsushima (1975).

Notes: The cylindrical conidia and short but distinct conidiophores are characteristic of *Stanjehughesia larvata*. The very short but distinctly differentiated conidiophores, as described and illustrated by Ellis (1958) and Matsushima (1975), were seen from both collections examined here, which might mean that this species probably should be remained in its original genus *Sporidesmium* (Castañeda-Ruiz and Kendrick, 1990b; McKenzie 1995). No living strain was obtained for molecular phylogenetic study, its affinity to Chaetosphaeriaceae remains to be confirmed when DNA sequence is available.

Stanjehughesia micheliae Jian Ma & X.G. Zhang, Mycotaxon 117: 251, 2011. Typification: **China**, Guangdong Province, Chebaling National Park Reserve, on dead branches of *Michelia skinneriana*, 16 Oct 2010, J. Ma (HSAUP H5414, holotype; HMAS146143, isotype).

Ecology/substrate/host: Saprobes on dead branch of *Michelia skinneriana*.

Geographical distribution: China (Ma et al. 2011a, b). Description and illustration: Ma et al. (2011a, b).

Notes: *Stanjehughesia micheliae* is unique in producing obclavate to obclavate-rostrate conidia with 0–2 branches at the upper part. No DNA sequence is available for phylogenetic study, its phylogenetic relationship with other known *Stanjehughesia* species is remained to be studied.

Stanjehughesia minima W.P. Wu, *Sporidesmium*, *Endophragmiella* and related genera from China: 97, 2005.

Materials examined: **China**, Hainan Province, on dead culm of bamboo, 20 December 2000, W.P. Wu and Yan Huang (WU5558, holotype).

Ecology/substrate/host: Saprobe on dead culm of bamboo.

Geographical distribution: China (Wu and Zhuang 2005). Description and illustration: Wu and Zhuang (2005).

Notes: *Stanjehughesia minima* differs from all other known species in the genus by small-sized, fusiform to ellipsoidal conidia. Morphologically it resembles *S. larvata*, but differs by absence of conidiophores, small-sized conidia with less septa (Ellis 1958; Subramanian 1992a, b; Wu and Zhuang 2005). No living strain was obtained for molecular phylogenetic study, its affinity to Chaetosphaeriaceae remains to be confirmed when DNA sequence is available.

Stanjehughesia polypora W.P. Wu, *Sporidesmium*, *Endophragmiella* and related genera from China: 99, 2005.

Description on the natural substrate: Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae, 2–3.5 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells discrete, determinate, monoblastic, cylindrical to ampulliform, solitary, short, simple, brown to dark brown, 13–18×3.5–5 μ m, 3.5–4.5 μ m wide at the truncate apex. Conidia holoblastic, straight or slightly curved, fusiform, obclavate to obclavate-rostrate, 15–20-euseptate, pale brown to brown, become pale brown to subhyaline at the apex, smooth, constricted at the septation, each cell with a germination pore, 110–165×10–12 μ m; apical cells subhyaline, rounded; basal cell cylindrical, conical-truncate, 3.5–4.5 μ m wide at the base.

Materials examined: **China**, Jilin Province, Changbaishan, on dead branch, 5 September 1998, W.P. Wu (Wu1774b1, holotype); Guangxi province, Shangsi County, on rotten wood, 31 December 1997, W.P. Wu (Wu1690); Yunnan Province, Gaoligongshan, on rotten wood, October 2003, W.P. Wu (Wu7308). Living strain: 47796 (from Wu7308).

Ecology/substrate/host: Saprobes on dead branch and rotten wood.

Geographical distribution: China (Wu and Zhuang 2005). Description and illustration: Wu and Zhuang (2005).

Notes: *Stanjehughesia polypora* differs from all known species in the genus by obclavate and multiseptate conidia with a germination pore in each cell (Ellis 1958, 1971, 1976; Subramania1992; Wu and Zhuang 2005). The ITS and LSU sequences were obtained from the single isolate 47796 and they clearly showed affinity to Chaetosphaeriaceae.

Stanjehughesia nigroaca (B. Sutton) Subram., Proc. Indian Natn. Sci. Acad. B 58: 184, 1992.

 \equiv Sporidesmium nigroaca B. Sutton, Sydowia 41: 341, 1989.

Description and illustration: Sutton (1989).

Substrate: On rotten wood.

Geographical distribution: Australia and China (Sutton 1989; Lu et al. 2000).

Notes: Lu et al. (2000) reported this species on submerged wood from Hong Kong.

Falholtia W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB841517.

Etymology: Named after the former senior R&D leader, Per Falholtia, from Novozymes.

Diagnosis: Similar to *Stanjehughesia*, but differs from it by producing septate conidiophores in clusters or synnemata. Phylogenetically they are also distinct.

Type species: *Falholtia kaohsiungensis* (S.Y. Hsieh, Goh & C.H. Kuo) W.P. Wu & Y.Z. Diao.

Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnematous, cylindrical, dark brown to blackish, composed of closely compacted conidiophores, with a long fertile region; or composed of aggregated conidiophores in cluster. Conidiophores cylindrical, septate, dark brown. Conidiogenous cells integrated, monoblastic, determinate, cylindrical or lageniform, truncate at the apex. Conidial ontogeny holoblastic, 1 locus per conidiogenous cell, solitary conidia, delimitated by 1 septum, maturation by diffuse wall-building, secession schizolytic, no proliferation. Conidia holoblastic, straight or slightly curved, obclavate-rostrate, conical-truncate at the base, euseptate, pale brown to brown, smooth or verrucose, paler towards the apex.

Ecology/Substrate/Host: Saprobe on decaying branches. Geographical distribution: China.

Notes: *Falholtia* is characterized by cylindrical and septate conidiophores in clusters or synnemata, integrated and determinate conidiogenous cells, and dark

brown, obclavate-rostrate, euseptate conidia. The genus is monotypic.

Falholtia kaohsiungensis (S.Y. Hsieh, Goh & C.H. Kuo) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 33, MycoBank MB841677.

≡ *Stanjehughesia kaohsiungensis* S.Y. Hsieh, Goh & C.H. Kuo, Phytotaxa 484: 267, 2021.

Description on the natural substrate: Colonies on natural substratum scattered, brown. Mycelium partly immersed and partly superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnematous, solitary or in group of 2-5, erect, cylindrical, dark brown to blackish, up to 2.5 mm high, 100-500 µm wide, become narrower toward the apex, composed of closely compacted conidiophores, with a long fertile region. Conidiophores short, septate, cylindrical, dark brown to black, smoothwalled; upper part divergent from synnemata, 1-2-septate, $13-30(-34) \times 4-5$ µm. Conidiogenous cells integrated, terminal, monoblastic, determinate, cylindrical or lageniform. Conidia acrogenous, holoblastic, solitary, straight to flexuous or slightly sigmoid, obclavate-rostrate, lower portion ventricose, thick-walled and somewhat verrucose at the ventricose region, brown to dark olivaceous brown, smooth and slightly paler toward the rostrate apex, (9-)19-27-euseptate, slightly constricted at the septa, $(60-)100-140 \ \mu m$ long, 10.5–14.5 µm wide at the broadest part, tapering to 4.5–5.5 μ m near the apex, 3.5–4 μ m wide at the truncated base.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1.2 cm diameter in 14 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, yellow brown, reverse of the same color or slightly dark brown, with yellow pigment in the medium (Fig. 161).

Materials examined: **China**, Hubei Province, Shengnongjia, on dead stem of unidentified plant, September 2004, W.P. Wu (Wu8321). Living strain: 50711 (from 8321).

Ecology/substrate/host: Saprobe on decaying branch and wood.

Geographical distribution: China (Hsieh et al. 2021).

Description and illustration: Hsieh et al. (2021).

Note: *Stanjehughesia kaohsiungensis* is a recently described species and its affinity to Chaetosphaeriaceae was confirmed by molecular phylogenic analysis (Hsieh et al. 2021). The ITS sequence from the living strain derived from the specimen Wu8321 is almost identical to the one from the type specimen. However, the fungus from our specimen forms synnemata on natural substrate, which is different from the clustered conidiogenous cells in the type specimen.

Both ITS and LSU sequences were obtained from the studied strain. Based on ITS blast in NCBI's GenBank, the



Fig. 33 *Falholtia kaohsiungensis* (Wu8321). **a, b** Synnemata. **c** Hyphae in the synnemata. **d** Conidiophores with 1–2 septa and bearing terminal conidiogenous cells. **e–k, r** Conidia. **l–q** Development of conidia. Scale bar: **a, b** 100, **c, e–k, r** 20 μm, **d, l–q** 10 μm

6

closest matches to the strain 50711 include *Stanjehughe-sia kaohsiungensis* (GenBank NR_172187, 100% identity), *Stilbochaeta novae-guineensis* (MycoBank OL654123, 95% identity), *S. malaysiana* (GenBank NR_175769, 95

identity), *S. submersa* (GenBank NR_168800, 95% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the strain 50711 include *S. kaohsiungensis* (GenBank OL655083, 100% identity), *S. brevisetula* (GenBank

OL654177, 97% identity) and *Chaetosphaeria rivularia* (GenBank KR347357, 97% identity).

Riisgaardia W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB841516.

Etymology: Named after the former CEO of Novozymes A/S, Steen Riisgaard, who made great contribution in promoting industrial biotechnology for sustainability.

Diagnosis: Similar to *Stanjehughesia* and *Stanjehughesia* synanamorph of *Zanclospora* in absence of conidiophores, monoblastic and determinate conidiogenous cells, and obclavate-rostrate, euseptate conidia, but differs phylogenetically.

Type species: *Riisgaardia longispora* W.P. Wu & Y.Z. Diao.

Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells discrete, determinate, lageniform, subcylindrical, ampulliform, short, solitary or in groups from basal stroma, simple, brown to black, truncate at the apex. Conidial ontogeny holoblastic, 1 locus per conidiogenous cell, delimitated by 1 septum, maturation by diffuse wall–building, secession schizolytic. Conidia solitary, straight or slightly curved, narrowly obclavate to obclavaterostrate, conical-truncate at the base, euseptate, pale brown to brown, smooth, subhyaline at the apex.

Ecology/Substrate/Host: Saprobes on rotten plant material.

Geographical distribution: China and Europe.

Notes: Riisgaardia is similar to Stanjehughesia and Stanjehughesia synanamorph of Zanclospora in absence of conidiophores, dark brown to black conidiogenous cells with truncate apex, and cylindrical, obclavate to obclavaterostrate, multiseptate conidia, and in fact they can hardly be distinguished from each other on morphology (Subramanian 1992a, b; Wu and Zhuang 2005; Seifert et al. 2011; Hsieh et al. 2021; Réblová et al. 2021a). However, in the phylogenetic tree generated from the integrated ITS and LSU data, they are clearly distinguished: species of Riisgaardia, together with several other Sporidesmium-like species, are clustered together with several chaetosphaeriaceous genera producing lateral phialides and hyaline conidia; while the type species of Stanjehughesia, S. hormiscioides, is clustered together with Exserticlava and Stephembruneria, both with brown and septate conidia.

Both ITS and LSU sequences were obtained from the studied strain of the type species, *R. longispora*. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 50731 include *Cryptophiale fasciculata* (GenBank MH758195, 90% identity) and *Kionochaeta ivoriensis* (GenBank NR_160149, 90% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the strain 50731

include *Kionochaeta ivoriensis* (GenBank MH872758, 98% identity), *Cryptophiale udagawae* (GenBank MN104619, 97% identity) and *Riisgaardia vermiculata* (GenBank DQ408570, 97% identity).

Riisgaardia longispora W.P. Wu & Y.Z. Diao, sp. nov., Fig. 34, MycoBank MB841551.

Etymology: Refers to its long conidia.

Diagnosis: Conidiophores absent. Conidiogenous cells lageniform, $14-19 \times 5.5-6 \ \mu m$, $9-12 \ \mu m$ at the swollen base. Conidia narrowly obclavate, obclavate-rostrate, (11-)15-23-septate, $(125-)\ 230-273 \times 10-11.5 \ \mu m$.

Typification: **China**, Hubei Province, Shennongjia, On rotten plant material, 20 Sept 2004, W.P. Wu, Holotype HMAS 352051 (=Wu8333), ex-type culture CGMCC3.20794 (=NN50731).

Description on the natural substrate: Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae, 2–3 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells discrete, determinate, monoblastic, subcylindrical, lageniform, solitary or in groups, short, brown to dark brown, 14–19×5.5–6 μ m, 9–12 μ m at the swollen base, 4–5.5 μ m wide at the truncate apex. Conidia holoblastic, solitary, straight or slightly curved, obclavate-rostrate, (11–)15–23-euseptate, brown to dark brown, smooth, (125–) 230–273×10–11.5 μ m; apical cells subhyaline, rounded, 2.5–3 μ m; basal cell cylindrical, conical-truncate, 5–6.5 μ m wide at the base.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, grey, brown to dark brown, reverse of the same color or slightly darker (Fig. 17i, j).

Other material examined: **China**, Hubei Province, Shennongjia, on rotten plant material, September 2004, W.P. Wu (Wu8314). Living strains: 50687 (from Wu8314).

Ecology/substrate/host: Saprobe on dead branches. Geographical distribution: China.

Notes: *Riisgaardia longispora* resembles *R. vermiculata*, but differs from it by longer conidia with more septa (Wu and Zhuang 2005; Hsieh et al. 2021). Both ITS and LSU sequences were obtained from the two specimens examined by us and their phylogenetic relationship with other members of Chaetosphaeriaceae was confirmed.

Riisgaardia obclavata (W.P. Wu) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 35, MycoBank MB 841678.

 \equiv Linkosia obclavata W.P. Wu, Sporidesmium, Endophragmiella and related genera from China: 186, 2005.

Typification: China, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead culms of bamboo, 2 January 1997,



Fig. 34 Riisgaardia longispora (Wu8333, holotype). a-h Conidia. i-k Conidiogenous cells. Scale bar: a, b, k 10 µm, c-j 5 µm



Fig. 35 *Riisgaardia obclavata* (Wu1266a, holotype). **a** Conidiogenous cell bearing a conidium. **b–h** Conidia. **i–m** Conidiogenous cells. Scale bar: 10 µm

W.P. Wu, Holotype HMAS 352052 (= Wu1266a), ex-type strain CGMCC3.20787 (= NN43163).

Description on the natural substrate: Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae, 2–3.5 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores absent. Conidiogenous cells discrete, monoblastic, determinate, lageniform, solitary, short, brown to dark brown, 14–16×8–10 μ m, 4–5 μ m wide at the truncate apex. Conidia holoblastic, straight or slightly curved, obclavate to obclavate-rostrate, 12–14-distoseptate, pale brown to brown, smooth, 110–125×9–12 μ m; apical cells subhyaline, rounded; basal cell cylindrical, with truncate base of 4–5.5 μ m wide. Culture characteristics: Colonies on PDA effuse, colonies 0.3–1.2 cm diameter in 14 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, pale brown to brown, reverse of the same color or slightly lighter (Fig. 17k, l).

Ecology/Substrate/Host: Saprobe on rotten culm of bamboo.

Geographical distribution: China (Wu and Zhuang 2005). Description and illustration: Wu and Zhuang (2005).

Notes: Re-examination of the type specimen shows that *Linkosia obclavata* produces euseptate conidia. Phylogenetic analysis also shows it is grouped together with other *Riis-gaardia* species. It differs from the other similar species,


Fig. 36 Riisgaardia vermiculata (Wu1354g). a-h Conidia. i, j Conidiogenous cells. Scale bar: 10 µm

including *Stanjehughesia fusiformis*, *S. jiangxiensis*, and *S. polypora*, by the combination of conidial size and number of septa. The phylogenetic analysis based on the ITS and LSU sequences obtained from the type specimen shows it belongs to Chaetosphaeriaceae.

Riisgaardia vermiculata (Cooke) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 36, MycoBank MB841679.

 \equiv *Clasterosporium vermiculatum* Cooke, Grevillea 4: 69, 1875.

 \equiv Sporidesmium vermiculatum (Cooke) M.B. Ellis, Mycol. Pap. 70: 41, 1958.

≡ *Stanjehughesia vermiculata* (Cooke) Subram., Proc. Indian Natn. Acad. Sci. B 58: 184, 1992.

Description on the natural substrate: Colonies effuse, hypophyllous, brown. Mycelium superficial, composed of septate, brown to dark brown hyphae, 2–3.5 μ m wide. Teleomorph: Not observed. Anamorph: Conidiophores absent. Conidiogenous cells discrete, monoblastic, determinate, cylindrical, lageniform, solitary, short, brown to dark brown, 11–15×5–7 μ m, 4–5 μ m wide at the truncate apex. Conidia holoblastic, straight or slightly curved, obclavaterostrate, 12–19-euseptate, brown to dark brown, become pale brown to subhyaline at the apex, smooth, up to 250 μ m long, 12.5–15 μ m wide at the broadest part; apical cells subhyaline, rounded; basal cell cylindrical, conical-truncate, 7.5–9 μ m wide at the base.

Culture characteristics: Colonies on PDA effuse, colonies 1 cm diameter in 14 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, pale brown to brown, reverse of the same color (Fig. 16p).

Materials examined: **China**, Guangxi Province, Damingshan, on dead culm of bamboo, 18 December 1997, W.P. Wu (Wu1354g). Living strain: 42952 (from Wu1354g).

Ecology/substrate/host: Saprobes on rotten wood and bark of woody plants including *Fagus sylvatica*, *Quercus* sp. and bamboo.

Geographical distributions: Canada, China and UK (Ellis 1958; Wu and Zhuang 2005).

Description and illustration: Ellis (1958); Wu and Zhuang (2005).

Notes: *Riisgaardia vermiculata* resembles *S. longispora* in narrowly obclavate or obclavate-rostrate conidia, but differs from it by longer conidia with more septa (Ellis 1958; Wu and Zhuang 2005). The phylogenetic analysis based on the ITS and LSU sequences obtained from the specimen 42952 shows it belongs to Chaetosphaeriaceae.

Hyphomycetous genera with phialidic anamorphs

Among the 89 accepted genera of chaetosphaeriaceous fungi, majority of them are known as dematiaceous hyphomycetes with phialidic conidiogenous cells in their anamorphic states (Réblová and Winka 2000, 2001; Fernández et al. 2006; Magyar et al. 2011; Hyde et al. 2019; Luo et al. 2019; Réblová et al. 2020, 2021a, b, c, d; Zheng et al. 2021). Some of these phialidic genera have both anamorph and teleomorph found and their phylogenetical connection are established for at least one species within the genus, including Cacumisporium, Catenularia, Chaetosphaeria, Chloridium, Dictyochaeta, Exserticlava, Menispora, Paragaeumannomyces, Sporoschisma, Striatosphaeria, Tainosphaeria, Thozetella and Zanclospora. While large number of these genera are known with only anamorph (Borowska 1986; Dennis 1986; Constantinescu et al. 1995; Heredia-Abarca et al. 1995, 1997a, b; Okada et al. 1997; Réblová 1998a, b, 1999a, b, 2000, 2004; Réblová et al. 1999, 2011a, b; Réblová and Gams 2000; Réblová and Winka 2000; Grunig et al. 2002; Réblová and Seifert 2003; Hyde et al. 2016a, b; Lin et al. 2019; Luo et al. 2019; Hyde et al. 2020; Réblová et al. 2020, 2021a, b, c, d).

Key to phialidic asexually typified genera in Chaetosphaeriaceae

1.	Conidiomata sporodochia or synnemata2
1.	Conidiophore not formed from sporodochia or synne-
	mata15
2.	Sporodochia or synnemata with sterile setae or micro-
	awn3
2.	Sporodochia without sterile setae or micro-
	awn13
3.	Sporodochia or synnemata with microawn
	Thozetella
3.	Sporodochia or synnemata with sterile setae4
4.	Conidiomata synnemata with one central setae and con-
	idiophores5
4.	Conidiomata sporodochia9
5.	Conidiomata sporodochial or synnematous; sterile
	setae absent; microawn presentThozetella
5.	Conidiomata synnematous; sterile setae present; micro-
	awns absent6
6.	Synnemata diverge from setae towards apices and
	become unilateral; conidia septateArcuatospora
6.	Sterile setae in the middle of synnemata7

7.	Conidia brown, septate, without appendage
	Phialoarthrobotryum
7.	Conidia hyaline, aseptate, with appendage
8.	Conidia round-tetrahedral to pyramidal, with 3 pro-
	tuberant corners each corner furnished with one
	setula, base slightly truncate to rounded with one set-
	ulaPhialosporostilbe
8.	Conidia falcate, fusiform, with one setulae at end
	Menisporopsis
9.	Conidia dark brown, 3-septate, ellipsoid
	Adautomilanezia
9.	Conidia hyaline, 0–1 septate10
10.	Conidia without appendagesVerhulstia
10.	Conidia bearing appendages11
11.	Conidia star-shaped, 5-lobed, bearing 4-6 filiform
	appendagesNeonawawia
11.	Conidia fusiform, falcate, with 1 filiform appendage at
	each end12
12.	Conidia 1-septateRattania
12.	Conidia aseptateMinimidochium
13.	Conidia ellipsoidal, fusiformEucalyptostroma
13.	Conidia lunate or falcate14
14.	Condiogenous cells cylindrical, lageniform; conidia
	falcatePseudothozetella
14.	Conidiogenous cells with bulbous base and cylindrical
15	upper part; conidia lunateEucalyptostromiella
15.	Philades always borne laterally on condition of the single single and the single single and the single sing
	orated in the conidionhores, anical or intercalary
15	Dialidas always integrated in the conidiophores, ani
15.	cal 26
16	Conidia forming at multiple conidiogenous loci with the
10.	collarette hvaline or nale brown short ellipsoid ase-
	tulate: phialides in whorls or single <i>Chloridium</i>
16.	Conidia forming at a single conidiogenous locus without
10.	the collarette 17
18.	Phialides borne singly, on $1-3$ supporting cells or
101	on short branches of the conidiophores, collarette
	inconsp-icuous or strongly recurved toward the con-
	idiophore axis: conidia hvaline, oblong, fusiform, with
	or without setulae, 0–3-septate <i>Menispora</i>
18.	Apex of the phialide not strongly recurved toward the
	conidiophore axis
19.	Phialides in palisade along the main axis of the conidi-
	ophores
19.	Phialides not in a palisade22
20.	Collarettes inconspicuous; phialides arising around the
	whole conidiophore, surrounded by a shield-like agg-
	regation of sterile cells
20.	Collarettes distinct; phialides formed in a palisade or
	small bundles on one side of the conidiophores, no sh-
	ield-like structure presentCryptophialoidea

21.	Conidia dictyospores with both transversely and longi- tudinal septa, ellipsoid, apical cell with a single apical
21.	appendageParacryptophiale Conidia aseptate or with transversely septa only, vari- ous in shape from falcate, fusiform, cylindrical, to gl- obose without or with appendage
22.	Phialides exclusively borne singly or in whorls along the main axis of conidiophore or its branches; con-idio- phore branched or unbranched; conidia hyaline, various
22	In shape
22. 23.	Phialides exclusively borne singly or in whorls along the main axis of conidiophore or its branches; conid-
	iophore branched or unbranched; conidia hyaline, vari- ous in shapeZanclospora
23.	Phialides borne singly along the main axis of conidi- ophores or directly from superficial hyphae; setiform
	conidiophores with swollen apex; conidia falcate
24	Conidionhores not setiform branched: Conidia short
27.	ellipsoidal asetulate: phialides arising in whorls along
	the conidiophore or on its verticillate branches
	Phaeostalagmus
24.	Conidiophores setiform, branched, fertile or sterile at
	apex25
25.	Phialides born on single or poorly branched conidi-
	ophores; Conidia falcate or fusiform, symmetrical, or
25	Phialides on closely packed branches along the main
23.	axis of conidiophores
26.	Conidiophores adhering and twining around the setae; conidiogenous cells mostly intercalary27
26.	Conidiophores not adhering and twining around the
27	setae; conidiogenous cells terminal
27.	Paraceratocladium
27.	Setae unbranched, conidia cylindrical with rounded
	apexParaceratocladiella
28.	Conidiophores with branched apex, with several phi- alides
28.	Conidiophores unbranched, with one terminal phialide only
29.	Conidia cylindrical, formed in chain
29.	Conidia ellipsoid, subglobose, formed in wet spore
30.	Conidia forming at multiple conidiogenous loci
30.	within a collarette, sometimes extending beyond the collarette
	une contateure

7	5
1	J

31.	Conidia pigmented, distoseptate; collarette shallow, with a torn margin resulting from the rupture of the
	orig-inal outer wallExserticlava
31.	Conidia hyaline, lightly pigmented or bicolorous, no
	distoseptate present; collarette cylindrical or flared,
	well-defined; phialides sometimes with percurrently
	extending conidiogenous zone above the collarette
32.	Conidiophores and conidiogenous cells extending
	percurrently; conidia oblong, ellipsoidal to fusiform,
	bicolo-rous, 3-septateCacumisporium
32.	Conidia aseptate33
33.	Conidia brown, asymmetrical, with setulae
	Stratiphoromyces
33.	Percurrent extension occurring or not; conidia hyaline
	or pale brown, aseptateChloridium
34.	Collarettes long, tubular, conidiogenous locus deep-
	seated; conidia septate35
34.	Collarettes narrow, short, or broadly flared, campanu-
	late, vase- or funnel-shaped
35.	Sterile capitate hyphae present among conidiophores;
	conidia cylindrical, darkly pigmented; collarettes deep,
	cylindricalSporoschisma
35.	Sterile capitate hyphae absent; conidia fusiform,
	bicolorous; collarette cupulate <i>Pseudofuscophiales</i>
36.	Sterile or fertile setae present
36.	Sterile or fertile setae absent
37.	apex; conidia brown to dark brown
37.	Setae sterile or fertile, not capitate; conidia hya- line
38.	Sterile capitate hyphae present or absent; conidia
	rounded-obconical and aseptateCatenularia
38.	Sterile capitate always present; conidia cylindrical to
	oblong and 3-septateMonosporoschisma
39.	Conidia lacking setulae40
39.	Conidia with setulae43
40.	Conidia obclavate, aciculate, septate
	Aciculadictyochaeta
40.	Conidia aseptate, not obclavate or aciculate41
41.	Conidia fusiform, tapering towards both ends, centrally
	constrictedFusichloridium
41.	Conidia not centrally constricted42
42.	Conidia falcate, fusiform, subcylindrical
	Dictyochaeta and Lunatochaeta*
42.	Conidia globose, ellipsoidal, cylindrical
	Anacraspedodidymum
43.	Setae sterile, unbranched; conidiophores did not sur-
	round the setae; conidiophores of one kind around the
	ce-ntral sterile setae; conidiogenous cells terminal;
	collarettes wide, funnel-shaped; conidia conical to
	pyramidal with rounded base, aseptate
	Paragaeumannomyces (Obeliospora)

	rounded the setae; conidiogenous cells terminal44
44.	Conidia septateStilbochaeta
44.	Conidia aseptate45
45.	Setae uniformly brown and without darker apical 1–2 cells <i>Codinaea</i>
45.	Setae with apical $1-2$ cells darker than other cells:
10.	conidia multiguttulateXyladelphia
46.	Conidia with appendage47
46.	Conidia lacking appendage
47.	Conidia formed in chains, obconical, bearing two setu- lae at the distal end
47.	Conidia formed singly or in slimy
48.	Conidia dark brown, septate
48	Conidia hvaline 51
49.	Conidia star-shaped, with 3 arms and septate
	Phaeonawawia
49.	Conidia not star-shaped50
50.	Conidia ellipsoidal, 3-septate, with 1-appendage at
	each endAnacacumisporium
50.	Conidia reniform to ellipsoidal, straight or slightly
	curved, 1-septateStriatosphaeria
51.	Conidia triangular to quadrangular, with > 2 setulae
	Nawawia
51.	Conidia not triangular to quadrangular52
52.	Conidia 3-septate, ellipsoidalMultiguttulispora
52.	Conidia aseptate or 1-septeate53
53.	Conidia formed single, rounded-cubical to globose,
	with > 2 setulaeCodinaea
53.	Conidia not rounded–cubical, with 1–2 setulae54
54.	Conidia falcate, fusiform, obclavate, straight or curved, aseptate or septate55
54.	Conidia ellipsoid, globose, straight, aseptate56
55.	Conidia falcate, fusiform, curved, with setulae at both endsCodinaeella & Tainosphaeria
55.	Conidia falcate, tapering toward apex, bearing append-
	age at base onlyCodinaea
56.	Conidia globose57
56.	Conidia ellipsoid58
57.	Conidia in chain or dry mass, with 1 setula only <i>Parabahusutrabeeja</i>
57.	Conidia in wet spore mass, with 1–3 setulae
58.	Conidiogenous cells polyphialidic: conidia ellipsoid,
	aseptateNimesporella
58.	Conidiogenous cells monophialidic; conidia ellipsoid,
	aseptateCalceisporiella
59.	Conidia hyaline60
59.	Conidia light to dark brown, aseptate or septate61
60.	Conidiogenous cells mono- or polyphialidic; conidia
	falcate to lunatePhialoturbella
60.	Conidiogenous cells monophialidic; conidia not falcate
	or lunate

Setae sterile or fertile, unbranched; conidiophores sur-

61.	Collarettes narrowly funnel-shaped and do not become
	apicany incurved; condita cynnorical–ciavate, inore
(1	gradually tapering toward the basalAchrochaeta
61.	Collarettes funnel-snaped, usually become apically
	incurved; conidia various shaped
62.	Conidia ellipsoidal to obovoid, slightly curved, in
	slimy headsFlectospora
62.	Conidia ellipsoidal, clavate or reniform, straight,
	formed in slimy head or chainChloridium
63.	Conidia formed in chain64
63.	Conidia not formed in chain65
64.	Sterile capitate present or absent; conidia rounded-
	obconical, with 3–4 cornersCatenularia
64.	Sterile capitate absent; conidia rounded-obconical,
	apex roundedFuscocatenula
65.	Conidia different, sterile capitate absent or present66
66.	Conidiogenous cells with very narrow sporulating
	lociStephembruneria
66.	Conidiogenous cells with wide sporulating loci67
67.	Phialides with collarette inconspicuous; conidia 3-sep-
	tatePhaeodischloridium
67.	Phialides inflated with large, funnel-shaped collarettes;
	conidia ellipsoidal to globose, rarely septate, formed
	singly, aggregating in slide heads <i>Craspedodidymum</i>
	6,, 66 6 6

Codinaea, Dictyochaeta and related fungi

Among the dematiaceous hyphomycetes growing saprophytically on decaying plant materials including leaf litter, dead twigs and bark, rotten wood etc., Codinaea s. lat. and Dictyochaeta s. lat. are two of the large genera, presently comprising about over 115 known species name (currently 63 species of Dictyochaeta and 54 species of Codinaea) with great diversity on morphology of conidiomata, setae, conidiophores, conidiogenous cells and conidia (Index Fungorum 2020) and distributed all over the world. From taxonomic and nomenclature aspects, the concept and distinction of these two genera have been very confusing and reviewed by many different authors (Morris 1956; Hughes and Kendrick 1968; Gamundi et al. 1977; Morgan-Jones 1982; Holubová-Jechová 1984; Arambarri et al. 1987a, b; Arambarri and Cabello 1990; Kuthubutheen and Nawawi 1991b, d, e; Réblová 2000; Whitton et al. 2000; Réblová 2004; Seifert et al. 2011; Lin et al. 2019; Luo et al. 2019; Hyde et al. 2020; Réblová et al. 2020, 2021a, b, c). Two different opinions have in practice been adapted by different researchers: accepting both genera and delimiting by Codinaea for species with setulate conidia and Dictyochaeta for species with asetulate conidia (Réblová 2000, 2004; Réblová and Winka 2000, 2000; Li et al. 2012; Wijayawardene et al. 2018; Hernández-Restrepo et al. 2017; Hyde et al. 2020; Réblová et al. 2020, 2021a); or

43.

using *Dictyochaeta* to accommodate all these fungi regardingless of setulate and asetulate conidia (Kuthubutheen and Nawawi 1991a; Whitton et al. 2000; Lin et al. 2019; Luo et al. 2019; Réblová et al. 2020, 2021c). Based on recent morphological (including re-examination of type specimen *Dictyochaeta fuegiana*) and phylogenetic analysis, more and more evidence support that the setulate and asetulate species represent two different groups and should be separated (Réblová et al. 2020, 2021a, b, c, e). In addition, these analysis also showed that these two genera are polyphyletic and suggested on future detailed morpho-molecular analysis with more taxonomic sampling to confirm their phylogenetic status.

Based on analysis of morphology and phylogeny, the two genera Codinaea s. lat. and Dictyochaeta s. lat. were systematically revised by Réblová et al. (2020, 2021b, c, e), who provided an excellent framework for classification of this group of fungi. Both Codinaea and Dictyochaeta were emended to monophyletic genera with narrow concept, and several new genera were introduced to accommodate other morphologically similar but phylogenetically unrelated fungi. For species with asetulate conidia, Dictyochaeta s. str., as typified by D. fuegiana and acceptance of 11 species, is emended with very narrow concept and characterized by presence of sterile or fertile setae, several short conidiophores in fascicles with 1-2 setae, terminal mono- or poly-phialidic conidiogenous cells with funnelshaped collarettes, and hyaline, aseptate and asetulate conidia. Other species with asetulate conidia are classified into Achrochaeta, Flectospora, Phialogeniculata and Phialoturbella (Réblová et al. 2021b, c). For species with setulate conidia, the genus Codinaea s. str., as typified by C. aristata and acceptance of 14 species, is also emended with a narrow concept and characterized by four morphotypes of arrangement of setae, conidiophores and conidiogenous cells, and mono- or poly-phialidic conidiogenous cells, and hyaline, aseptate and setulate conidia. Other species with setulate conidia are accommodated under Codinaeella, Menispora, Multiguttulispora, Nimesporella, Stilbochaeta, Striatosphaeria, Tainosphaeria, Tainosphaeriella, and Xyladelphia.

The result from our phylogenetic analysis by using the combined LSU and ITS sequence data for all sequences available in GenBank and also freshly generated sequences in this study is aligned with previous studies and also supported the above framework for reclassification of these fungi (Liu et al. 2016; Perera et al. 2016; Hernández-Restrepo et al. 2017; Tibpromma et al. 2018; Yang et al. 2018a; Lin et al. 2019; Luo et al. 2019; Hyde et al. 2020; Réblová et al. 2020, 2021a, b, c, e; Fig. 3, Supplementary Figs. 1 and 2). Based on this analysis and for better resolving the classification of these fungi, the framework

is further emended by a). accepting the emended Codinaea s. str. and Dictyochaeta s. str. in narrow concept, b). accepting sixteen established genera such as Achrochaeta, Anacraspedodidymum, Codinaeella, Flectospora, Multiguttulispora, Phialogeniculata, Phialoturbella, Tainosphaeria, Menispora, Multiguttulispora, Nimesporella, Stilbochaeta, Striatosphaeria, Tainosphaeria, Tainosphaeriella, and *Xyladelphia*, and c). introducing eight new genera, including Aciculadictyochaeta W.P. Wu & Y.Z. Diao, typified by A. luquillensis (F.A. Fernández & Huhndorf) W.P. Wu & Y.Z. Diao; Brachydictyochaeta W.P. Wu & Y.Z. Diao, typified by B. antillana (R.F. Castañeda) W.P. Wu & Y.Z. Diao; Calceisporiella W.P. Wu & Y.Z. Diao, typified by C. sinensis W.P. Wu & Y.Z. Diao; Curvichaeta W.P. Wu & Y.Z. Diao, gen. nov., typified by Curvichaeta curvispora (Réblová) W.P. Wu & Y.Z. Diao; Kylindrochaeta W.P. Wu & Y.Z. Diao, gen. nov., typified by Kylindrochaeta lignomollis (F.A. Fernández & Huhndorf) W.P. Wu & Y.Z. Diao Lunatochaeta W.P. Wu & Y.Z. Diao, typified by L. shenzhenense W.P. Wu & Y.Z. Diao; Neotainosphaeria W.P. Wu & Y.Z. Diao, typified by Neotainosphaeria microsperma W.P. Wu & Y.Z. Diao; Oxenbollia W.P. Wu & Y.Z. Diao, typified by Oxenbollia lunatospora W.P. Wu & Y.Z. Diao; Parabahusutrabeeja W.P. Wu & Y.Z. Diao, typified by Parabahusutrabeeja minima W.P. Wu & Y.Z. Diao; Paracodinaea W.P. Wu & Y.Z. Diao, typified by Paracodinaea japonica W.P. Wu & Y.Z. Diao. Two identification keys for those genera are provided under Codinaea and Dictyochaeta sessions.

With this emended framework, most species previously known under *Codinaea* and *Dictyochaeta* can be reassigned with right generic name. However, still a number of described species need to be further studied for their phylogenetic relationship and right taxonomic position when those isolates and DNA sequence data will be available in future, especially for those species with synnemata conidiomata, those with asetulate conidia, those with branched conidiophores or lateral phialides, and those species with colored conidia (Kuthubutheen et al. 1992; Whitton et al. 2000; Kirschner et al. 2001; Kirschner and Chen 2002; Silva and Gusmão 2013).

Dictyochaeta and related genera with asetulate conidia

Among the *Codinaea* and *Dictyochaeta* complex, several genera are with conidia bearing no setulae and they are *Achrochaeta*, *Aciculadictyochaeta*, *Anacraspedodidymum*, *Brachydictyochaeta*, *Curvichaeta*, *Dictyochaeta*, *Flectospora*, *Kylindrochaeta*, *Lunatochaeta*, *Phialogeniculata*, *Phialoturbella*. Phylogenetically they are polyphyletic and distributed in three different clades in the phylogenetic trees (Figs. 3, 37), i.e., 3 genera (*Flectospora*)



Phialogeniculata and *Phialoturbella*) in *Tainosphaeria* clade, 2 genera (*Curvichaeta* and *Kylindrochaeta*) in *Paragaeumannomyces* clade, and all other 6 genera are in the broad *Dictyochaeta* clade.



Fig. 38 Colony of *Dictyochaeta, Codinaea* and related genera on PDA after 20 days at 25 °C. **a**, **b** *Brachydictyochaeta bulliformis* (ex-type strain 78,320). **c**, **d** *Codinaea trisetula* (ex-type strain 44720). **e** *Paracodinaea japonica* (ex-type strain 77,392). **g**, **h** *Parabahusutrabeeja minima* (ex-type strain 43967). **i** *Lunatochaeta shenzhenensis*

(ex-type strain 78,259). **j** Paracodinaea japonica (76,395). **k** Calceisporiella sinensis (ex-type strain 44686). **l** Parabahusutrabeeja minima (55,337). **m** Oxenbollia lunatospora (ex-type strain 47501). **n** Codinaea dwaya (44,655). **o** Dictyochaeta fuegiana (43,191). **p** Phialogeniculata guadalcanalensis (44,662)

Phylogenetically all these genera are monophyletic and well-defined (Figs. 3, 42, 118). Morphologically most of these genera are also well-delimited by a combination of different morphology of setae, conidiophores, conidiogenous cells and conidia, except for *Lunatochaeta* and *Dictyochaeta* which are difficult to be distinguished by morphology but phylogenetically well supported.

Living strains of many studied species were also studied on PDA (Fig. 38), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Key to *Dictyochaeta* and related genera with asetulate conidia:

1.	Sterile or fertile setae present2
1.	Sterile or fertile setae absent
2.	Setae with a swollen apex, always sterile, with or with- out lateral phialides
2.	Setae without swollen apex, sterile or fertile, lateral branch absent
3.	Setae without lateral phialides; conidia ellipsoidal to oblong, symmetrical <i>Curvichaeta</i>
3.	Setae with lateral phialides, terminal cell slightly swol- len and sterile; conidia falcate Brachydictyochaeta
4.	Conidia septate, obclavate, aciculateAciculadictyochaeta
4.	Conidia aseptate, not obclavate or aciculate5
5.	Conidia fusiform, tapering towards both end, centrally constricted <i>Fusichloridium</i>
5.	Conidia not centrally constricted
6.	Conidiogenous cells monophialidic; conidia ellipsoid to subgloboseAnacraspedodidymum
6.	Conidiogenous cell mono- or poly-phialidic; conidia cylindrical, obclavate, falcate7
7.	Conidia acicular, obclavate, 3-septateAciculadictyochaeta
7.	Conidia falcate, fusiform, aseptate
8.	Conidiophores geniculate, extending sympodially; conidia obclavate, septate <i>Phialogeniculata</i>
8.	Conidiophores not geniculate; conidia other shaped, aseptate9
9.	Conidiogenous cell mono- or poly-phialidic; conidia cylindrical, falcate or lunate10
9.	Conidiogenous cells monophialidic; conidia not falcate or lunate11
10.	Conidia cylindrical to fusiform, multiseptate
10.	Conidia falcate to lunate, aseptatePhialoturbella

- 11. Collarettes narrowly funnel-shaped and do not become apically incurved; conidia cylindrical-clavate, more gradually tapering toward the basal.......*Achrochaeta*

Aciculadictyochaeta W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB841519.

Etymology: Refers to its similarity to *Dictyochaeta* but with aciculate conidia.

Diagnosis: Setae sterile, septate. Conidiophores solitary or in groups of 2–3 associated with base of setae, septate, pale brown. Conidiogenous cells monophialidic or polyphialidic, terminal, collarette conspicuous and funnel-shaped. Conidia acicular with rounded base, 3-septate, hyaline, arranged in slimy mass. Ascospores hyaline, fusiform, sometimes inequilateral, sometimes ends curved opposite directions, mostly one-septate, sometimes two or three-septate, covered with a gelatinous sheath.

Type species: Aciculadictyochaeta luquillensis (F.A. Fernández & Huhndorf) W.P. Wu & Y.Z. Diao (\equiv Chaeto-sphaeria luquillensis F.A. Fernández & Huhndorf).

Saprobe, lignicolous on decorticated wood or petiole. Teleomorph: Ascomata broadly ovoid, dark brown, separate, superficial to partly immersed, papillate, with sparse, scattered setae, light brown, multiseptate, slender, tapering to an acute apex. Ascomatal wall in surface view, opaque in water, textura epidermoidea in lactophenol, composed of pseudoparenchymatic cells. Ascomatal apex papillate, acute, short. Paraphyses sparse, simple, septate. Asci unitunicate, cylindro-clavate, short-stalked, firm-walled, thin apical cap, with 8 ascospores irregularly arranged. Ascospores hyaline, fusiform, sometimes inequilateral, sometimes ends curved opposite directions, mostly one-septate, sometimes two or three-septate, covered with a gelatinous sheath. Anamorph: Colony effused. Stroma absent. Setae sterile, straight to slightly flexuous, septate, light brown, smooth or verrucose. Conidiophores macronematous, mononematous, simple, solitary or in groups of 2-3 associated with base of setae, smooth, straight to slightly flexuous, septate, pale brown to subhyaline at apex. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, smooth, pale brown to subhyaline; collarette conspicuous, funnel-shaped. Conidia acicular with rounded bases, 3-septate, smooth, hyaline; produced in slimy mass (Adapted from Fernández and Huhndorf 2005).

Ecology/Substrate/Host: saprobe on dead branches and rotten wood of palm and broad leaf tree.

Geographical distribution: Brazil and Puerto Rico.

Notes: The new genus Aciculadictyochaeta is created to accommodate two species, Chaetosphaeria luquillensis and Dictyochaeta aciculata, which are phylogenetically distinct from other Chaetosphaeria and Codinaea/Dictyochaeta. On morphology, these two fungi share some similarity on forming sterile setae, short conidiophores in group and associated with base of setae, terminal phialidic conidiogenous cells with conspicuous collarettes, and hyaline, septate, acicular conidia with rounded base and formed in slimy mass (Fernández and Huhndorf 2005; Silva and Gusmão 2013). They differ from *Dictyochaeta* by septate and acicular conidia, and from Codinaea by lacking conidial setulae. Both anamorph and teleomorph are known for the type species A. luquillensis, and differs from Chaetosphaeria s. str., typified by C. innumera Berk. & Broome, in Chloridium anamorph and ascospore without gelatinous sheath in the latter genus (Gams and Holubová-Jechová 1976).

Key to accepted species of Aciculadictyochaeta.

1. Conidia 3-septate, $36-40 \times 1.5-2 \mu m...A.$ aciculata

1. Conidia $40-49 \times 2.7-3 \mu m...A.$ luquillensis

Aciculadictyochaeta aciculata (S.S. Silva & Gusmão) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841681.

 \equiv Dictyochaeta aciculata S.S. Silva & Gusmão, Mycosphere 4: 702, 2013.

Description on the natural substrate: Saprobes on submerged petiole. Teleomorph: Unknown. Anamorph: Setae sterile, straight to slightly flexuous, up to 11-septate, light brown, finely verrucose, $195 - 205 \times 6 - 9 \mu m$. Conidiophores solitary or in groups of 2 - 3 associated with base of setae, smooth, straight to slightly flexuous, 3 - 5-septate, pale brown to subhyaline at apex, $46.5 - 70 \times 4.5 \mu m$. Conidiogenous cells integrated, terminal, monophialidic, smooth, pale brown to subhyaline, $24 - 31.5 \times 4.5 \mu m$; collarettes conspicuous, funnel-shaped. Conidia acicular with rounded bases, 3-septate, smooth, hyaline, $36 - 40 \times 1.5 - 2 \mu m$; arranged in slimy mass (Silva and Gusmão 2013).

Typification: **Brazil**, Piauí, Caracol, Serra das Confusões, on submerged petiole, 6. May 2011, S.S. Silva (HUEFS 192,225).

Ecology/substrate/host: Saprobes on submerged petiole. Geographical distribution: Brazil (Silva and Gusmão 2013).

Description and illustration: Silva and Gusmão (2013).

Notes: Morphologically *A. aciculata* is closely related to anamorph of *Chaetosphaeria luquillensis*, but differs in producing shorter and narrower conidia (Fernández & Huhndorf 2005; Silva and Gusmão 2013). No living strain is available for molecular phylogeny study. *Aciculadictyochaeta luquillensis* (F.A. Fernández & Huhndorf) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841680.

≡ *Chaetosphaeria luquillensis* F.A. Fernández & Huhndorf, Fungal Divers. 18: 32, 2005.

Description on the natural substrate: Anamorph: Setae singly on the substrate, multiseptate, light brown, $124-190 \times 5-6.5 \mu m$, tapering to a rounded apex, $3-4.7 \mu m$ wide. Conidiophores single, light brown, cylindrical, mostly multiseptate, $28-104 \times 3-4.8 \mu m$. Conidiogenous cell a phialide, cylindrical, most often proliferating sympodially to produce multiple lateral conidiogenous loci, sometimes proliferating percurrently, $29-41 \times 4.5-6.3 \mu m$; Conidia obclavate, straight and acute at apex, hyaline, $40-49 \times 2.7-3 \mu m$ on the substrate (Adapted from Fernández and Huhndorf 2005, who also descripted the teleomorph).

Typification: **Puerto Rico**, Caribbean National Forest, El Verde Research Area, on decorticated wood of dead trunks, 15 January 1997, on 30 cm log, S.M. Huhndorf, F.A. Fernández SMH2973 (F; holotype).

Ecology/substrate/host: Saprobe on decorticated wood.

Geographical distribution: Puerto Rico (Fernández and Huhndorf 2005).

Description and illustration: Fernández and Huhndorf (2005).

Notes: Both anamorph and teleomorph of *Chaetosphaeria luquillensis* were found on natural substrate, and the connection was also confirmed in pure culture (Fernández and Huhndorf 2005).

Anacraspedodidymum C.R. Silva, R.F. Castañeda & Gusmão, Mycotaxon 128: 12, 2014.

Colonies effuse, hairy, brown to black. Mycelium superficial and immersed. Teleomorph: Unknown. Anamorph: Setae cylindrical, septate, pale brown to brown, fertile and terminated by a phialidic conidiogenous cell, associated with conidiophores at the base. Conidiophores macronematous, mononematous, unbranched, straight to slightly flexuous, septate, smooth or verruculose, brown to pale brown. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, sometimes with percurrent elongations; collarette funnel shaped or infundibuliform, brown. Conidia solitary, hyaline, aseptate, solitary, ellipsoid, globose, obpyriform to obovoid, with an inconspicuous basal hilum or slightly papillate, sometimes with mucous adherences or tunicate ornamentation (Silva et al. 2014).

Type species: *Anacraspedodidymum aquaticum* C.R. Silva, R.F. Castañeda & Gusmão.

Ecology/Substrate/Host: saprobe on dead branches and rotten wood.

Geographical distribution: Brazil (Silva et al. 2014) and China (Zheng et al. 2021).

Description and illustration: Silva et al. (2014).

Notes: The genus Anacraspedodidymum, typified by A. aquaticum, is characterized by cluster of one long fertile setae and several short conidiophores, monophialidic conidiogenous cells with a broad funnel-shaped collarette, and hyaline, aseptate, ellipsoid, globose, obpyriform to obovoid conidia without appendage (Silva et al. 2014). Morphologically it is very similar to some species of Dictyochaeta s. lat. and Codinaea s. lat. species, although the authors only compared it with Bahusutrabeeja Subram., Cylindrotrichum Bonord, Kylindria DiCosmo et al. and Monilochaetes Halst. No DNA bar coding was provided for the type species, its location in Chaetosphaeriaceae is based on the morphological similarity and also the phylogenetical analysis of the recently described species A. submersum. Phylogenetically A. submersum has close relationship with members of Thozetella (Zheng et al. 2021).

Three species are known in the genus, including *Anacraspedodidymum aquaticum*, *A. hyalosporum* and *A. submersum*. They can be distinguished by morphology of setae, conidiophores and conidia (Silva et al. 2014; Zheng et al. 2021). The three known species are morphologically diverse and future phylogenetic analysis is needed to elucidate their relationship. Only one species is known from China.

Key to all accepted species of Anacraspedodidymum:

- 1. Setae absent......2

Anacraspedodidymum submersum Z.F. Yu & R.F. Castañeda-Ruiz, Inter. J. Syst. Evol. Microbiol. 2021.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores simple, unbranched, 2–4-septate, smooth-walled, brown to reddish brown, paler toward the apex, up to 100 µm long, 4.5–6.8 µm wide. Conidiogenous cells monophialidic, terminal, cylindrical to subulate, sometimes with 1–3 with enteroblastic percurrent extensions, $13–38 \times 4.6-5.6$ µm; collarette funnel shaped, 1.3–2 µm deep, 2–3 µm wide, pale brown. Conidia solitary, globose or subglobose, aseptate, multiguttulate, $6.8–9.4 \times 5.6-8.4$ µm, hyaline, smooth-walled, sometimes slightly papillate at the base (Zheng et al. 2021).

Typification: **China**, Yunnan Province, Simao Country, Xiaoheijiang Natural Preserve, isolated from leaves of an unidentified dicotyledonous plant submerged in a stream, October 2013, Zefen Yu, YMFT 1.04176 (Holotype), Extype culture: CGMCC3.19622). Ecology/substrate/host: Saprobe on decorticated wood. Geographical distribution: China (Zheng et al. 2021). Description and illustration: Zheng et al. (2021).

Notes: Anacraspedodidymum submersum can be distinguished from A. aquaticum in absence/presence of setae, and the shape and size of their conidia: absence of setae, and subglobose to globose conidia with smaller size ($6.8-9.4 \times 5.6-8.4 \mu m$) in A. submersum; presence of setae, and ellipsoidal, spherical to obovoid conidia ($8-12 \times 7-8 \mu m$) with irregular or subreticulate mucilaginous ornamentation in A. aquaticum. Anacraspedodidymum hyalosporum can be easily distinguished from A. submersum by having one-septate and short-cylindrical to broadly ellipsoidal conidia (Silva et al. 2014; Zheng et al. 2021). Its affinity to Chaetosphaeriaceae was confirmed by molecular phylogenetic study.

Brachydictyochaeta W.P. Wu & Y.Z. Diao, gen. nov., Myco-Bank MB841520.

Etymology: Refers to its similarity with *Dictyochaeta* but with branched setiform conidiophores.

Diagnosis: Similar to *Dictyochaeta*, but differs in setae with sterile and swollen apex and lateral phialides.

Type species: *Brachydictyochaeta bulliformis* W.P. Wu & Y.Z. Diao.

Colony effuse, hairy, inconspicuous. Mycelium superficial and immersed, pale brown to brown, thick-walled, smooth, septate, from which setae are formed. Teleomorph: Unknown. Anamorph: Setae solitary, simple, erect, straight, brown, dark brown towards the base, fading to pale brown towards the apex, smooth, thick-walled, septate, apical cell rounded and slightly swollen; basal cell thick-walled, swollen; sterile or fertile with lateral phialides. Conidiophores reduced, consisting of short lateral branches from the setae or short phialides from the superficial hyphae, aseptate or septate. Conidiogenous cells integrated or discrete, monophialidic, produced through pores in the middle section of the setae, or directly from the superficial hyphae, pale brown, smooth, thin-walled, lageniform, subcylindrical, tapered to the apex, apex narrow with a very small flared collarette. Conidia aggregated into a moist, slimy mass at the apex of the conidiogenous cells, hyaline, aseptate, smooth, thin walled, falcate, lunate, typically curved, acerose, both ends attenuated and rounded, sometime slightly tapering towards one end; setulae absent.

Ecology/Substrate/Host: saprobe on decaying leaf and fruit, rotten wood.

Geographical distribution: China and Cuba.

Notes: In the phylogenetic tree, *Dictyochaeta antillana* and one undescribed species formed a strongly supported clade, and the new genus *Brachydictyochaeta* is established for them. Morphologically *Brachydictyochaeta* is similar to *Dictyochaeta s. str.* in producing sterile or fertile setae and



Fig. 39 Brachydictyochaeta antillana (Wu13318). a-d Setiform conidiophores with lateral phialides. e-n Conidia. o-s Conidiogenous cells directly from the superficial hyphae and with funnel-shaped collarettes. Scale bar: $5 \,\mu m$

falcate, asymmetrical conidia without setulae; but differs in setae with sterile and swollen apex, and monophialidic

conidiogenous cells formed from superficial hyphae or laterally on the setae. Two species are accepted under the genus. *Brachydictyochaeta antillana* (R.F. Castañeda) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 39, MycoBank MB841682.

≡ Dictyochaeta antillana R.F. Castañeda, Fungi Cubenses 3: 7, 1988.

≡ Dictyochaetopsis antillana (R.F. Castañeda) Whitton, McKenzie and K.D. Hyde, Fungal Divers. 4: 153, 2000.

Description on the natural substrate: Colony effuse, hairy, inconspicuous. Mycelium superficial and immersed, pale brown to brown, thick-walled, smooth, septate, 2-3 µm wide, from which setae are formed. Teleomorph: Unknown. Anamorph: Setae simple, erect, straight, brown, dark brown towards the base, fading to pale brown towards the apex, smooth, thick-walled, 2-4-septate, apical cell rounded and slightly swollen, 3-4 um wide; basal cell thick-walled, swollen, up to 10 µm wide. Conidiophores reduced, consisting of short lateral branches from the setae or short phialides from the superficial hyphae, 0-1-septate. Conidiogenous cells integrated or discrete, monophialidic, produced through pores in the middle section of the setae, or directly from the superficial hyphae, pale brown, smooth, thin-walled, lageniform, subcylindrical, tapered to the apex, apex narrow with a very small flared collarette, 9-15 µm long, 3-4.5 µm side at the widest part. Conidia aggregated into a moist, slimy mass at the apex of the conidiogenous cells, hyaline, aseptate, smooth, thin walled, falcate, lunate, typically curved, acerose, both ends attenuated and rounded, sometime slightly tapering towards one end, setulae absent, $10-16 \times 1.5-2 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, yellow brown, with pale colored margin, reverse of the same color or slightly darker.

Materials examined: **China**, Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of *Cinnamomum* sp., 12 June 2015, W.P. Wu (Wu13318); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of bamboo, 12 June 2015, W.P. Wu (Wu13368); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of unidentified tree, 12 June 2015, Wu W.P. (Wu13291). Living strains: 58987 and 59041 (from Wu13318), 59031 (from Wu13291) and 59084 (from Wu13368).

Ecology/substrate/host: Saprobe on dead leaves of trees, including *Cinnamomum* sp.

Geographical distribution: China, Cuba and Mexico (Castañeda-Ruiz 1988; Heredia et al. 2000; Whitton et al. 2000).

Description and illustration: Castañeda-Ruiz (1988); Heredia et al. (2000); Whitton et al. (2000).

Notes: *Brachydictyochaeta antillana* is characterized by the setae with rounded and slightly swollen apex, lateral lageniform phialides produced through pores in the middle part of the setae, or directly from superficial hyphae, monophialidic conidiogenous cells with a flared or funnel-shaped collarette, and falcate or lunate, acerose, aseptate and asetulate conidia measuring $10-16 \times 1.5-2 \,\mu\text{m}$. Of the five species of Dictyochaeta and Dictyochaetopsis with asetulate conidia formed in slimy mass around the tips of lateral phialides on setiform conidiophores, only Dictyochaeta antillana and Dictyochaetopsis maharashtrensis have aseptate conidia. These two species are easily distinguished as D. maharashtrensis has longer setae (up to 350 µm) which are blunt and often develop into a single phialide, and the conidia are more or less cylindrical and typically straight, the phialides are not flared (Pirozynski and Patil 1970; Castañeda-Ruiz 1988; Heredia et al. 2000; Whitton et al. 2000; Arias et al. 2018; Réblová et al. 2021c). Except for the slightly smaller conidia in B. antillana, it can can hardly be distinguished from B. bulliformis described in this paper. The ITS sequences were obtained from three studied strains, and they have 17 bp differences from those from B. bulliformis.

Its occurrence on decaying leaves of *Pandanus furcatus* from Hongkong (setae 2–4-septate, 43–110×2.5–4 μ m; conidiogenous cells lageniform to cylindrical, 9.5–15.5×3–4.8 μ m; conidia aggregated into a slimy mass, 10.5–15.5×1.5–2 μ m) was also reported (Whitton et al. 2000).

Brachydictyochaeta bulliformis W.P. Wu & Y.Z. Diao, sp. nov., Figs. 40, 41, MycoBank MB841552.

Etymology: Refers to its setae with swollen apex surrounded by mucilaginous sheath.

Diagnosis: Setae 2–5-septate, $37-120 \times 2-3 \mu m$, swollen apex up to 6 μm wide. Conidiogenous cells monophialidic or polyphialidic, $7-10 \times 3-4.5 \mu m$. Conidia acerose, aseptate, $11-18 \times 1.5-2 \mu m$.

Typification: **China**, Guangdong Province, Shenzhen, Yangtaishan, on dead leaves of unidentified broad leaf tree, 17 October 2020, W.P. Wu, Holotype MHAS 351964 (= Wu17533), ex-type strain CGMCC 3.20759 (=NN78320).

Description on the natural substrate: Saprobe, on dead leaves, decaying fruits, rotten wood. Colony effuse. Mycelium superficial and immersed, pale brown to brown, thickwalled, smooth, septate, 2-3 µm wide, from which setae are formed. Teleomorph: Unknown. Anamorph: Setae simple, erect, straight, brown, dark brown towards the base, fading to pale brown towards the apex, smooth, thick-walled at the base, becoming thin-walled and paler toward the apex, 2–5- septate, $37-120 \times 2-3 \mu m$, with 1–2 percurrent proliferations; apical cell rounded and slightly swollen, 3-4 µm wide; basal cell thick-walled, swollen, up to 6 µm wide; sterile or fertile with lateral phialides right below septa of the main stipe. Conidiophores reduced, consisting of short lateral branches from the setae or short phialides from the superficial hyphae, 0-1-septate. Conidiogenous cells integrated or discrete, monophialidic, produced through pores



Fig. 40 Brachydictyochaeta bulliformis (Wu16818). a, b, e-h Setiform conidiophores with lateral phialides and swollen apex. c, d Conidiogenous cells. i-p Conidia. Scale bar: 5 µm

in the middle section of the setae, or directly from the superficial hyphae, pale brown, smooth, thin-walled, lageniform, subcylindrical, tapered to the apex, apex narrow with a very small flared collarette, $7-10 \times 3-4.5 \mu m$. Conidia aggregated into a moist, slimy mass at the apex of the conidiogenous cells, hyaline, aseptate, smooth, thin–walled, falcate or



Fig. 41 Brachydictyochaeta bulliformis (**a–l** Wu17533 holotype, **m–r** Wu16818). Wu 17533: **a, b, i** Setae with swollen apex. **c–f** Conidia. **g–k** Conidiogenous cells. Wu16818: n Setae. **p–r** Conidiogenous cells. **s** Conidia. Scale bar: 5 μm

lunate, typically curved, acerose, both ends attenuated and rounded, sometime slightly tapering towards base, setulae absent, $11-18 \times 1.5-2 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, yellow brown, with pale colored margin, reverse of the same color or slightly darker (Fig. 38a, b).

Other materials examined: **China**, Guangdong Province, Guangzhou, South China Botanical Garden, on rotten wood, 4 Mar. 2012, Wu W.P. (Wu12367); Guangxi Province, Damingshan, on dead leaves of *Rhododendron* sp., 18 December 1997, W.P. Wu (Wu1357d); Guangxi Province, Nanning, on dead fruit of *Leguminosae*, 3 January 1998, W.P. Wu (Wu1661b); Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead fruit of *Cyclobalanopsis* sp., 25 Aug 2019, W.P. Wu (Wu16818, 16876); Yunnan Province, Pu Er, on dead leaves of unidentified tree, 18 June 2018, Yu Zhang (Wu15187); **Japan**, Mie Prefecture, Tsu, Tsukairaku Park, on dead leaves of unidentified tree, 2 October 2019, W.P. Wu (Wu16938, Wu16952, Wu16948a); Living strains: 42845 (from Wu1357d), 43907 (from Wu1661b), 54435 (from12367), 76027 and 76028 (from Wu15187), 77173 (from Wu16818), 77189 (from Wu16876)), 77400 (from Wu16952) and 77358 (from Wu16948b).

Ecology/Substrate/Host: Saprobe on decaying leaves, fruit and rotten wood of *Cyclobalanopsis* sp., *Rhododen-dron* sp. etc.

Geographical distribution: China.

Notes: Among the many described *Codinaeal Dictyochaeta* species, only *Dictyochaeta antillana* produces setae with sterile swollen apices and is comparable to B. bulliformis (Pirozynski and Patil 1970; Castañeda-Ruiz 1988; Heredia et al. 2000; Whitton et al. 2000; Arias et al. 2018). As pointed above, morphologically D. antillana and B. bulliformis can hardly be distinguished, but their ITS sequences are significantly different from each other.

Some morphological variation on septation and length of setiform conidiophores and lateral phialides was observed from different specimens of *B. bulliformis*. For example, in the specimen Wu15187, Wu16948 and Wu17533, no lateral phialide was observed, while the lateral phialide is commonly found in all other collections. In the specimen Wu17533, the setae are fewer septate and somewhat shorter than those in other specimens. Its occurrence on dead petiole of *Archontophoenix alexandrae* from Hong Kong, China (Setae fertile, terminating in a polyphialide, $150-205 \times 4.5-5 \mu m$; conidiophores in cluster with setae, $24-42 \times 4-4.5 \mu m$; Conidia aseptate, $12.5-15 \times 2.5-3.5 \mu m$, without setulae) was also reported by Taylor and Hyde (2003).

The eleven ITS sequences obtained from relevant specimens are almost identical (only 1–3 bps differences among them). These ITS sequences have 17 bp difference from those in *B. antillana*. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 78,320 include *Chaetosphaeria hebetiseta* (GenBank Y906955, 92% identity), *Chaetosphaeria dilabens* (GenBank NR_159784, 88% identity) and *Dictyochaeta qerca* (GenBank MT454489, 88% identity. Based on LSU blast in NCBI's GenBank, the closest matches to the ex-type strain 78,320 include *Tainosphaeria crassiparies* (GenBank AF466089, 98% identity), *T. cecropiae* (GenBank MW984568, 98% identity) and *Phialoarthrobotryum triseptatum* (GenBank MH873417, 96% identity).

Curvichaeta W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB 842,442.

Etymology: *Curvus*- (L) and chaeta (Greek); in reference to the slightly curved ascospore and conidia, and hair-like conidiophores.

Diagnosis: Setae present, sterile and with swollen apex. Conidiophores cylindrical, brown, septate, terminated with a monophialidic conidiogenous cell bearing collarette. Conidia hyaline, aseptate, ellipsoidal to oblong, slightly curved.

Type species: *Curvichaeta curvispora* (Réblová) W.P. Wu & Y.Z. Diao.

Colonies on the natural substratum irregularly effuse, dark brown, hairy, consisting of conidiophores and the perithecia. Teleomorph: Perithecia superficial, solitary to gregarious, subglobose to globose, papillate, black, setose, ostiolate. Setae sparsely covering the perithecia, arising on the perithecial wall and around the perithecia from the substrate, cylindrical, dark brown, septate, unbranched. Ostiolar canal periphysate. Perithecial wall carbonaceous, fragile, consisting of two regions; outer region formed of dark brown, thin-walled, brick-like cells; inner region formed of hyaline, thinner-walled, elongated, compressed cells. Paraphyses persistent, branching, hyaline, septate, not tapering, broadly rounded at the top, longer than the asci. Asci unitunicate, cylindrical-clavate, short-stipitate, truncate at the apex, with a distinct refractive apical annulus, 8-spored. Ascospores fusiform, often curved, inequilateral, 3-septate, not constricted at the septa, hyaline, smooth, 2-seriate in the ascus. Anamorph: Setae present, cylindrical, septate, brown, sterile and with a swollen apex. Conidiophores macronematous, mononematous, solitary, erect, straight or slightly flexuous, cylindrical, unbranched, septate, brown, darker brown at the septa, paler towards the top. Conidiogenous cells terminal, integrated, phialidic, cylindrical, conidia formed on a single conidiogenous locus within the aperture; collarette subhyaline to hyaline, funnel-shaped. Conidia ellipsoidal to oblong, broadly rounded apically, truncate at the base, 0-1-septate, hyaline, smooth (adapted from Réblová 2004).

Ecology/Substrate/Host: Saprobes on decorticated wood. Geographical distribution: New Zealand (Réblová, 2004).

Notes: The new genus *Curvichaeta* is created to accommodate for *Chaetosphaeria curvispora* with both teleomorph and anamorphs known (Réblová, 2004). Phylogenetically it is distinct from other genera of Chaetosphaeriaceae. Morphologically its anamorph resembles *Achrochaeta*, *Dictyochaeta*, *Flectospora* and *Phialoturbella*, but can easily be distinguished from all of them (Réblová et al. 2021a, b, c, d, e). It differs from *Achrochaeta*, *Flectospora* and *Phialoturbella* by presence of sterile setae; differs from *Dictyochaeta* by sterile setae with swollen apex and ellipsoidal to oblong conidia. The genus is also created as possible home for some *Dictyochaeta*-like fungi with asetulate conidia but phylogenetically unrelated. *Curvichaeta curvispora* (Réblová) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB842445.

≡ Chaetosphaeria curvispora Réblová, Stud. Mycol. 50: 176, 2004.

Typification: **New Zealand**, Tasman Prov., Abel Tasman National Park, Takaka, *ca.* 100 km NW of Nelson, Pigeon Saddle point, on unpaved road between Tata Beach and Totaranui *ca.* 10 km NW of Totaranui, on decorticated wood of a branch buried in the soil, 24 February 2003, M. Réblová M.R. 2607/03, PDD 78,268, culture ex-type CBS 113,644, ICMP 15,115.

Ecology/Substrate/Host: saprobe on decorticated wood.

Geographical distribution: broadly distributed incl. Asia, Europe South American and North American (Réblová 2004).

Description and illustration: Réblová (2004).

Notes: The fungus was fully documented by Réblová (2004).

Dictyochaeta Speg., Physis 7: 18, 1923.

Colonies effuse, hairy, gray to dark brown on the natural substrate, composed of setae, shorter conidiophores, and ascomata. Teleomorph: Ascomata perithecial, nonstromatic, superficial, globose to subglobose, papillate, dark brown to black. Ostiole periphysate. Ascomatal wall fragile, carbonaceous, two-layered. Paraphyses abundant, hyaline. Asci unitunicate, 8-spored, cylindrical to cylindrical-clavate, shortstipitate, ascal apex nonamyloid with a shallow, refractive apical annulus. Ascospores fusiform to ellipsoidal-fusiform, straight or inequilateral, transversely septate, hyaline, 2-seriate or obliquely 1-seriate within the ascus. Anamorph: Setae simple, erect, straight, brown, dark brown towards the base, fading to pale brown towards the apex, smooth, thick-walled, septate, sterile, or fertile and terminated with a phialide. Conidiophores macronematous, mononematous, single or in cluster, cylindrical, pale brown to brown, septate, terminating with a phialide. Conidiogenous cells integrated, terminal, mono- or poly-phialidic, pale brown, smooth, thinwalled, cylindrical, subcylindrical, lageniform, tapered to the apex, apex narrow with an apical opening or one to several lateral openings formed by successive sympodial elongation of the conidiogenous cell. Collarettes funnel-shaped, apically incurved, hyaline to pale brown, often evanescent. Conidia aggregated into a moist, slimy mass at the apex of the conidiogenous cells, hyaline, aseptate, smooth, thinwalled, usually asymmetrical, falcate, clavate to fusiform, rarely almost cylindrical, typically curved, rounded at the apex, tapered toward the truncated base, asetulate (Adapted from Réblová et al. 2021c).

Type species: Dictyochaeta fuegiana Speg.

Ecology/Substrate/Host: saprobe on decaying leaf and fruit, branches and rotten wood.

Geographical distribution: broadly distributed incl. Asia, Europe South American and North American.

Description and illustration: Hughes and Kendrick (1968); Godeas et al. (1977); Réblová (2004); Réblová et al. (2021c).

Notes: The genus Dictyochaeta s. str. was redefined with narrow concept and fully documented in a recent publication (Réblová et al. 2021c). The diagnosis characters for the genus include presence of sterile or fertile setae in colony, cylindrical and septate conidiophores, terminal and monophialidic or polyphialidic conidiogenous cells with funnel-shaped collarette, and hyaline, aseptate, falcate, clavate to fusiform, asymmetrical conidia (Hughes and Kendrick 1968; Gamundi et al. 1977; Godeas et al. 1977; Réblová 1998a, 2004; Réblová et al. 2020, 2021c). Morphologically it is closely related to several other genera in the Codinaea/Dictyochaeta complex, and can be distinguished from Codinaea s. str., Nimesporella, Codinaeella and Stilbochaeta by asetulate conidia. Réblová (2004) described Chaetosphaeria fuegiana Réblová as the sexual stage of Dictyochaeta fuegiana Speg. and also clarified the taxonomic status of several related species (including Dictyochaeta fuegiana, D. querna P.M. Kirk and Dictyochaeta anamorph of Chaetosphaeria callimorpha) by comparing the types and other herbarium materials.

Réblová et al. (2021c) accepted the following species under the genus and the identification key was also provided: *D. abnormis*, *D. callimorpha*, *D. detricicola*, *D. falcatispora*, *D. fuegiana*, *D. hughesii*, *D. montana*, *D. pluriguttulata*, *D. querna*, *D. sampahia*, *D. setosa*, *D. stratosa* and *D. tumidoseta* (Réblová et al. 2020, 2021c). In addition to these species, a few described species with similar morphological characters might fit well to this genus and are discussed below. Only two species, *Dictyochaeta fuegiana* and *D. guizhouensis*, were found from China.

Key to accepted species of *Achrochaeta* (*A*.), *Dictyochaeta* s. str. (*D*.) and *Tubulicolla* (*T*.) with asetulate conidia (Updated from Réblová et al. 2021c)

1. Condiogenous cell with a tubular extension below the collarette (*Tubulicolla*).....2 1. Conidiogenous cell without a tubular extension (Dictyoc haeta/Lunatochaeta)......4 2. Conidia spear-shaped, wider at the base, attenuated towards the rounded apex, $12.5-17.5 \times 2.5-4 \mu m$T. stipitocolla 2. 3. Conidia 4.8–7.2×1.1–1.5 µm; long.....T. microcylindrospora Conidia 8–11×2–2.5 µm.....T. cylindrospora 3. Setae absent; collarettes narrowly funnel-shaped and 4. not apically incurved; conidia cylindrical-clavate,

	straight or slightly curved, gradually tapered towards
	the base, 7.4–11×1.6–2.6 µmAchrochaeta talbotii
4.	Setae present or absent; collarettes usually apically
	incurved; conidia falcate, clavate, spear-shaped, cylin-
	dric-al5
5.	Conidia filiform or cylindrical
5	Conidia falcate, spear-shaped, not filiform or cylindri-
5.	cal 7
6	Conidia filiform asentate curved $20-25 \times 1$ um:
0.	setae sterile 275-300 um long: conidionhores
	setae sterne, $275-500$ µm long, conditionities
6	40–150 µm r-ong
0.	25 55 um lange conidionhorse 2.5 18 um lang
	55–55 µm long; contaiophores 5.5–18 µm long
7	D. jruncola
7.	Conidia I-septate
7.	Conidia aseptate
8.	Setae with a swollen apex; conidia curved, falcate,
	$20-24 \times 2-2.8 \ \mu m$ D. setosa
8.	Setae not with swollen apex; conidia
	$12-18 \times 1.8 \ \mu mD.$ ixorae
9.	Setae absent10
9.	Setae present; conidiophores in group with setae11
10.	Conidia clavate, fusoid, straight, base acute, apex
	obtuse, 5.5–9.1×0.6–1 μm <i>D. minutissima</i>
11.	Conidia falcate, curved, $15-21.5 \times 1.2-2 \ \mu m$
	D. seychellensis
11.	Conidia broadly to narrowly rounded at some-
	times slightly tapered apical end, gradually tapered
	toward the basal end, with inconspicuous basal
	scar
12.	Conidia abruptly tapered toward both ends23
12.	Conidia cylindrical, straight or slightly curved13
13.	Conidia clavate, fusiform to falcate, curved
13.	Conidia cylindrical. $(9-)10-13.5 \times 2-2.5$ µm
	D. abnormis
14.	Conidia $8-12 \times 1.5-2.2 \text{ µm}$ D. maharashtrensis
14.	Conidia $4-6 \times 2-2.5$ µm. D. tumidoseta
15.	Conidia longer than 6 µm. 15
15	Conidia $10-155$ µm long 16
16	Conidia 15 um long and longer 19
16	Conidia $8 - 10 \times 1 - 12$ um
10.	Lunatochaota shonzhanansis
17	Conidia more than 10 µm long 1.5, 2.5 µm wide 17
17.	Conidia 11 12(15) × 2 2 5(2) um setes un to 16
17.	Contrata $11-15(-15) \times 2-2.5(-5)$ µm, set at up to 10-
	septate, as cospores $12.3-10(-17) \times (3-)3.3-4.5 \ \mu \text{m}$,
	asci $(88-)92-100 \times (8-)9-10 \mu\text{m}$
10	D. callimorpha
18.	Conidia slightly narrower, 1.5–2.5 µm wide18
18.	Conidia in vitro $10-14(-15.5) \times 1.5-2.5 \mu m$, setae up to
	23-septate, apical cell developing into a polyphialide,
	teleomorph unknownD. detriticola
19.	Conidia in vitro $11-15.5 \times 1.5-2 \mu m$, setae absent
	in vitro; on the natural substrate, setae up to 20-sep-

	tate, apical cell sterile, rounded, ascospores (15.5-
)16.5–19×4–5 μm, asci 95–110(–118)×(9.5–)10–
	13 µm <i>Dictyochaeta</i> sp.
19.	Conidia 20–26×2.5–4 µmD. hughesii
20.	Conidia narrower, up to 2.5 µm wide20
20.	Conidia 1.5–2 µm wide
21.	Conidia 2–2.5 µm wide
21.	Setae sterile, $190-320 \times 5-6$ µm; conidiophores
	$47-110 \times 4-6 \mu m$; conidiogenous cells polyphialidic;
	conidia falcate, 16–19×1.8 µmD. circaei
22.	Conidia $15-21(-22) \times 1.5-2.5 \ \mu m$; host specific to
	decaying wood and acorns of Quercus spp.; teleo-
	morph unknownD. querna
22.	Conidia (16-)17-21(-23) µm long, ascospores (15-
	$17-22 \times 4-5 \mu m$, asci (77-)83-92 × 12-13(-15)
	μmD. fuegiana
23.	Conidia (16.5-)17.5-22 µm long, ascospores
	(12-)13-16.5(-17)×3.5-4.5 µm, asci (78-)80-
	93×9–10.5 μm <i>D. stratosa</i>
23.	Conidia less than 10 µm long24
24.	Conidia more than 10 µm long25
24.	Conidia 8–10×1.5–2 µmD. calvatata
25.	Conidia $6-9.6 \times 1.8-2 \ \mu mD.$ falcatispora 25.
	Both ends of conidia elongate into an appendage-like
	structure, $(22-)24-30(-31) \times 3-4 \mu m$, ascospores
	17-22(-25)×4.5-5.5 μm, asci 94-116(- 130)×8.5-
	11 μmD. montana
25.	Conidia without appendage-like structures, pointed at
	both ends, tapered sharply and attenuated toward the
	basal end, $14.5-18.5 \times 1.25-2 \ \mu\text{m}$, hooked near the
	apex, sickle-shapedD. sampahia

Dictyochaeta fuegiana Speg., Physis 7: 18, 1923. Figure 42a-c

= Chaetosphaeria fuegiana Réblová, Stud. Mycol. 50: 179, 2004.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 4-5 µm wide. Teleomorph: Not observed. Anamorph: Setae straight, arising mostly single, erect, straight or flexuous, cylindrical, smooth and thick-walled, up to 330 µm long, 5-8 µm wide above the swollen base, up to 20 µm wide at the swollen base, tapering graduate towards the rounded apex, 5–9-septate, dark brown in the lower part, becoming paler towards the apex, apex fertile with a funnel-shaped collarette. Conidiophores macronematous, mononematous, simple, crowded, up to 3 around the base of one setae, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, 1-3-septate, smooth-walled, $30-70 \times 3-5$ µm. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, cylindrical, $20-25 \times 4-5 \mu m$,



Fig. 42 a-c Dictyochaeta fuegiana (Wu1445a). a Fertile setae and conidiophores in clusters. b Conidiophores and conidiogenous cells with funnel-shaped collarettes. c Conidia. d, e Dictyochaeta lunulospora (Wu3524b). d Conidiophores and conidiogenous cells. e Conidia. f, g Phialogeniculata guadalcanalensis (Wu1850f). f Per-

currently and sympodially proliferated conidiophores and conidiogenous cells bearing funnel-shaped collarettes **g** Conidia. **h**, **i** *P*. *obclavata* (Wu1885b). **i** Conidia. **h** Percurrently and sympodially proliferated conidiophores and conidiogenous cells bearing funnelshaped collarettes. Scale bar: 20 μ m pale brown, thin-walled, collarette funnel-shaped, $2.5-4 \mu m$ wide, $2-3.5 \mu m$ deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, usually asymmetrical, falcate, slightly curved, $17-20 \times 1.8-2 \mu m$, aseptate, hyaline, smooth, apex acute, base rounded, with no setulae.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, pale brown, with pale colored margin, reverse of the same color or slightly darker (Fig. 380).

Materials examined: **China**, Guangxi Province, Damingshan, on dead culms of *Arundo donax*, 19 December 1997, W.P. Wu (Wu1445a); Guangxi Province, Damingshan, on dead leaves of *Rhododendron* sp., 18 December 1997, W.P. Wu (Wu1373b). Living strains: 42943 (from Wu1445a) and 43191 (from Wu1373b).

Geographical distribution: Argentina, Chile, China, New Zealand and UK (Réblová et al. 2021c).

Description and illustration: Hughes and Kendrick (1968); Kirk (1982a, b); Réblová (2004); Réblová et al. (2021c).

Notes: *Dictyochaeta fuegiana* Speg., described from fallen leaves of *Nothofagus betuloides* from Chile, differs from all known species in the genus *Dictyochaeta* by its fertile setae, monophialidic conidiogenous cells, aseptate conidia without setulae (Réblová et al. 2021c).

Apart from the species documented by Réblová et al. (2021c), several species among the many known species in the genus Dictyochaeta, including D. sampahia, D. abnomis, D. hughesii, D. circei, Dictyochaeta seychellensis and Dictyochaeta callimorpha, resembles D. fuegiana in producing fertile or sterile setae and aseptate, asetulate conidia (Spegazzini 1923; Hughes and Kendrick 1968; Matsushima 1971; Ellis 1976; Godeas et al. 1977; Kirk 1982a, b; Holubová-Jechová 1984; Kuthubutheen 1987a, b, c, d, 1991; Whitton et al. 2000; Réblová 2004; Réblová et al. 2021c). D. hughesii and D. circei are with sterile setae, thus can easily be distinguished from *D. fuegiana*. In D. sampahia and D. abnormis, the setae are fertile, but their conidial shape are rather different from D. fuegiana. Dictyochaeta seychellensis also produces similar conidia but in this species, no setae are formed. Réblová (2004) noted the anamorphs of D. fuegiana and Chaetosphaeria callimorpha can only be distinguished by the wider and smaller conidia in the latter species $(10-15 \times 2-3 \ \mu\text{m} \text{ in})$ C. callimorpha). Variation on size of setae, conidiophores and conidia among different collections were reported (Spegazzini 1923; Hughes and Kendrick 1968; Ellis 1976; Godeas et al. 1977; Gamundi et al. 1977; Kirk 1982a, b; Holubová-Jechová 1984; Réblová 2004). The fungus from the Chinese collections agrees well with those in the type specimen (Réblová 2004; Réblová et al. 2021c).

Dictyochaeta guizhouensis J.Y. Zhang & Y.Z. Lu, J. Fungi 8, 643: 17, 2022.

Ecology/Substrate/Host: Saprobe on rotten wood. Geographical distribution: China (Zhang et al. 2022). Description and illustration: Zhang et al. (2022).

Notes: Dictyochaeta guizhouensis is an asexually typified species and characterized by sterile setae and conidiophores in groups, poly-phialidic conidiogenous cells with flared collarette, and hyaline, aseptate, asymmetrical, falcate conidia $(13-16 \times 1.5-2.2 \ \mu m)$.

Apart from the accepted species by Réblová et al. (2021c), several known *Dictyochaeta* species might belong to the genus and they are discussed here:

Dictyochaeta circaei Tempesta & Rambelli, Flora Mediterranea 19: 269, 2009.

Geographical distribution: Italy (Rambelli et al. 2009).

Description and illustration: Rambelli et al. (2009).

Notes: Seen from the excellent description and illustration, *Dictyochaeta circaei* Tempesta & Rambelli fits well to the revised concept of *Dictyochaeta* s. str., including sterile setae, clustered short conidiophores with setae, terminal conidiogenous cells with inconspicuous cylindrical collarette, and falcate and aseptate conidia bearing no setulae. No molecular data is available for phylogenetic study.

Dictyochaeta clavulata (Hol.-Jech.) Hol.-Jech., Folia Geobot. Phytotaxa 19: 425, 1984.

 \equiv *Codinaea clavulata* Hol.-Jech., Stud. Mycol. 13: 55, 1976.

Geographical distribution: Slovakia (Gams and Holubová-Jechová 1976).

Description and illustration: Gams and Holubová-Jechová (1976).

Notes: Except for lacking the clear description of setae, *Codinaea clavulata* fits well to the revised concept of *Dictyochaeta* s. str. by Réblová et al. (2021c). Although no setae were specifically described in the original description, the conidiophores was described as 'forming a dense velvety layer on wood; very dark brown but becoming lighter in the uppermost part, 130–240 µm tall and to 15-septate; sometimes percurrently proliferating after rupture; to 8 µm wide at the base, 2.5–4.5 µm wide centrally, tapering to 1.0–1.5 µm with a very shallow collarette; short sympodial elongations occur'. The broad range in length of conidiophores might indicate presence of fertile setae. Morphologically it differs from other species by smaller conidia (8–10×1.7–2.5 µm). No molecular data is available for phylogenetic study.

Dictyochaeta falcatispora (M.S. Patil, U.S. Yadav & S.D. Patil) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 137, 2000.

 \equiv *Codinaea falcatispora* M.S. Patil, U.S. Yadav & S.D. Patil, Indian Phyto path. 44: 308, 1991.

Geographical distribution: India (Patil et al. 1991).

Description and illustration: Patil et al. (1991).

Notes: In this species, the presence of setae (up to 120 μ m long), short conidiophores (up to 30 μ m long), and aseptate, falcate and asetulate conidia (6–9×1.8–2 μ m) fits the concept of *Dictyochaeta* s. str.

Dictyochaeta fructicola (M.S. Patil, U.S. Yadav & S.D. Patil) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 140, 2000.

 \equiv *Codinaea fructicola* M.S. Patil, U.S. Yadav & S.D. Patil, Indian Phytopath. 44: 309, 1991.

Geo graphical distribution: India (Patil et al. 1991).

Description and illustration: Patil et al. (1991).

Notes: *Codinaea fructicola* differs from other related species by cylindrical and 1-septate conidia $(12-18 \times 1.8 \ \mu m)$ without setulae. Its placement in *Dictyochaeta* s. str. can be questionable due to the septate conidia.

Dictyochaeta ixorae (M.S. Patil, U.S. Yadav & S.D. Patil) Whitton, McKenzie & K.D. Hyde, Fun. Div. 4: 140, 2000.

 \equiv *Codinaea ixorae* M.S. Patil, U.S. Yadav & S.D. Patil, Indian Phytopath. 44 (3): 309, 1991.

Geographical distribution: India (Patil et al. 1991).

Description and illustration: Patil et al. (1991).

Notes: *Dictyochaeta ixorae* produces setae up to 100 μ m long, short conidiophores up to 20 μ m long, and 1-septate and asetulate conidia 12–18×1.8 μ m. Its placement in *Dictyochaeta* s. str. is questionable due to the septate conidia.

Codinaea maharashtrensis Prioz. & S.D. Patil, Can. J. Bot. 48: 578, 1970.

≡ Dictyochaetopsis maharashtrensis (Piroz. & S.D. Patil) Aramb. & Cabello, Mycotaxon 38: 13, 1990.

Geographical distribution: India (Pirozynski and Patil 1970).

Description and illustration: Pirozynski and Patil (1970).

Notes: *Codinaea maharashtrensis* was well documented and fits well to the revised concept of *Dictyochaeta* s. str.. Except for slightly difference on conidial shape, it can hardly be distinguished from *D. callimorpha* and *D. dentriticola* (Réblová et al. 2021c). For now, this species is best place under *Dictyochaeta*, and future molecular phylogenetic study might show this species is co-specific with other known species.

Dictyochaeta minutissima A. Hern. & J. Mena, Mycol. Res. 100: 687, 1996.

Geographical distribution: Cuba (Hernandex-Gutierrez and Mena Portales 1996).

Description and illustration: Hernandex-Gutierrez and Mena Portales (1996).

Notes: *Dictyochaeta minutissima* is similar to other accepted species of *Dictyochaeta* s. str. on conidiophores and conidia. However, its conidiogenous cells have a broad and deep cylindrical collarettes where the conidia are produced, which is similar to those in *Chloridium codinaeoides* (Pirozynski, 1972; Gams and Holubová-Jechová, 1976). Until the molecular data is available for phylogenetic study, this fungus can be maintained in *Dictyochaeta* s. str.

Dictyochaeta seychellensa Whitton, McKenzie & K.D. Hyde, Fungal Divers. 148, 2000.

Geographical distribution: Seychelles (Whitton et al. 2000).

Description and illustration: Whitton et al. (2000).

Notes: *Dictyochaeta seychellensa* was originally described on decaying leaves of *Pandanus multispicatus* from Seychelles. Morphologically it fits well into the Dictyochaeta genus, including dark brown and septate conidiophores, terminal conidiogenous cells with narrow sporulating loci and inconspicuous collarette, and falcate and aseptate conidia without setulae (Whitton et al. 2000). Until the molecular data is available for phylogenetic study, this fungus can best be placed into *Dictyochaeta* s. str.

Dictyochaeta uninata R.F. Castañeda & W.B. Kendr., Mycol. Res. 102: 58, 1998.

Geographical distribution: Cuba (Castañeda-Ruiz et al. 1998).

Description and illustration: Castañeda-Ruiz et al. (1998).

Notes: Until the molecular data is available for phylogenetic study, *Dictyochaeta uninata* is best maintained in the genus. It differs from other species by narrow and unicinate conidia (Castañeda-Ruiz et al. 1998).

Dictyochaeta setosa (S. Hughes & W.B. Kendr.) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 148, 2000.

 \equiv *Codinaea setosa* S. Hughes & W.B. Kendr., New Zealand J. Bot. 6:360, 1968.

≡ *Dictyochaeta setosa* (S. Hughes & W.B. Kendr.) Aramb. & Cabello, Mycotaxon 34: 682, 1989 (invalid).

Geographical distribution: Brazil and New Zealand (Cruz et al. 2008; Hughes and Kendrick 1968; Arambarri and Cabello 1989).

Description and illustration: Cruz et al. (2008), Hughes and Kendrick (1968); Arambarri and Cabello (1989).

Notes: This species has sterile setae, clustered conidiophores with setae, polyphialidic conidiogenous cells, and falcate, 1–2-sepate conidia. Its placement in *Dictyochaeta* s. str. is questionable due to the septate conidia. *Kylindrochaeta* W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB842443.

Etymology: *Kylindro*—refers to its similarity to some members of *Kylindria* in conidiophores, conidiogenous cells and conidia; chaeta (Greek) hair, bristle.

Diagnosis: Ascospore cylindrical-fusiform, hyaline to subhyaline, 7-septate. Conidiophores simple and terminated with conidiogenous cells, mono- or poly-phialidic, with sympodial extension. Conidia hyaline, cylindrical, multiseptate, asetulate.

Type species: *Kylindrochaeta lignomollis* (F.A. Fernández & Huhndorf) W.P. Wu & Y.Z. Diao.

Teleomorph: Ascomata superficial, broadly ovoid to obpyriform, papillate, dark brown, separate. Setae scattered, brown, multiseptate, slender, tapering to an attenuated apex. Ascomatal wall of textura angularis in surface view, composed of pseudoparenchymatic cells. Paraphyses unbranched, septate, hyaline. Asci cylindro-clavate, short stalked, unitunicate, thin-walled, with 8 biseriately arranged ascospores. Ascospores cylindrical-fusiform, sometimes inequilateral, sometimes one end slightly curved, hyaline to subhyaline, seven-septate. Anamorph: Conidiophores produced in fascicles of three or more on the substrate, unbranched, dark brown becoming light brown towards the apex, multiseptate. Conidiogenous cell phialidic, terminal, cylindrical, mono- or poly-phialidic with a single apical collarette and multiple lateral old conidiogenous loci that appear as refractive pegs; proliferation mostly sympodial, occasionally percurrent. Conidia hyaline, cylindrical, broadly rounded at the apex, with a truncate base, 3-6-septate, straight or diagonal, unevenly spaced (Adapted from Fernández and Huhndorf 2005).

Ecology/Substrate/Host: Saprobe on decorticated wood. Geographical distribution: Costa Rica, Puerto Rico.

Notes: The new genus *Kylindrochaeta* is created to accommodate *Chaetosphaeria lignomollis* which is phylogenetically distinct from the type species of *Chaetosphaeria* and other known genera in Chaetosphaeriaceae. Morphologically it is also unique in produce hyaline, multiseptate and cylindrical to fusiform ascospore and conidia bearing no setulae, which are also different from other genera in the family (Fernández and Huhndorf 2005). Although the type material was not examined by us, the excelente documentation on both morphology and molecular data provided by Fernández and Huhndorf (2005) supports our treatment.

Kylindrochaeta lignomollis (F.A. Fernández & Huhndorf) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB842444.

≡ Chaetosphaeria lignomollis F.A. Fernández & Huhndorf, Fungal Divers. 18: 27, 2005.

Description on the natural substrate: Ascomata 148–198 µm in diam., 178–218 µm in height. Setae scattered,

brown, multiseptate, slender, $135-292 \times 3.5-6.5 \mu m$, tapering to an attenuated apex. Ascomatal wall $10.5-17.5 \mu m$ thick in longitudinal section. Paraphyses unbranched, septate, hyaline, $2-3 \mu m$ wide. Asci cylindro-clavate, shorts talked, $92.5-118 \times 9.7-14 \mu m$, unitunicate, thin-walled, with 8 biseriately arranged ascospores, apical ring $2.8-3.1 \mu m$ wide, $1.2-1.5 \mu m$ deep. Ascospores cylindrical-fusiform, $24-33 \times 4.7-6 \mu m$, hyaline to subhyaline, seven-septate, septa sometimes diagonal or at angles. Conidiophores cylindrical, multiseptate, $162-192 \times 4-5.9 \mu m$. Conidiogenous cell polyphialide with a single apical collarette and multiple lateral old conidiogenous loci. Conidia hyaline, cylindrical, broadly rounded at the apex, with a truncate base, 3-6-septate, unevenly spaced, $21-28 \times 6-7.3$ on the substrate (Adapted from Fernández and Huhndorf 2005).

Typification: **Puerto Rico**, Caribbean National Forest, El Verde Research Area, 16-ha Grid, Luquillo Mts., 350 to 425 m, on wood fragment, 16 Jan 1997, S.M. Huhndorf, F.A. Fernández, *SMH3015* (F; holotype).

Ecology/Substrate/Host: Saprobe on decorticated wood. Geographical distribution: Costa Rica and Puerto Rico (Fernández and Huhndorf 2005).

Description and illustration: Fernández and Huhndorf (2005).

Notes: *Kylindrochaeta lignomollis* is fully described and illustrated by Fernández and Huhndorf (2005).

Lunatochaeta W.P. Wu & Y.Z. Diao, gen. nov. MycoBank MB841521.

Etymology: Refers to its lunate-shaped conidia and similarity with *Dictyochaeta* in producing setae.

Diagnosis: Similar to *Dictyochaeta* and *Brachydicty-ochaeta* in presence of setae, cylindrical conidiophores bearing terminal conidiogenous cells, funnel-shaped collarettes, and hyaline, falcate, asymmetrical, aseptate conidia without setulae, but are phylogenetically distinct. Morphologically it differs from *Brachydictyochaeta* in lacking of lateral phialides and the apex of setae are not swollen.

Type species: *Lunatochaeta shenzhenense* W.P. Wu & Y.Z. Diao.

Colony effuse. Mycelium superficial and immersed, pale brown to brown, thick-walled, smooth, septate, from which setae and conidiophores are formed. Teleomorph: Unknown. Anamorph: Setae simple, erect, straight, brown, dark brown towards the base, fading to pale brown towards the apex, smooth, thick-walled, septate, basal cell swollen, apical cell sterile and obtuse or acute at the apex; basal cell thickwalled, swollen. Conidiophores arise in cluster and associated with setae, cylindrical, straight, or flexuous, brown, slightly paler towards the apex, thick-walled, smooth, septate, terminating by a conidiogenous cell. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, brown, smooth, thin-walled, cylindrical, subcylindrical,



Fig. 43 Lunatochaeta shenzhenensis (Wu17504, holotype). a–d Setae and conidiophores in cluster. e, g Conidiophores and terminal phialidic conidiogenous cells. f Upper part of setae with obtuse apex. h–p conidia. Scale bar: a–d 20 μm, e–p 5 μm

tapered to the apex, apex narrow with flared collarette. Conidia aggregated into slimy mass at the apex of the conidiogenous cells, hyaline, aseptate, smooth, thin walled, falcate, asymmetrical, typically curved, acerose, both ends attenuated and rounded, sometime slightly tapering towards one end, without setulate.

Ecology/Substrate/Host: Saprobe on dead leaves of broad leaf tree.

Geographical distribution: China.

Notes: Morphologically *Lunatochaeta* resembles *Dictyochaeta* s. str. and *Brachydictyochaeta*, but they are phylogenetically distinct.

Lunatochaeta shenzhenensis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 43, MB841553.

Etymology: Refers to the locality where this fungus was originally discovered.

Diagnosis: Similar to species of *Dictyochaeta*, but differs in producing lunate conidia in smaller size $(8-10 \times 1-1.2 \ \mu\text{m})$ and different ITS sequence.

Typification: **China**, Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead leaves of unidentified broad leaf tree, 17 October 2020, W.P. Wu, Holotype HMAS 352,016 (=Wu17504) ex-type strain CGMCC 3.20757 (=NN78259).

Description on the natural substrate: Colony effuse. Mycelium superficial and immersed, pale brown to brown, thick-walled, smooth, septate, 2-3 µm wide, from which setae and conidiophores are formed. Teleomorph: Unknown. Anamorph: Setae simple, erect, straight, brown, dark brown towards the base, fading to pale brown towards the apex, smooth, thick-walled, 4–8-septate, $100-150 \times 3.5-4 \mu m$, basal cell swollen and 11-15 µm wide, apical cell sterile and rounded at the apex and 2-2.2 µm wide; basal cell thick-walled, swollen, up to 10 µm wide. Conidiophores 2-5 in cluster around 1 setae, cylindrical, straight, or flexuous, brown, slightly paler toward the apex, thick-walled, smooth, 0–2-septate, $14-50 \times 2.2-2.8 \,\mu\text{m}$, terminating by a conidiogenous cell. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, brown, smooth, thin-walled, cylindrical, subcylindrical, $15-20 \times 1.8-2.3$ µm, tapered to the apex, apex narrow with 1-5 very small flared collarette, collarette 1-1.5 µm wide and 2-2.5 µm deep. Conidia aggregated into slimy mass at the apex of the conidiogenous cells, hyaline, aseptate, smooth, thin walled, falcate, asymmetrical,

typically curved, acerose, both ends attenuated and rounded, sometime slightly tapering towards one end, setulate absent, $8-10 \times 1-1.2 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, brown, with pale colored margin, reverse of the same color or slightly darker (Fig. 38i).

Other material examined: **China**, Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead leaves of unidentified broad leaf tree, 17 October 2020, W.P. Wu (Wu17505). Living strains: 78,345 (from Wu17504), 78326 and 78347 (from Wu17505).

Ecology/Substrate/Host: Saprobe on dead leaves of broad leaf tree.

Geographical distribution: China.

Notes: *Lunatochaeta shenzhenensis* differs from *Dictyochaeta* species by producing sterile setae, and smaller conidia; from *Brachydictyochaeta* by setae without swollen apex and lateral phiales (Hughes and Kendrick 1968; Pirozynski and Patil 1970; Taylor and Hyde 2003; Castañeda-Ruiz 1988; Kirk 1982a, b; Réblová 1998a, 2004; Whitton et al. 2000; Réblová et al. 2020, 2021c).

Both ITS and LSU sequences were obtained from the several studied strains of the species. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 78,259 include *Ellisembia folliculata* (GenBank OK360950, 90% identity), *Phaetostalagmus cyclosporus* (GenBank MH859892, 89%), *Chaetosphaeria guttulata* (GenBank NR_168803, 90% identity) and *Chaetosphaeria myriocarpa* (MycoBank MH857668, 88% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the ex-type strain 78,259 include *Chaetosphaeria pygmaea* (GenBank AF466077, 98% identity), *Phialophora phaeophora* (GenBank MH878532, 98% identity), *Chaetosphaeria myriocarpa* (GenBank AF466076, 97% identity) and *Phaeostalagmus cyclosporus* (GenBank MH872661, 96% identity).

Phialogeniculata Matsush., Microfungi of the Solomon Islands and Papua-New Guinea (Kobe): 471, 1971.

Colonies hairy, brown, or blackish brown. Mycelium partly superficial, partly immersed, composed of branched, septate, smooth, pale brown to brown hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, arising from superficial mycelium, erect, straight, or slightly curved, cylindrical then becoming geniculate due to sympodial proliferation, smooth, septate, thickwalled, brown to dark brown, with sympodial proliferation. Conidiogenous cells cylindrical, obclavate, pale brown to brown, thin- and smooth-walled; collarette funnel-shaped, with a narrow sporulating locus. Conidia acrogenous, solitary, borne in a liquid droplet, hyaline, aseptate or septate, smooth, obclavate, subcylindrical, base obtuse and with a narrower truncate scar, apex acute.

Type species: *Phialogeniculata guadalcanalensis* Matsush.

Ecology/Substrate/Host: saprobe on decaying leaf, seed, branches and rotten wood.

Geographical distribution: Asia, South Africa, South America.

Description and illustration: Matsushima (1971); Kuthubutheen and Nawawi (1991a, b, c, d, e); Réblová et al. (2021b).

Notes: The genus *Phialogeniculata* was introduced by Matsushima (1971) for the dematiaceous hyphomycete, Phialogeniculata guadalcanalensis and it has been found to be a common fungus from subtropical and tropical area, including Australasia, South Africa and South America (Brazil). Kuthubutheen and Nawawi (1991a, b, c, d, e) transferred this fungus to Dictyochaeta, based on closely related morphology. However, the phylogenetic analysis based on rDNA sequences shows the type species of this genus is closely related to members of Tainosphaeria and formed a distinct subclade (Réblová et al. 2021b). Morphologically it is also unique in producing unbranched and septate conidiophores with geniculate proliferations, funnel-shaped collarettes, and hyaline, aseptate or septate conidia without setulae. Under the generic name *Phialogeniculata*, four species, mainly distinguished by shape, size and septation of conidia, are known and no teleomorph is known for any of those species (Matsushima 1971, 1993; Hyde et al. 1998). The phylogenetic relationship of other three species with the type species of the genus needs to be studied in future.

Key to known species of Phialogeniculata

1. Conidia obclavate, aseptate, $10-15 \times 2.5-4 \mu m$P. obclavata 2. 4. Conidia 2–5-septate......4 5. Conidia 1-septate in the middle, $17-21 \times 5-6 \mu m$P. guadalcanalensis Conidia with 1 subapical septa, $11-16 \times 2.5-3 \mu m...$ 6.P. africana 7. Conidia 2-septate, 13–22×4–6 µm.....P. dimorpha 8. Conidia 2–5-septate, 26–50×3–5 µm.....P. multiseptata

Phialogeniculata guadalcanalensis Matsush., Microfungi of the Solomon Islands and Papua-New Guinea (Kobe): 472, 1971. Figure 42f, g

≡ Dictyochaeta guadalcanalensis (Matsush.) Kuthub. & Nawawi, Mycol. Res. 95: 1220, 1991.

= Tainosphaeria obclavata D.F. Bao, Z.L. Luo, K.D. Hyde & H.Y. Su, Fungal Divers. 99: 604, 2019.

Description on the natural substrate: Colonies hairy, brown, or blackish brown. Mycelium partly superficial, partly immersed, composed of branched, septate, smooth, pale brown to brown hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, arising from superficial mycelium, erect, straight, or slightly curved, cylindrical then becoming geniculate due to sympodial proliferation, smooth, 7-9-septate, thick-walled, brown to dark brown, with sympodial proliferation, $110-140 \times 4.5-5 \mu m$. Conidiogenous cells integrated, cylindrical, obclavate, pale brown to brown, thin- and smooth-walled, with a funnel-shaped collarette of 2.5-3.5 µm deep and 3.5-5 µm wide, with a narrow sporulating locus of 2-2.5 µm wide. Conidia acrogenous, solitary, borne in a liquid droplet, hyaline, uniseptate, smooth, obclavate, $20-22 \times 4.5-5 \,\mu\text{m}$, base obtuse and with a narrower truncate scar, apex acute.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, grey to brown, with pale colored margin, reverse of the same color or slightly darker (Fig. 38p).

Materials examined: **China**, Guangdong Province, Dinghushan, on rotten wood of unidentified plant, 9 October 1998, W.P. Wu (Wu1850f); Yunnan Province, Xishuangbanna, on dead branches, 16 October 1999, W.P. Wu & Yan Huang (Wu2864b). Living strain: 44,662 (rom Wu1850f).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Australia, Brazil, China, Papau-New Guinea, South Africa and Thailand (Réblová et al. 2021b).

Description and illustration: Matsushima (1971); Kuthubutheen and Nawawi (1991a, b, c, d, e); Hyde et al. 1998); Luo et al. (2019); Réblová et al. (2021b).

Notes: *Tainosphaeria obclavata*, a recently described fungus on submerged decaying wood from Thailand, is identical to *P. guadalcanalensis* in both morphology (conidia aseptate, obclavate, $17-21 \times 5-6 \mu m$) and the ITS sequence.

Phialogeniculata obclavata (Matsush.) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 42h, i. MycoBank MB841684.

 \equiv Chloridium obclavatum Matsush., Matsush. Mycol. Mem. 7: 47, 1993.

Description on the natural substrate: Colonies hairy, brown, or blackish brown. Mycelium partly superficial, partly immersed, composed of branched, septate, smooth, pale brown to brown hyphae. Teleomorph: Not observed. Anamorph: Conidiophores macronematous, mononematous, arising from superficial mycelium, erect, straight, or slightly curved, cylindrical then becoming geniculate due to sympodial proliferation, smooth, 3–7-septate, thickwalled, brown to dark brown, with sympodial proliferation, $60-100 \times 4.5-5 \mu m$. Conidiogenous cells integrated, cylindrical, obclavate, pale brown to brown, thin- and smoothwalled, with a funnel-shaped collarette of 2–2.5 µm deep and 4.5–5 µm wide, with a narrow sporulating locus of 2–2.5 µm wide. Conidia acrogenous, solitary, borne in a liquid droplet, hyaline, aseptate, smooth, obclavate, guttulate, $10-15 \times 2.5-4$ µm, base obtuse and with a narrower truncate scar, apex acute.

Material examined: **China**, Jilin Province, on rotten wood of unidentified plant, 20 August 2001, W.P. Wu (Wu1885b). Living strain: 44,678 (from Wu1885b).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China and Peru (Matsushima 1993; Hyde et al. 1998).

Description and illustration: Matsushima (1993); Hyde et al. (1998).

Notes: Chloridium obclavatum is similar to Phialogeniculata guadalcanalensis, but differs in producing aseptate and smaller conidia (6–18×2.5–4 µm) (Matsushima 1993). Phylogenetic analysis based on rDNA sequences showed that *C. obclavatum* is closely related to members of *Phialogeniculata* and differs from all other known species in the genus. Among the known species under *Phialogeniculata*, *Chloridium* and *Dictyochaeta*, *P. africana* is very similar to *C. obclavatum* on conidial shape (obclavate) and size $(11-16\times2.5-3 \mu m)$, but the conidia in *P. africana* are with a septum near the apex (Hyde et al. 1998).

Other known Phialogeniculata species:

Phialogeniculata africana Goh, K.D. Hyde & Steinke, S. Afr. J. Bot. 64: 156, 1998.

Typification: **South Africa**, Durban, Palmiet River, on submerged wood, November 1994, K.D. Hyde & TD. Steinke, SAPR 54 (HKU(M) 2122, holotype).

Geographical distribution: South Africa (Hyde et al. 1998).

Description and illustration: Hyde et al. (1998).

Noted: *Phialogeniculata africana*, described from submerged wood from South Africa, has geniculate conidiophores with percurrent proliferation $(35-70 \times 3-4.5 \ \mu\text{m})$, funnel-shaped conidiogenous cells, ad obclavate conidia in $11-16 \times 2.5-3 \ \mu\text{m}$, and except for the 1-septate conidia, which is very similar to those in the original description of *Chloridium obclavatum* (Hyde et al. 1998).

Phialogeniculata dimorpha Matsush., Matsush. Mycol. Mem. 7: 60, 1993.

Typification: **Peru**, Loreto, Rio Amazonas, Rio Momon, isolated from palm petiole, June 1991 (IP–347, holotype,

preserved in MFC, Kobe, Japan). Ex-type strain is also in MFC.

Geographical distribution: Peru (Matsushima 1993).

Description and illustration: Matsushima (1993).

Notes: *Phialogeniculata dimorpha* differs from other known species in the genus by producing two type of conidia: macroconidia obclavate, 2-septate, $13-22 \times 4-6 \mu m$; microconidia ellipsoid, $3-6 \times 1.8-2.2 \mu m$ (Matsushima 1993).

Phialogeniculata multiseptata Matsush., Matsush. Mycol. Mem. 7: 60, 1993.

Typification: **Peru**, Loreto, Rio Amazonas, Rio Negro, isolated from palm petiole, June 1992 (2P-011, holotype in MFC, Kobe, Japan). Ex-type strain is also in MFC.

Geographical distribution: Mexico and Peru (Matsushima 1993; Becerra-Hernández et al. 2011).

Description and illustration: Matsushima (1993); Becerra-Hernández et al. (2011).

Notes: *Phialogeniculata multiseptata* differs from other known species in the genus by obclavate and 2–5-septate conidia measured $26-50 \times 3-5 \mu m$ (Matsushima 1993).

Phialoturbella Réblová & Hern.-Restr., J. Fungi 7 (6, no. 438): 27, 2021.

Colonies on the natural substrate effuse, hairy, composed of conidiophores, occasionally ascomata. Teleomorph: Ascomata perithecial, non-stromatic, superficial, sub-globose to conical, papillate or with a beak-like neck, dark brown, glabrous. Ostiole periphysate. Ascomatal wall two-layered, carbonaceous. Paraphyses persistent, septate, hyaline. Asci unitunicate, cylindrical-clavate, sessile or with a short stipe, ascal apex with a non-amyloid apical annulus, 8-spored. Ascospores ellipsoidal, hyaline, aseptate, smooth. Anamorph: Setae absent. Conidiophores macronematous, mononematous, single or arise in groups from dark stromatic cells, unbranched, erect, straight or flexuous, septate, smooth, brown. Conidiogenous cells integrated, terminal, mono- or poly-phialidic, extending percurrently and sympodially, cylindrical, pale brown, subhyaline towards the apex; collarettes funnel-shaped. Macroconidia falcate, lunate or oblong and curved, slightly truncate at the basal hilum, hyaline, aseptate, without setulae, accumulated in slimy fascicles. Microconidia (observed only in culture) falcate, lunate or oblong-clavate, curved, truncate at the basal hilum, hyaline, aseptate, without setulae, formed from the same conidiogenous loci (Adapted from Réblová et al. 2021b).

Type species: *Phialoturbella lunata* (Z.L. Luo, K.D. Hyde & H.Y. Su) Réblová & Hern.–Restr.

Geographical distribution: China, Japan and New Zealand.

Ecology/Substrate/Host: Saprobe on dead plant material. Description and illustration: Réblová et al. (2021b)

Note: Phialoturbella was established to accommodate two known Tainosphaeria species (Tainosphaeria aseptata and T. lunata) and one undescribed fungus (Phialoturbella *calva*) which are clustered together as a separate lineage, and characterized by macronematous, solitary or crowded, simple conidiophores with mono- or occasionally polyphialidic conidiogenous cells and aseptate, falcate to lunate conidia without setulae. Species of this genus are known as saprobes on decaying bark and wood in China, Japan and New Zealand. Réblová et al. (2021b) also mentioned that several morphologically similar species of Dictyochaeta can be considered relatives or possible candidates for inclusion in Phialoturbella, namely D. apiculata, D. botulispora, D. heteroderae, D. illinoensis and D. occidentalis. Unfortunately, none of these species has available DNA sequence or culture for phylogenetic analysis.

Key to known species of *Phialoturbella* (*P*.) and *Flectospora* (*F*.)

- 1. Conidia ellipsoidal to obovoid, slightly curved, aseptate, 5–6×2.5–3 μm.....*F. laminata*
- Conidia two types; macroconidia falcate to lunate or oblong and slightly curved, tapering towards both ends, with a basal hilum, hyaline, 12.5–17×2–3 μm; microconidia falcate or oblong-clavate, 4–6.5×1–1.5 μm..... *P. calva*

- 4. Conidia long fusiform, curved, 14.5–20×3–4.5 μm..... *P. aseptata*
- 4. Conidia fusiform, curved, $16-24 \times 3.5-5.5 \mu m$, with short setulae up to $3 \mu m \log \dots P$. *lunata*

Phialoturbella apiculata (Matsush.) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841685.

 \equiv *Codinaea apiculata* Matsush., Icon. Microfung. Matsush. Lect. (Kobe): 35, 1975.

≡ Dictyochaeta apiculata (Matsush.) Aramb. & Cabello, Mycotaxon 34: 681, 1989 (invalid).

≡ Dictyochaeta apiculata (Matsush.) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 136, 2000.

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: Japan (Matsushima 1975). Description and illustration: Matsushima (1975).

Notes: *Phialoturbella apiculata* differs from other known species in the genus by its larger conidia $(20-30 \times 4-5.5 \ \mu\text{m})$ (Matsushima 1975; Réblová et al. 2021b).

Phialoturbella aseptata (C.G. Lin & J.K. Liu) Réblová & Hern.-Restr., J. Fungi 7 (6, no.438): 27, 2021. Figure 44a-j

 \equiv Tainosphaeria aseptata C.G. Lin & J.K. Liu, Mycosphere 10: 683. 2019.

Description on the natural substrate: Colonies effuse, aggregate, brown, with a hyaline, glistening conidial mass, hairy, short. Teleomorph: Unknown. Anamorph: Conidiophores mononematous, macronematous, cylindrical, 3–8-septate, erect, straight, or flexuous, unbranched, smooth, dark brown at the base, paler towards the apex, often with percurrent proliferations, 50–120 μ m long, 3–4.5 μ m wide at the base. Conidiogenous cells monophia-lidic, integrated, terminal, pale brown to subhyaline, clavate, cylindrical, 30–50×3–4 μ m; collarettes funnel-shaped, 3–3.5 μ m wide and 1.5–2.2 μ m deep. Conidia aggregated in slimy mass at the apex of the conidiophore, acrogenous, smooth, hyaline, aseptate, straight to curved, long fusiform, 16–20×3–4.3 μ m, base truncated, apex acute.

Material examined: **China**, Hubei Province, Shengnongjia, on rotten wood of unidentified plant, 14 September 2004, W.P. Wu (Wu8316a). Living strain: 50689 (from Wu8316a).

Ecology/Substrate/Host: Saprobe on rotten wood. Geographical distribution: China (Lin et al. 2019).

Description and illustration: Lin et al. (2019).

Notes: *Phialoturbella aseptata* is characterized by unbranched, solitary conidiophores, monophialidic conidiogenous cells extending percurrently and long fusiform, curved, aseptate conidia. *Phialoturbella aseptata* is similar to *Dictyochaeta heteroderae* (Morgan-Jones) Carris & Glawe, *Codinaea lunata* Matsush. and *D. lunulospora*. However, the conidia of *D. heteroderae* (9–13×3–4 µm) and *D. lunulospora* (8.8–12.0×0.8–1.0 µm) are smaller than those of *T. aseptata* (15.7–23.3×3.8–4.5 µm) (Matsushima 1975). Réblová et al. (2021b) also compared it with *D. illinoensis*.

Phialoturbella calva Réblová & Hern.-Restr., J. Fung. 7(6, no.438): 28, 2021. Figure 44k–n

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of $3-5 \,\mu$ m wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, mononematous, simple, crowded, erect, straight, or slightly flexuous, cylindrical to geniculate, dark brown and thick-walled in lower part, becoming paler and thin walled towards the apex, 2–4-septate, smooth, $50-100 \times 3-4 \,\mu$ m. Conidiogenous cells integrated, terminal, monophialidic with sympodial proliferation, cylindrical, $18-22 \times 3-4 \,\mu$ m, pale brown to brown, thin-walled, ending in a flared collarette which is funnelshaped, 2.5–3.5 μ m wide, 1.5–2 μ m deep. Conidia acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, fusiform, allantoid, straight or curved,



Fig. 44 *Phialoturbella calva* (k–n Wu8115c) and *P. aseptata* (a–j Wu8316a). a–d, k, l Conidiophores and conidiogenous cells with funnel-shaped collarettes. f–j, m, n Conidia. Scale bar: k 10 µm, a–j, l–n 5 µm



Fig. 45 Phialoturbella lunata. a-e Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. f-m Conidia. Scale bar: 5 µm

aseptate, hyaline, smooth, $14.5-17 \times 2.8-3.2 \ \mu\text{m}$, obtuse at both ends.

Material examined: **China**, Hubei Province, Shengnongjia, on rotten wood of unidentified plant, 14 September 2004, W.P. Wu (Wu8115c). Living strain: 48020 (from Wu8115c).

Ecology/Substrate/Host: Saprobe on dead plant material.

Geographical distribution: China and New Zealand (Réblová et al. 2021b).

Notes: Morphologically *Phialoturbella calva* (conidia are falcate to lunate or oblong, slightly curved, $12.5-17 \times 2-3 \mu m$) differs from other species by shape and size of conidial (Réblová et al. 2021b). Among the known species *P. apiculata* (conidia falcate, $20-30 \times 4-5.5 \mu m$), *P. aseptata* (conidia long fusiform,

curved, $14.4-18.9 \times 3.3-4.4 \ \mu\text{m}$) and *P. lunata* (conidia fusiform, curved, $16-19 \times 4.5-5.5 \ \mu\text{m}$) produce much wider conidia (Matsushima 1975; Luo et al. 2019; Réblová et al. 2021b). Among the known *Dictyochaeta* s. lat. species, few species, including *D. illinoensis*, *Dictyochaeta* state of *Chaetosphaeria pulchriseta* and *Dictyochaeta zapatensis*, produce conidia with rudimentary setulae (Hughes and Kendrick 1968; Hewings and Crane 1981; Castañeda-Ruíz and Kendrick 1990a). *Dictyochaeta illinoensis* and *D. zapatensis* differs from *D. apiculata* by their 1-septate conidia. *Dictyochaeta* state of *Chaetosphaeria pulchriseta* (conidia $23-29 \times 2.4-3 \ \mu\text{m}$) differs from *P. obtusa* by its larger and multiguttulate conidia.

Both ITS and LSU sequences were obtained from the studied strain. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 48020 include *Phialoturbella calva* (GenBank NR_173238, 98% identity), *P. aseptata* (GenBank NR_166295, 92%), *P. lunata* (GenBank NR_168796, 90% identity) and *Phialogeniculata guadalcanalensis* (GenBank NR_168797, 91% identity).

Phialoturbella lunata (Z.L. Luo, K.D. Hyde & H.Y. Su) Réblová & Hern.-Restr., J. Fungi 7(6, no.438): 29, 2021. Figure 45

≡ *Tainosphaeria lunata* Z.L. Luo, K.D. Hyde & H.Y. Su, Fungal Divers. 99: 604. 2019.

Description on the natural substrate: Saprobic on submerged decaying wood. Colonies effuse, greyish brown, in groups. Mycelium partly superficial, composed of septate, branched, brown, smooth hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, $50-90 \mu m \log 3-4 \mu m wide$, 2-4-septate, unbranched, erect, flexuous, greyish black, pale towards apex, in groups, arising from a common stroma. Conidiogenous cells monophialidic, terminal, $15-20 \times 3-3.5 \mu m$; collarettes conspicuous, flared. Conidia acrogenous, fusiform, solitary, guttulate, aseptate, curved, hyaline, smooth-walled, $19-24 \mu m \log 3$, $3.5-3.8 \mu m$ wide, narrow and rounded at both ends, without or with very short polar appendages less than $3 \mu m \log 3$.

Materials examined: **China**, Hubei Province, Shengnongjia, on rotten wood of unidentified plant, 14 September 2004, W.P. Wu (Wu8270a). Living strain: 50674 (from Wu8270a).

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: China (Luo et al. 2019).

Description and illustration: Luo et al. (2019).

Notes: *Tainosphaeria lunata* is a recently described species on submerged decaying wood from Yunnan, China and it differs from the relevant species in the genus by lunate-shaped conidia without setulae (Liu et al. 2016; Lu et al. 2016; Luo et al. 2019). On the conidial morphology, the fungus from our collection agrees well with the those in the original description, but it has relatively longer but narrower

conidia ($19-24 \times 4-4.5 \mu m$ vs. $16-19 \times 4.5-5.5 \mu m$ in the original description). The ITS sequence from our strain is identical to the one from the ex-type strain.

Codinaea and related genera with conidia bearing setulae

Among the *Codinaea* and *Dictyochaeta* complex, most genera are with conidia bearing setulae. These genera are *Calceisporiella*, *Codinaea*, *Codinaeella*, *Dictyochaetopsis*, *Xyladelphia*, *Nimesporella*, *Multiguttulispora*, *Neotainosphaeria*, *Oxenbollia*, *Parabahusutrabeeja*, *Paracodinaea*, *Stilbochaeta*, *Tainosphaeria*, *Tainosphaeriella* and *Xyladelphia*.

Phylogenetically all these genera are well-defined monophyletic genera (Fig. 3), however they are distributed in several different clades in the phylogenetic tree, i.e., the *Codinaea* clade (*Bahusutrabeeja*, *Codinaea*, *Codinaeopsis*, *Nimesporella*, *Phialolunulospora*), the *Xyladelphia* clade (*Xyladelphia*), the *Multiguttulispora* clade (*Multiguttulispora*), the *Dictyochaeta* clade (*Neotainosphaeria* and many other genera), the *Codinaeella* clade (*Calvolachnella*, *Codinaeella*, *Rattania*), the *Stilbochaeta* clade (*Falholtia*, *Stilbochaeta*), and the *Tainosphaeria* clade (*Calceisporiella*, *Oxenbollia*, *Parabahusutrabeeja*, *Paracodinaea*, *Tainosphaeria*, *Tainosphaeriella*).

Morphologically most of these genera are also welldelimited by a combination of setae, conidiophores, conidiogenous cells and conidia. However, some of these genera such as *Oxenbollia*, *Paracodinaea*, *Codinaeella*, *Tainosphaeria and Tainosphaeriella* can hardly be distinguished from each other by morphology. The living strains of many studied species were also studied on PDA, some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species and they are described under each species (Figs. 38, 48).

Key to genera of *Codinaea* and related genera with conidia bearing setulae

Sterile or fertile setae present......2 1. 1. Sterile or fertile setae absent......7 2. Setae sterile or fertile only at the apex, unbranched...3 2. Setae fertile and with lateral phialides or secondary 3. Conidia septate.....Stilbochaeta 3. Conidia aseptate......4 4. Setae versicolored, uniformly brown except at the ultimate or penultimate cells which are dark brown; conidia multiguttulate, without setulae...Xyladelphia 4. Setae uniformally brown; conidia with setulae......5 Conidiophores in clusters with one centrally located 5. setae.....Codinaea



Fig. 46 *Calceisporiella sinensis* (**a**–**c** Wu1900a, holotype) and *Codinaea dwaya* (**d**–**f** Wu1853b). **a**, **d** Conidia. **b**, **f** Upper part of conidiophores and conidiogenous cells. **c**, **e** Conidiophores. Scale bar: **c**, **e** 40 μm, **a**, **b**, **d**, **f** 20 μm

5.	Conidiophores and setae not formed in clusters,
~	enuseCoainaeena
6.	Setae regularly branched; conidiophores bearing short
	encircling collar hyphae; conidia with setula-e
	Codinaea*
6.	Setae irregularly branches; no encircling collar
	hyphaeDictyochaetopsis/Codinaeella**
7.	Conidia 3-septate, ellipsoidalMultiguttulispora
7.	Conidia aseptate8
8.	Conidia globose, subglobose, ellipsoid, broadly fusi-
	form, straight9
8.	Conidia falcate, fusiform, allantoid, curved13
9.	Conidiogenous cells mostly polyphialidic; conidia
	broadly ellipsoid, guttulate, with one setula at each
	endNimesporella
9.	Conidiogenous cells monophialidic; conidia globose
	to subglobose, pyriform10
10.	Conidia globose, thin-walled, with one very short
	setulaParabahusutrabeeja
10.	Conidia globose to subglobose, thick-walled, with more
	than one setula11
11.	Conidia subglobose, with one terminal setula at each
	endCalceisporiella
11.	Conidia globose, subglobose, pyriform, setulae terminal
	or lateral

12.	Conidiogenous cells rough-walled; conidia globose,
	with 2–3 lateral setulaeNeotainosphaeria
12.	Conidiogenous cells smooth-walled, mono- or poly-
	phialidic; conidia with more than 3 or more setulae
	Codinaea
13.	Conidia long lunate, vermiform to sigmoid, with basal
	appendage only; appendage cellular unbranched and
	eccentric appendagePhialolunulospora
13.	Conidia falcate, fusiform, lunate, allantoid, bearing one
	setulae at each end14
14.	Conidia allantoidal, curvedParacodinaea
14.	Conidia lunate, falcate, fusiform, straight or
	curved15
15.	Conidia lunate, guttulate, symmetrical, strongly
	curvedOxenbollia
15.	Conidia falcate, fusiform, symmetrical or asymmetri-
	cal
	Codinaeella, Tainosphaeria, Tainosphaeriella***

(*Only include one species of *Codinaea* s. str., *C. gony-trichoides*; **Only include one species of *Codinaeella*, *C. sinense*; ***phylogenetically different genera, but morphologically can hardly be distinguished).

Calceisporiella W.P. Wu & Y.Z. Diao, gen. nov. MycoBank MB841522.

Etymology: Refers to its similarity on conidial morphology with *Calceispora* Matsush.

Diagnosis: Similar to *Codinaea* s. str. and *Calceispora* in well-developed conidiophores, phialidic conidiogenous cells, and hyaline, aseptate conidia bearing setulae, but differs in rough-walled and monophialidic conidiogenous cells bearing inconspicuous collarettes, and subglobose to ellipsoidal conidia with thick wall and one setula at each end.

Type species: *Calceisporiella sinensis* W.P. Wu & Y.Z. Diao.

Description on the natural substrate: Saprobe on dead branches. Colonies effuse, hairy, dark brown. Mycelium partly superficial and partly immersed, composed of pale brown to brown, branched and septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, simple, erect, straight, or slightly flexuous, cylindrical, dark brown, septate, smooth or verruculose, thick-walled, proliferating percurrently. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, smooth or verruculose, apex with narrow sporulating loci without distinct periclinal thickening, collarette inconspicuous. Conidia holoblastic, acrogenous, solitary, subglobose to ellipsoidal, aseptate, hyaline, smooth, with one slender at each end. Conidia secession schizolytic.

Ecology/Substrate/Host: saprobe on dead branches of broad leaf tree.

Geographical distribution: China.

Notes: *Calceisporiella* is morphologically similar to *Codinaea* s. str. and *Calceispora* in producing well-developed conidiophores, phialidic conidiogenous cells, and hyaline, aseptate conidia with unbranched setulae, but differs from them in rough-walled and monophialidic conidiogenous cells bearing inconspicuous collarettes, and the globose to ellipsoidal conidia with thick wall and one setula at each end (Carmichael et al. 1980; Sutton 1993; Seifert et al. 2011; Réblová et al. 2021c). The appendages in the type species of *Calceispora* are cellular and much wider, and differs from the setulae appendage in *Calceisporiella*. Phylogenetically *Codinaea* and *Calceisporiella* and *Codinaea* s. str. are distinctly related and grouped into two different clades in the phylogenetic tree (Fig. 3).

Calceisporiella sinensis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 46a-c, MycoBank MB841555.

Etymology: refers to the locality (China) where this fungus was originally discovered.

Diagnosis: Conidiophores 7–12-septate, $200-300 \times 4.5-5.5 \mu m$; Conidiogenous cells monophialidic, verruculose, $23-30 \times 4-5 \mu m$, apex with a narrow sporulating locus, collarettes inconspicuous. Conidia solitary, hyaline, subglobose, ellipsoidal, aseptate, $15-17 \times 11.5-12.5 \mu m$, with one setula at each end and $8-10 \mu m \log$.

Typification: **China**, Guangdong Province, Dinghushan, on dead branches of unidentified tree, 9 October 1998, W.P. Wu, Holotype HMAS 351966 (= Wu1900a), ex-type strain CGMCC 3.20635 (= NN44684).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly superficial and partly immersed, composed of pale brown to brown, branched and septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, simple, erect, straight, or slightly flexuous, cylindrical, dark brown, 7–12-septate, smooth- and thick-walled, $200-300 \times 4.5-5.5 \mu m$, proliferating percurrently through the collarette. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, pale brown to medium brown, verruculose, $23-30 \times 4-5 \mu m$, apex with a narrow sporulating locus, no collarette or only a small one. Conidia holoblastic, acrogenous, solitary, subglobose, ellipsoidal, aseptate, hyaline, smooth, $15-17 \times 11.5-12.5 \mu m$, with one setula inserted laterally at each end, 8–10 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1.5–2.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, grey to grey-brown, with pale colored margin, reverse of the same color or slightly darker (Fig. 38k).

Ecology/Substrate/Host: Saprobe on dead branches of broad leaf tree.

Geographical distribution: China.

Notes: Calceisporiella sinensis resembles Calceispora hachijoensis and Calceispora subglobosa in producing verruculose and monophialidic conidiogenous cells with narrow sporulating loci without distinct periclinal thickening, and inconspicuous collarettes, and subglobose to ellipsoidal conidia with a single appendage at each end, but differs from them in morphology of conidia and appendages (Matsushima 1975; Sutton 1993). The appendages in C. hachijoensis are cellular and much wider, and differs from the setulae appendage in *Calceisporiella*. Among the known species of Codinaea s. lat., Dictyochaeta s. lat. and Tainosphaeria, only two species, i.e., D. fimbriaspora and D. ciciata, are closely related to C. sinensis in subglobose to ellipsoidal conidia with setulate at both ends (Rambelli and Onofri 1987; Bhat and Kendrick 1993; Kuthubutheen and Nawawi 1990; Whitton et al. 2000). In Dictyochaeta fimbriaspora, the conidiogenous cells are smooth-walled and with a wide sporulating loci and conspicuous collarette (Whitton et al. 2000). In D. ciciata the conidia are smaller and thin-walled (Rambelli and Onofri, 1987).

Both LSU and ITS sequences were obtained from the single spore isolate of the ex-type strain 44684 and its affinity to other members of Chaetosphaeriaceae was confirmed by phylogenetic analysis (Fig. 3). Based on ITS blast in NCBI's



0.05

◄ Fig. 47 Maximum likelihood (ML) tree based on ITS sequence data for the genus *Codinaea*. Bootstrap support values≥60%, Bayesian posterior probability values≥0.95 are shown at the nodes. *Paracodinaea japonica* 77,205 was chosen as the outgroup. Ex-type strains are indicated with "T" in the end of the taxa labels. Latin names and extype strain numbers of the new species described in the current study are shown in font

GenBank, the closest matches to the ex-type strain 44684 include *Tainosphaeria siamensis* (GenBank NR_154524, 90% identity), *T. jonesii* (GenBank MN121306, 90% identity) and *T. cecropiae* (GenBank NR_173030, 90% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the ex-type strain 44684 include *Tainosphaeria crassiparies* (GenBank AF466089, 98% identity) and *T. cecropiae* (GenBank MW984568, 97% identity).

Codinaea Maire, Publ. Inst. Bot. Barcelona 3: 15, 1937

=*Menisporella* Agnihothr., Proc. Natl. Acad. Sci. India B 56: 98, 1962.

Codinaeopsis Morgan-Jones, Mycotaxon 4: 166, 1976. *Bahusutrabeeja* Subram. & Bhat, Can. J. Bot. 55: 204, 1977.

= *Phialolunulospora* Z.F. Yu & R.F. Castañeda, MycoKeys 76: 23, 2020.

Colonies on natural substrate effuse, hairy, brown to black, composed of setae and conidiophores. Teleomorph: Unknown. Anamorph: Setae present or absent, if present single or arise in groups, erect, straight or flexuous, septate, pigmented, thick-walled, paler and thinner-walled toward the apex, unbranched, apex sterile, tapering or modified into a phialide with a terminal or several lateral openings. Conidiophores macronematous, mononematous, single or arise in fascicles, erect, straight or flexuous to slightly geniculate or undulate, unbranched or branched, occasionally with nodose or collar-like hyphae formed just below the septa, septate, smooth, pigmented, paler toward the apex, terminating into a phialide or with a sterile setiform extension. Conidiogenous cells integrated, terminal, or discrete, lateral, mono- or polyphialidic, extending percurrently and sympodially, paler than the conidiophore; collarettes funnel-shaped. Conidia predominantly falcate to lunate, sometimes oblong-falcate, ellipsoid to ellipsoid-fusiform or broadly oblong, occasionally vermiform, with a straight or gently curved setula at each end, sometimes setulae also inserted ventrally and dorsally, or also globose to pyriform with setulae distributed over the surface of the conidium, aseptate, hyaline, conidia accumulate in slimy fascicles (Adapted from Réblová et al. 2021e).

Type species. Codinaea aristata Maire.

Ecology/Substrate/Host: saprobe on decaying plant materials.

Geographical distribution: Broadly distributed.

Description and illustration: Maire (1937); Hughes and Kendrick (1968); Réblová et al. (2021e).

Notes: The genus Codinaea was proposed by Maire (1937) with C. aristata as the type species and redescribed by Hughes and Kendrick (1968). Gamundi et al. (1977) rediscovered Dictyochaeta fuegiana, the type species of Dictyochaeta (Spegazzini 1923) and proposed Codinaea as a synonym. However, recent molecular phylogenetic studies suggested that species with setulate conidia (Codinaea) are distinct from those lacking conidial setulae (Dictyochaeta) (Réblová and Winka 2000; Seifert et al. 2011; Li et al. 2012; Lin et al. 2019; Luo et al. 2019; Hyde et al. 2020; Réblová et al. 2020, 2021c). Based on both morphological and phylogenetic analysis, the genus Codinaea s. str. is recently emended with a narrow concept by Réblová et al. (2021e). The emended concept of the genus includes 14 accepted species with diverse morphology in term of presence or absence of setae, morphology of conidiophores, conidiogenous cells and conidia.

Our phylogenetic analysis with inclusions of more species supported the separation of *Codinaea* s. str. from other related genera, as proposed by Réblová et al. (2021e). A total of 18 species with similar morphological characters with the type species of *Codinaea* s. str. formed a distinct phylogenetic group from other *Codinaea/Dictyochaeta* (Figs. 3 and 47) These species include *Codinaea assamica*, *C. ellipsoidea*, *C. lignicola*, *C. lithocarpi*, *C. pandanicola*, *C. paniculata*, *C. siamensis*, *C. terminalis* and ten undescribed species.

Based on the arrangement of setae and conidiophores and their branching pattern, Réblová et al. (2021e) distinguished four morphotypes (C1-C4) in Codinaea. In the phylogenetic analysis, all the 14 accepted species with 4 different morphotypes (C1-C4) were clustered together as monophyletic genus. Majority of nine accepted species are with long sterile or fertile setae associated with short conidiophores at the base. Among the species without distinct differentiation of setae and conidiophores, Codinaea dwaya, C. ellipsoidea, C. lignicola, C. puerensis and C. trisetula are with unbranched, dark brown, thick-walled conidiophores that closely resemble the setae and terminate into a monophialidic conidiogenous cell (C2); Codinaea pyriformis and C. vermispora with short conidiophores and monophialidic conidiogenous cells (C2) and only known from pure culture; C. amazonensis with conidiophores with a sterile setiform extension and integrated, terminal phialides borne in groups on short unilateral, branched stalks (C3), and C. gonytrichodes with branched conidiophores and discrete, lateral phialides borne on nodose hyphae or directly on conidiophores (C4) (Réblová et al. 2021e).

Conidia in all accepted species of this genus are aseptate and setulate, but also show some variability in shape (Réblová et al. 2021e). They are mostly falcate to lunate, 106



Fig. 48 Colony of *Codinaea*, *Xyladelphia*, *Nimesporella* and *Multiguttulispora* species on PDA after 20 days at 25 °C. **a**, **b** *C*. *clavatophora* (ex-type strain 47943). **c**, **d** *C*. *oxenbolliae* (ex-type strain 77,595). **e**, **f** *C*. *dinghushanensis* (ex-type strain 54218). **g**, **h** *C*. *phasma* (ex-type strain 75,986). **i**, **j** *C*. *kendrickii* (ex-type strain 75,986).

curved, occasionally vermiform, but several species have ellipsoidal-fusiform to more or less ellipsoidal conidia with setulae inserted at the apical and basal ends. The globose to pyriform conidia of *Codinaea dwaya*, *C. pyriformis* and *C. trisetula* with both polar and lateral setulae irregularly distributed over the surface represent a character that is unusual in *Codinaea*. The falcate conidia of *C. phasma* Hern.-Restr. & Réblová bear a simple setula at each end on natural substrate, however, in culture, they become irregularly ellipsoidal and have 3(–5) setulae inserted also on the ventral and dorsal sides.

Apart from the above-mentioned species, several other described species under *Codinaea* and *Dictyochaeta* clearly belong to *Codinaea* and should be correctly included under

57551). **k**, **l** *C. pyriformis* (ex-type strain 45929). **m**, **n** *C. latispora* (ex-type strain 77,341). **o**, **p** *X. parapulchriseta* (ex-type strain 77,767). **q**, **r** *C. simaoensis* (ex-type strain 76,046). **o** *C. fanglanii* (ex-type strain 58983). **p** *X. sinensis* (ex-type strain 78,332). **s**, **t** *X. parapulchriseta* (ex-type strain 77,767)

Codinaea. These species are *Codinaea britannica*, *C. fertilis*, *C. pakhalensis*, *Dictyochaeta brachysetula*, *D. chinensis* and *D. plovercovensis* (Hughes and Kendrick 1968; Ellis 1976; Reddy and Reddy 1977; Kuthubutheen and Nawawi 1991a; Goh and Hyde 1999; Whitton et al. 2000; Liu et al. 2016; Lin et al. 2019; Luo et al. 2019; Réblová et al. 2020, 2021c). All these species are briefly discussed as well. Phylogenetic relationship of a large number of described species under *Codinaeopsis* and *Dictyochaetopsis* is unclear and remain to be studied.

Living strains of many studied species were also studied on PDA (Fig. 48), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species. Key to accepted species of Codinaea (C.)

1. Sterile or fertile setae present......2 1. Sterile or fertile setae absent; conidiophores solitary or Only setiform conidiophores present, with lateral 2. 2. Both setae or setiform and non-setiform conidiophores present, and formed in fascicles......4 3. Conidiophores with unilateral phialide-bearing stalks just below the septa: conidiogenous cells arise from sta-lks; conidia $9-11.5 \times 1.5-3$; setulae 5.5-9 long...C. amazonensis 3. Conidiophores with nodose and collar-like hyphae below septa; conidiogenous cells in groups of 3-6 arise from nodose or collar-like hyphae; conidia $12-14.5 \times 2-2.5(-3) \mu m$; setulae 7.5-11.5 $\mu m \log ...$C. gonytrichoides 4. Setae becoming fertile, terminated with a mono- or polyphialide.....5 4. 5. Conidia $24-26 \times 6-8 \mu m$; setula spiral and only apical, 65–135 µm long.....D. gyrosetulata 5. 6. Conidia 16–25 µm long.....7 6. Conidia less than 16 µm long.....13 7. Conidia broadly fusiform, falcate, $20-25 \times 10-12.5 \,\mu\text{m}$; setulae 5–6 µm.....D. tiklifrei 7. Conidia fusiform, falcate, less than 6.5 µm wide.....8 Conidiophores 4–6 in clusters from basal stroma; 8. conidiogenous cells mono- or poly-phialidic; conidia $16-26 \times 4-6 \ \mu m$; setulae $8-13.5 \ \mu m \ long$C. pandanicola 8. Conidia less than 4 µm wide......9 9. Conidial setulae 7–15 µm long......10 9. Conidial setulae 5–8.5 µm long.....11 10. Conidia $16-20 \times 2-3 \mu m$; setulae $10-15 \mu m \log ...$D. gamundiae 10. Conidia $15.5-21 \times 2.5-4 \mu m$; setulae 7-12 $\mu m \log ...$C. siamensis 11. Conidiogenous cells polyphialidic; conidia $10-20 \times 2-4 \mu m$, usually 14×3 ; setulae absent or present, in one to two ends 1.5-8 µm long.....C. zhangii 11. Conidiogenous cells monophialidic; conidia always with setulae at both ends......12 12. Conidia $12-19.5 \times 2.3-3.5 \ \mu\text{m}$; setulae 4.7-8.5 $\ \mu\text{m}$ long.....C. coryli 12. Conidia in two types: narrower and longer, 13.5- $17 \times 2.5 - 3.5 \mu m$; shorter and usually wider, $11.5 - 3.5 \mu m$; shorter and $10.5 \mu m$ $13.5 \times 3-3.5$ (-4) µm, falcate, asymmetrical; setulae 5–8 µm long.....C. paniculata 13. Conidia 1.5–2 µm wide.....14 13.

14.	Conidia $6-11 \times 1.7-2 \ \mu\text{m}$; setulae $4-10 \ \mu\text{m}$ long
14	Conidia 13–15 um long 15
15.	Conidia 13–15 × 1.5–2 μ m; setulae 8–9 μ m long
	C. plovercovensis
15.	Conidia falcate, fusiform, $13-15 \times 2 \mu m$, setulae 5–7 μm long <i>C. oxenbolliae</i>
16.	Conidia 10–13 μm long17
16.	Conidia 11–17 µm long
17.	Setae, $130-215 \times 4-6$ µm; conidiophores
	$30-85 \times 3.5-5 \mu m$, with terminal conidiogenous cells
	bearing funnel-shaped collarettes; conidia falcate, fusi-
	form, $11-13 \times 2.5-3 \mu m$; setulae 6 -12 $\mu m \log$ long
	C. latispora
17.	Conidial setulae 4–6 µm long
18.	Setae up to 420 µm long; conidiophore
	$45-80 \times 3.5-5$ µm, terminated with a polyphialidic
	conidiogenous cell bearing up to 10 funnel-shaped
	collarette: conidia falcate. $10-11 \times 2-3$ µm. setulae
	4–5 µm long
18	Setae $150-200 \times 5-65$ µm ² conidiophores
10.	$50-80 \times 2$ 5-4 µm ² conidiogenous cells monophia-
	lidic or rarely p-olyphialidic cylindrical to clavate
	$30-50 \times 3-4$ µm ² conidia $11-13 \times 2-2.5$ µm ² setulae
	4_6 um long <i>C dinghushanensis</i>
19	Conidia 2–3 um wide 20
19	Conidia 3–5 um wide 23
20	Conidial setulae 5–10 um long 21
20. 20	Conidial setulae 8–12 µm long 25
20. 21	Setae $195-240 \times 45-5$ µm; conidiophores
21,	$50-85 \times 3-35$ µm with a terminal monophialidic con-
	idiogenous cell: conidia falcate $15-17 \times 22-25$ µm:
	setulae 6.7 μ m long <i>C</i> simacarsis
21	Conidiogenous cells polyphialidic: conidia 0, 15.5 um
21.	long
22.	Conidiophores 2-3 fasciculate; conidiogenous cells
	cylindrical, up to 10 successive proliferations; conidia
	$9-15.4 \times 2-3 \mu m$; setulae $5-10 \mu m$ <i>C. fertilis</i>
22.	Setae 300–370 × 4–5 μ m; conidiophores 45–100 × 2.8–
	3.3 µm; conidiogenous cell clavate; conidia falcate,
	fusiform, $11-15.5 \times 2.5-3 \ \mu\text{m}$; setulae 5-9.5 $\ \mu\text{m}$
	longC. clavatophora
23.	Setae up to 400 µm long; conidiophores up to 6-fascic-
	ulate, up to 140 µm long; conidiogenous cells with up
	to 2 successive proliferations; conidia 14-16.8×2.6-
	2.8 μm; setulae 9.6–12.8 μm <i>C. assamica</i>
23.	Setae up to 250 µm long24
24.	Setae sterile or fertile, 170-200 µm long; conidi-
	ophores 2–5 fasciculate, $65-89 \times 3-5 \mu m$. Conidiog-
	enous cells monophialidic, $23-30 \times 3-3.5 \mu m$, with
	funnel-shaped collarettes, 2-2.5 (-8.5) µm wide,
	1.5–3 µm deep; conidia 15–16.5 × 2–2.5 µm; setulae
	9.5–12.5 μm longC. fanglanii

24.	Setae fertile, $180-235 \times 4-6 \mu m$; conidio- phores $55-110 \times 4-5 \mu m$; conidiogenous cells $18-25 \times 3-4 \mu m$, with up to 3 funnel-shaped collar- ettes 2-3 μm wide, $1.5-2 \mu m$ deep; conidia falcate, fusiform, $13-15 \times 2-2.8 \mu m$, setulae $8-12 \mu m$ long
25.	Conidiogenous cells monophialidic; conidia $13-15\times5.5-6.5 \mu m$, guttulate; setulae $8-10 \mu m \log$
25.	Conidiogenous cells mono or polyphialidic; conidia
26.	Conidia 7–15×2.5–4 µm long; setulae up to 5 µm long.
26.	Conidial setulae longer than 5 µm
27.	Conidia $13-15 \times 4.5-5.5 \mu\text{m}$; setulae $8-10 \mu\text{m}$ long
27.	Conidia 13.5–18×3–4 μ m; setulae 5–13 μ m
28.	Basal and terminal setulae of unequal length; conidia
	$12-14 \times 2 \ \mu m$; terminal setula $4-6 \ \mu m \ long$
20	
28. 29.	Conidia falcate, slightly curved, $6-8 \times 1.5-2$ µm; setu-
	lae 5–7 µm longC. minima
29.	Conidia more than 10 µm long30
30.	Conidia $15-20 \times 2-3 \mu m$; setulae $5-9 \mu m \log$
30	Conidia broader 2–3 8 µm wide 31
31.	Conidia 16–21 \times 3–3.5 µm; setulae 5–7.5 µm long
	C. australensis
31.	Conidia $(11-)15.5-21.5 \times 2-3.8$; setulae 7.3-9.5
32	Conidia lunate vermiform 31–55 × 2 5–3 5 µm; with
52.	polor setulae only, 1.5–4.6 µm long
22	C. vermiform
32. 33	Conidia with both polor and lateral setulae
00.	setulae numerous, 1–1.5 µm longC. dwaya
33.	Conidia with less than 5 setulae
34.	Conidiogenous cells polyphialidic, with sympodial
	proliferation, $15-20 \times 6-7 \mu m$; conidia ellipsoidal,
	signify papinate at the apex, $15-15 \times 6-10$ µm; setulae one at the apex and 2 setulae in the middle part of the
	conidial body, 5–10 µm long
34.	Conidiogenous cells monophialidic, with a broad
	sporulating loci and collarette, $22-35 \times 5-6 \mu m$; col-
	larette funnel-shaped, up to 5 μ m wide, 2–2.5 μ m deep;
	with one apical and two lateral setulae appendages of
	2–3 µm longC. pyriformis

Codinaea aseptata J.Y. Zhang & Y.Z. Lu, J. Fungi 8, 643: 13, 2022.

Ecology/Substrate/Host: Saprobe on decaying wood in a freshwater stream.

Geographical distribution: China (Zhang et al. 2022).

Description and illustration: Zhang et al. (2022).

Notes: *Codinaea aseptata* is an asexually typified species and characterized by sterile or rarely fertile setae and conidiophores in groups, monophialidic conidiogenous cells with funnel-shaped collarettes, and hyaline, aseptate, cylindrical or long fusiform, and curved conidia $(13.4-16.2 \times 2.1-3 \ \mu\text{m})$ and bearing one setula $(7-10 \ \mu\text{m} \ \text{long})$ at each end.

Codinaea assamica (Agnihothr.) S. Hughes & W.B. Kendr., N. Z. J. Bot. 6: 334, 1968. Figure 49e-g

≡ Menisporella assamica Agnihothr., Proc. Indian Acad. Sci. 56: 99, 1962.

≡ Dictyochaeta assamica (Agnihothr.) Aramb., Cabello & Mengasc., Darwiniana 28: 297, 1988.

= *Codinaea acaciae* Crous & M.J. Wingf., Persoonia 34: 181, 2015.

Description on the natural substrate: Saprobe on dead leaves and fruit. Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2-3 µm wide. Teleomorph: Unknown. Anamorph: Setae straight, arising mostly single, erect, straight or flexuous, cylindrical, smooth- and thick-walled, up to 250 µm long, 6-8 µm wide above the swollen base, tapering gradually towards the rounded apex, 12–18-septate, dark brown in the lower part, becoming paler towards the rounded apex. Conidiophores macronematous, mononematous, simple, crowded, up to 5 around the base of one setae, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, 3–4-septate, thin- and smooth-walled, 50-80×3-3.5 µm. Conidiogenous cells integrated, terminal, polyphialidic, cylindrical, $20-25 \times 3.5-4 \mu m$, pale brown, thin-walled; collarette funnel-shaped, 3–3.5 µm wide, 1.5–2.5 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, slightly curved, $12-14 \times 2.2-2.5 \,\mu\text{m}$, aseptate, hyaline, smooth, apex rounded, base slightly truncate to rounded, with one setula at each end, 7-9 µm long.

Materials examined: **China**, Guangdong Province, Zhaoqing, Dinghushan, on dead leaves of *Smilax* sp., 9 October 1998, W.P. Wu (Wu2083b); Guangxi Province, Shiwandashan, on dead leaves of palm, 31 December 1997, W.P. Wu (Wu1574a).

Ecology/Substrate/Host: Saprobe on decaying woody plant material including wood, root, leaf litter, petioles etc.


Fig. 49 *Codinaea minima* (Wu1942b, holotype) **a** Setae. **b** Setae and conidiophores in cluster. **c** Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. **d** Conidia. *Codinaea assamica* (Wu2083). **e** Conidiophores and setae in cluster. **f** Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. **g** Conidia.

Codinaea tengii (Wu1645c, holotype). **h** Conidiophores and setae in clusters. **i** Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. **j** Conidia. Scale bar: **a**, **b**, **e**, **h** 40 µm, **c**, **d**, **f**, **g**, **i**, **j** 20 µm

Geographical distribution: Argentina, Brazil, Brunei Darussalam, China, Cuba, England, India, Malaysia and Mexico (Réblová et al. 2021e).

Description and illustration: Agnihothrudu (1962a, b); Hughes and Kendrick (1968); Hyde and Goh (1999); Réblová et al. (2021e).

Notes: *Codinaea assamica* is characterized by presence of basal stroma, clustered conidiophores and sterile or fertile setae, polyphialidic conidiogenous cells, falcate and aseptate conidia bearing one setula at each end (Hughes and Kendrick 1968; Ellis 1976; Reddy and Reddy 1977; Whitton et al. 2000; Arias et al. 2018; Réblová et al. 2021e). It resembles *C. britannica*, *C. paniculata*, *C. plovercovensis*, *C. siamensis* and *C. terminalis*, but can be distinguished from them by size of conidiophores, conidia and setulae (Hughes and Kendrick 1968; Kuthubutheen and Nawawi 1991b, d, e; Whitton et al. 2000; Liu et al. 2016).

Codinaea brachysetula (Y.L. Jiang & T.Y. Zhang) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841686.

 \equiv Dictyochaeta brachysetula Y.L. Jiang & T.Y. Zhang, Mycotaxon 131: 387, 2016.

Teleomorph: Unknown. Anamorph: Setae straight or curved, pale brown to brown, paler and almost always fertile towards the apex where there are persistent collarettes, smooth, up to 380 μ m long, 2.5–4.5 μ m thick. Conidiophores solitary or in small groups often associated with setae, rather closely septate, pale brown to brown, smooth, up to 150 μ m long, 2.5–4 μ m thick, polyphialidic; collarettes funnel-shaped with thick walls. Conidia fusiform, curved, hyaline, smooth, aseptate, 7–15×2.5–4 μ m, with a setula not more than 5 μ m long at each end or sometimes only at the apical end.

Material examined: China: Sichuan Province, Luding County, isolated from soil sample, 24 June 2006, Y.L. Jiang (HMAS196298, isotype).

Ecology/Substrate/Host: Saprobe, isolated from soil. Geographical distribution: China (Jiang et al. 2016). Description and illustration: Jiang et al. (2016).

Notes: The isotype material of *Dictyochaeta brachysetula* Y.L. Jiang & T.Y. Zhang, preserved in HMAS, was examined by us. It is mostly similar to *C. assamica*, *C. fertilis*, *Dictyochaeta gamundiae* and *D. plovercovensis*, but differs from these species by its broader conidia $(7-15 \times 2.5-4 \mu m)$ (Kuthubutheen and Nawawi 1991a; Holubová-Jechová 1984; Arambarri et al. 1987a, b; Whitton et al. 2000).

Codinaea britannica M.B. Ellis, More Dematiaceous Hyphomycetes: 472, 1976.

≡ Dictyochaeta britannica (M.B. Ellis) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 137, 2000.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3.5–4.5 µm wide. Teleomorph: Unknown. Anamorph: Setae straight, arising mostly single, erect, straight or flexuous, cylindrical, smooth- and thick-walled, up to 200 µm long, 6–9 µm wide above the swollen base, up to 10 µm wide at the swollen base, tapering gradually towards the rounded apex, 5-8-septate, dark brown, apex acute and sterile. Conidiophores macronematous, mononematous, simple, crowded, up to 5 around the base of 1 setae, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, 1-2-septate, smooth-walled, $30-60 \times 3-5$ µm. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, cylindrical, $10-20 \times 4-5 \mu m$, pale brown, thin-walled; collarette funnel-shaped, 2.5-3 µm wide, 1.5-2 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, slightly curved, $15-20 \times 2-3 \mu m$, aseptate, hyaline, smooth, apex acute, base rounded, with one setula of 5–9 µm at each end.

Materials examined: **China**, Yunnan Province, Kunming, Kunming Botanical Garden, on dead leaves of undetermined tree, 25 November 1995, W.P. Wu (Wu952a); **UK**, Perthshire, Loch Clunie, on dead stems of *Filipendula ulmaria*, November 1953, M.B. Ellis (Holotype IMI 54,365).

Ecology/Substrate/Host: Saprobe on dead leaves.

Geographical distribution: China, Brazil, Kenya and UK (Ellis 1976; Lu et al. 2000; Cruz et al. 2008).

Description and illustration: Ellis (1976); Kirk (1985); Cruz et al. (2008).

Notes: For comparison, the holotype specimen IMI54365 of *Dictyochaeta britannica* was examined and the fungus from the Chinese collection fits well to *D. britannica*. Its occurrence on submerged wood in a stream was also reported from Hong Kong (Lu et al. 2000).

Codinaea clavatophora W.P. Wu & Y.Z. Diao, sp. nov., Fig. 50, MycoBank MB841556.

Etymology: Refers to its clavate-shaped conidiophores.

Diagnosis: Setae $300-370 \times 4-5 \mu m$. Conidiophores $45-100 \times 2.8-3.3 \mu m$, with terminal polyphialidic conidiogenous cells bearing funnel-shaped collarette. Conidia falcate, fusiform, $11-15.5 \times 2.5-3 \mu m$, setulae 5–9.5 μm long.

Typification: **China**, Hubei Province, Shennongjia, on dead leaves of unidentified tree, 12 Sept 2004, W.P. Wu, Holotype HMAS 351979 (= Wu8015), ex-type strain CGMCC 3.20792 (= NN47943).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2–5 μ m wide. Teleomorph: Unknown. Anamorph: Basal stroma 20–30 μ m diam, formed by irregular,



Fig. 50 *Codinaea clavatophora* (Wu8015, holotype). **a–d** Setae and conidiophores in clusters. **e–j** Conidiophores and conidiogenous cells. **k–l** Conidia. Scale bar: **a–c** 20 μm, **d** 10 μm, **e–l** 5 μm



Fig. 51 Codinaea dinghushanensis (Wu17442). a, b Setae. c-e Conidiophores clustered together with setae. f-m Conidiophores and conidiogenous cells with funnel-shaped collarettes. n-t Conidia. Scale bar: a, b, d-h 10 μm, c 20 μm, i-t 5 μm

dark brown, thick-walled cells, bearing 3-5 conidiophores and one long setae in groups. Setae straight, single, erect, straight or flexuous, cylindrical, smooth- and thick-walled, 300-370 µm long, 4-5 µm wide, with a basal cell up to 13 µm wide, tapering gradually towards the apex, multiseptate, dark brown to black, becoming paler towards the apex, terminated with a fertile conidiogenous cell. Conidiophores macronematous, mononematous, simple, in cluster, up to 5 around the base of one setae, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, cylindrical, clavate, 3-4 septate, wall thick and smooth, 45-100×3.8-3.3 µm. Conidiogenous cells integrated, terminal, polyphialidic, clavate, $20-25 \times 3.5-5 \mu m$, pale brown to brown, thin-walled, collarette funnel-shaped, 2-3 µm wide, 1.5-2 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, fusiform, slightly curved, $11-15.5 \times 2.5-3 \mu m$, aseptate, hyaline, smooth, apex acute to rounded, with one setulae at each end, 5–9.5 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, grey to grew brown, with pale colored margin, reverse of the same color or slightly darker (Fig. 48a, b).

Ecology/Substrate/Host: Saprobes on dead leaves.

Geographical distribution: China.

Notes: *Codinaea clavatophora* resembles *C. oxenbolliae* in polyphialidic conidiogenous cells and fusiform conidia with one setulae at each end, but differs by fusiform, slightly curved and wider conidia in the former species. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 47943 include *Codinaea lithocarpi* (GenBank NR_171095, 94% identity) and *C. siamensis* (GenBank OL654082, 94% identity).

Codinaea dinghushanensis W.P. Wu & Y.Z. Diao, sp. nov., Figs. 51, 52, MycoBank MB841557.

Etymology: refers to the locality where this fungus was originally discovered.

Diagnosis: Similar to Codinaea pakhalensis, Dictyochaeta siamensis and D. plovercovensis, but differs in smaller conidia $(11-13 \times 2-2.5 \ \mu\text{m})$ and shorter setulae $(4-6 \ \mu\text{m} \ \text{long})$.

Typification: **China**, Guangdong Province, Zhaoqing, Dinghushan, on dead leaves of *Smilax* sp., 5 March 2012, W.P. Wu, Holotype HMAS 351980 (=Wu12155), ex-type strain CGMCC 3.20647 (=NN54218).

Description on the natural substrate: Saprobe on dead leaves. Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2–5 µm wide. Teleomorph: Unknown. Anamorph: Setae straight, arising mostly single, erect, straight, or flexuous, cylindrical, smooth- and thick-walled, 150-200 µm long, 5-6.5 µm wide, tapering gradually towards the apex, up to 10-septate, dark brown, becoming paler towards the apex, terminated with a fertile conidiogenous cell. Conidiophores 4-8 in cluster arising from basal stroma formed by irregular, dark brown, thickwalled cells, with one long setae in the middle. Conidiophores macronematous, mononematous, simple, in cluster, up to 8 around the base of setae, erect, straight or slightly flexuous, brown in the basal part, becoming paler towards the apex, cylindrical to clavate, 3-5-septate, wall thick and slightly vertuculose, 50-80×2.5-4 µm. Conidiogenous cells integrated, terminal, monophialidic or rarely polyphialidic, cylindrical to clavate, $30-50 \times 3-4 \mu m$, pale brown, thinwalled, collarette funnel-shaped, 2-3 µm wide, 1.5-2 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, curved, $11-13 \times 2-2.5 \mu m$, aseptate, hyaline, smooth, apex acute to rounded, base slightly truncate to rounded, with one setula at each end, 4-6 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to brown, with pale colored margin, reverse brown to dark brown.

Other materials examined: China, Guangdong, Guangzhou, South China Agriculture University, on dead leaves of Acacia sp., 3 December 2018, W.P. Wu (Wu16380); Guangdong Province, Shenzhen, Lianhuashan Park, on rotten seed of Bombax ceiba, 18 October 2020, W.P. Wu (Wu17442); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of Macadamia ternifolia, 4 March 2012, W.P. Wu (Wu12317); China: Guangdong Province, Guangzhou, Baiyunshan, on dead seed pod of unidentified Leguminosae, 5 March 2012, W.P. Wu (Wu12043); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 4 March 2012, W.P. Wu (Wu12301); Guangdong, Guangzhou, South China Botanical Garden, on dead fruit of unidentified tree, 2 December 2018, W.P. Wu (Wu16230); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (Wu16234, Wu16321); China, Guangdong, Guangzhou, on dead leaves of unidentified tree 10 December 2013, W.P. Wu (Wu12660, Wu16230a1); Guangdong, Guangzhou, on dead leaves of unidentified tree 10 December 2013, W.P. Wu (Wu12610); Guangdong, Shenzhen, Lianhuashan Park, on rotten wood, 11 November 2019, W.P. Wu (Wu17112, Wu17114); Guangxi Province, Nanning, Qingxiushan, on rotten wood,



Fig. 52 *Codinaea dinghushanensis* (Wu12155, holotype). **a**, **b** Seter and conidiophores in clusters. **c**, **e**, **f**, **h**–**j**, **l**–**n** Conidiophores and conidiogenous cells with funnel-shaped collarettes. **d** Sterile setae. **g**, **j**, **k**

conidiogenous cells with funnel-shaped collarette and spore mass. j Conidia. Scale bar: a, b 20 μ m, c, m, l 10 μ m, d–l, n 5 μ m

12 November 2013, W.P. Wu (Wu13131); Guangxi Province, Nanning, Nanning Subtropical Botanical Garden, on dead leaves of palm, 15 November 2013, W.P. Wu (Wu13066); Yunnan Province, Xishangbanna, on dead leaves of unidentified tree, 12 June 2018, Yu Zhang (Wu15156). Living strain: 54,216 (from Wu12043), 54,323 (from Wu12301), 54,384 (from Wu12317), 57,445 (from Wu13131), 57,442 (from Wu13066), 57,618 (from Wu12610), 57,682 and 57,683 (from Wu12660), 75,990 (from Wu15156), 75,990 (from Wu15156), 76,569 (from Wu16234), 76,638 (from Wu16230), 76,648 (from Wu16321), 76,743 and 76,756 (from Wu16380), 77,521 and 77,552 (from Wu17114), 77,646 and 77,649 (from Wu17112), 78,212 and 78,213 (from Wu17442).

Ecology/Substrate/Host: Saprobe on dead leaves of different plants including *Acacia* sp., *Macadamia* ternifolia, palm, and unidentified tree.

Geographical distribution: China.

Notes: Codinaea dinghushanensis is characterized by associated conidiophores and fertile setae formed from basal stroma, monophialidic or polyphialidic conidiogenous cells, and hyaline, aseptate conidia $(11-13 \times 2-2.5 \,\mu\text{m})$ with one 4-6 µm long setula at each end. Among the Codinaea s. lat. and Dictyochaeta s. lat. species with clustered conidiophores and fertile setae, several species produce aseptate conidia with setulae at both ends and they are *Codinaea fertilis*, *C*. pakhalensis S, C. siamensis, and Dictyochaeta plovercovensis (Kuthubutheen and Nawawi 1991b, d, e, f; Goh and Hyde 2000; Whitton et al. 2000; Liu et al. 2016). Codinaea pakhalensis (conidia 16.5-18×3.5-4.5 µm, setulae up to 9 μ m long), C. siamensis (conidia 15.5–21×2.5–4 μ m, setulae 7-12 µm long) and D. plovercovensis (conidia $13-15 \times 1.5-2 \mu m$, setulae $8-9 \mu m \log$) produce significant longer conidia with longer setulae than those in C. dinghushanense. Codinaea fertilis (conidia 9–15.3 \times 2–3 µm, setulae $5-10 \,\mu\text{m}$ long) has larger conidia with longer setulae, and its polyphialidic conidiogenous cells with up to 10 conspicuous collarettes.

The ITS sequences were obtained from many different strains and they are almost identical (>99% identiy). Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 54218 include *Codinaea acaciae* (GenBank MN560147, 96% identity) and *C. assamica* (GenBank MH858788, 96% identity).

Codinaea dwaya (Subram. & Bhat) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 32, 2021. Figure 46d–f

≡ Bahusutrabeeja dwaya Subram. & Bhat, Can. J. Bot. 55: 2204, 1977.

Description on the natural substrate: Saprobe on dead branches and rotten wood. Colonies effuse, hairy, dark brown. Mycelium partly superficial and partly immersed, composed of pale brown to brown, branched and septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, simple or occasionally branched, erect, dark brown, septate, smooth- and thick-walled. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, with a broad sporulating loci and collarette, proliferating percurrently through the collarette. Conidia holoblastic, acrogenous, solitary, globose to subglobose, aseptate, hyaline, smooth, $12-14 \mu m$ diam, with up to 13 slender appendages of up to 6 μm long distributed over the surface, accumulating in a slimy head at the tips of the conidiogenous cells.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, grey to grey-brown, with pale colored margin, reverse of the same color or slightly darker (Fig. 38n).

Materials examined: **China**, Guangdong Province, Zhaoqing, Dinghushan, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (Wu1853b); Guangxi Province, on rotten wood submerged in a stream, 23 December 1997, Wu W.P. (Wu2102c); Jilin Province, Changbaishan, on rotten wood of *Betula* sp., 5 September 1998, W.P. Wu (Wu1872a); Yunnan Province, Xishuangbanna, on rotten wood, 16 October 1999, W.P. Wu & Yan Huang (Wu2908c). Living strains: 44,655 (from Wu1853b) and 44,641 (from Wu1872a).

Ecology/substrate/host: Saprobe on dead branch and rotten wood of tree, including *Betula* sp.

Geographical distribution: China, India and Malaysia (Réblová et al. 2021e; Zhang et al. 2022).

Description and illustration: Subramanian and Bhat (1977); Chang (1990); Kuthubutheen et al. (1992); Tsui et al. (2001a, b, c); Wu and McKenzie (2003); Réblová et al. (2021e); Zhang et al. (2022).

Notes: *Bahusutrabeeja dwaya*, is characterized by monophialidic conidiogenous cells with a single broad collarette, globose or slightly ellipsoidal conidia with up to 13 setulae (Subramanian and Bhat 1977). It differs from other relevant species by conidial size, and number of conidial setulae. This fungus has been well documented from different substrates and geography (Subramanian and Bhat 1977; Chang 1990; Kuthubutheen et al. 1992; Tsui et al. 2001a; Wu and McKenzie 2003; Bhat 2010; Réblová et al. 2021e). Its occurrences on decaying twigs and submerged wood in Hong Kong and Taiwan were reported by Chang (1990) and Tsui et al. (2001a, b, c) respectively. Much larger conidia (15–18 µm diam.) were recorded from the collection in Taiwan (Chang 1990).

Phylogenetically *Bahusutrabeeja dwaya* Subram. & Bhat, the type species of the genus *Bahusutrabeeja*, is clustered together with other *Codinaea* species and thus the genus was synonymized (Bhat 2010; Lin et al. 2019; Réblová et al. 2021e). Reclassification is needed for the six remaining species under the genus, including *B. angularis*, *B. bunyensis*,



Fig. 53 Codinaea fanglanii (a-c, l-n Wu13345, holotype; d-k, o-q Wu13368). a, d, e Setae and conidiophores in cluster. b, f, k Conidiophores and conidiogenous cells. i, j Apical part of the setae bearing phialidic conidiogenous cells with funnel-shaped collarettes. c, g-k, l Phialidic conidiogenous cells with funnel-shaped collarettes. m-q Conidia. Scale bar: a, d, e 20 μm, b, c, f-q 5 μm

B. dwaya, *B. dubhashii*, *B. exappendagiculata*, *B. globosa* and *B. manoharacharii* (Subramanian and Bhat 1977; Rao and de Hoog 1986; Bhat and Kendrick 1993; Bhat 1994; McKenzie 1997; Pratibha and Bhat 2005; Réblová et al. 1999; Seifert et al. 2011; Li et al. 2012, 2014; Gao et al. 2015). Among these, three species, *B. angularis*, *B. dwaya* and *B. exappendagiculata*, were recently reported from China (Chang 1990; Wu and McKenzie 2003; Li et al. 2014; Gao et al. 2015).

Codinaea ellipsoidea (Z.L. Luo, K.D. Hyde & H.Y. Su) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 33, 2021.

≡ *Dictyochaeta ellipsoidea* Z.L. Luo, K.D. Hyde & H.Y. Su, Fungal Divers. 99: 593, 2019.

Teleomorph: Unknown. Anamorph: Conidiophores 254–288 μ m long, 8–10 μ m wide, percurrently proliferating. Conidiogenous cells monophialidic. Conidia 13–15×5.5–6.5 μ m wide, ellipsoid, solitary, curved, slightly pointed at both ends, with polar appendage, aseptate, guttulate, hyaline, smooth-walled (Luo et al. 2019).

Typification: **China**, Yunnan Province, Nujiang River, saprobic on submerged decaying wood, October 2016, Z.L. Luo, S–898 (MFLU 18–1612, holotype), ex-type living culture MFLUCC 18–1574.

Ecology/substrate/host: Saprobe on submerged decaying wood.

Geographical distribution: China.

Description and illustration: Luo et al. (2019).

Notes: Codinaea ellipsoidea is a recently described species with long conidiophores and broad conidia (Luo et al. 2019). In absence of setae, the species is an exception in *Codinaea* s. str.. However, it is phylogenetically clustered together with other species of Codinaea s. str.. It mostly resembles Dictyochaeta tropicalis and D. multisetula in absence of setae, monophialidic and terminal conidiogenous cells with funnel-shaped collarette, and hyaline, aseptate, ellipsoid conidia with one setula at each end (Bhat and Kendrick 1993; Whitton et al. 2000; Luo et al. 2019). Codinaea ellipsoidea differs from D. tropicalis (conidiophores 90–130 μ m long; conidia 7.5–9.5 \times 3–5 μ m) in having longer conidiophores and guttulate, larger conidia (Bhat and Kendrick 1993); differs from D. multisetula in conidia with multisetulae at each end in the latter species (Whitton et al. 2000; Luo et al. 2019).

Codinaea fanglanii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 53, MycoBank MB841558.

Etymology: Named after the former Chinese mycologist Fanglan Tai, who laid down the foundation for mycology in China.

Diagnosis: Setae $170-200 \times 4.5-5 \mu m$. Conidiophores $65-89 \times 3-5 \mu m$. Conidiogenous cells monophialidic, $23-30 \times 3-3.5 \mu m$. Conidia falcate, $15-16.5 \times 2-2.5 \mu m$, one setulae at each end and $9.5-12.5 \mu m$ long. Similar to *Codinaea fertilis, C. pakhalensis, D. plovercovensis* and *D. siamensis*, but can be distinguished from them by a combination of morphological characters including setae, conidiophores, conidiogenous cells and conidia.

Typification: China: Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of unidentified tree, 12 June 2015, W.P. Wu, Holotype HMAS 351981 (= Wu13345), ex-type strains CGMCC 3.20658 (= NN58983).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2-3 µm wide. Teleomorph: Unknown. Anamorph: Setae straight, crowded, arising mostly single, and surrounded by 2-5 conidiophores, smooth- and thick-walled, 170-200 µm long, 4.5-5 µm wide, tapering gradually towards the pointed apex, 7-9-septate, dark brown, becoming pale brown towards apex; basal cell dark brown and swollen, 8-10 µm wide; apex sterile and truncated or fertile with conidiogenous cells. Conidiophores macronematous, mononematous, simple, crowded, 2-5 around the base of one setae, erect, straight or slightly flexuous, pale brown to brown, becoming pale brown towards the apex, 4-6- septate, dark brown but becoming paler towards the apex, thin- and smooth-walled, 65-89×3-5 µm. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, $23-30 \times 3-3.5 \mu m$, pale brown, thin-walled, ending in a flared collarette which is funnel- or cup-shaped, 2-2.5 (-8.5) µm wide, 1.5–3 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, slightly curved, attenuated towards both ends, $15-16.5 \times 2-2.5 \mu m$, aseptate, hyaline, smooth, guttulate, with setulae at each end of the conidium, 9.5-12.5 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 3–3.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, grey to grey-brown, with pale colored margin, reverse pale brown to brown (Fig. 480).

Other material examined: **China** Shan'Xi Province, Xi An, Hua Qing Chi, on dead leaves of bamboo, 1 July 2015, W.P. Wu (Wu13368). Living strain: 59084 (from Wu13368) and 59025 (from Wu13345).

Ecology/substrate/host: Saprobe on submerged decaying leaf.

Geographical distribution: China.

Notes: Codinaea fanglanii resembles several species of Codinaea s. lat. and Dictyochaeta s. lat. species with clustered conidiophores, fertile setae, and aseptate, setulate conidia, including C. fertilis, C. pakhalensis, and C. siamensis and D. plovercovensis. They can be distinguished by a combination of morphological characters including setae, conidiophores, conidiogenous cells and conidia (Hughes and Kendrick 1968; Holubová-Jechová 1984; Kuthubutheen and Nawawi 1991b, d, e, f; Goh and Hyde 1999; Whitton et al. 2000; Liu et al. 2016). In C. siamensis (conidia $15.5-21 \times 2.5-4 \mu m$, setulae 7-12 $\mu m \log$) and C. pakhalensis (conidia $16.5-18 \times 3.5-4 \mu m$, setulae up to 9 μm long), the conidia are significantly longer and wider than those in C. fanglanii. In C. fertilis (conidia $9-15 \times 2-3 \mu m$, setulae 5-10 µm long) and D. plovercovensis (conidia $13-15 \times 1.5-2 \mu m$, setulae 8–9 μm long), the conidia are slightly shorter and the conidiogenous cells are polyphialidic with several flared collarettes.

The ITS sequences from the three studied strains are identical. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 58983 include *Codinaea* assamica (GenBank MH858788, 93% identity) and *C. vermispora* (GenBank MK165444, 93% identity).

Codinaea fertilis S. Hughes & W.B. Kendr., N.Z. J. Bot. 6:347, 1968.

= Dictyochaeta fertilis (S. Hughes & W.B. Kendr.) Hol.-Jech., Folia Geobot. Phytotaxon. 19:387, 1984.

Teleomorph: Unknown. Anamorph: Setae 155–385 μ m long, 4.5–7 μ m wide towards the base, 3.5–5 μ m wide at the apex, 10–20 septate, up to 15 successive sympodial proliferations. Conidiophores 54–170 μ m long, 3–5 μ m wide towards the base, 6–11 septate. Conidia 9–15×2.2–3 μ m. Setulae up to 9 μ m long.

Ecology/substrate/host: Saprobes on decaying leaves and branches.

Geographical distribution: broadly distributed in Africa, Australasia, Europe, South and North America, and Southeast Asia, including Brazil, Brunei, Canada, China, Czech Republic, Ivory Coast, Malaysia, Mexico, New Zealand, The Netherlands, Philippine, Slovak Republic, UK and USA (Réblová et al. 2021e).

Description and illustration: Hughes and Kendrick (1968); Ellis (1971); Holubová-Jechová (1984); Kuthubutheen and Nawawi (1991a, b, c, d, e); Heredia et al. (2000); Whitton et al. (2000); Réblová et al. (2021e).

Notes: *Codinaea fertilis* was reported on decaying leaves of *Pandanus tectorius* from Hongkong (Whitton et al. 2000).

Codinaea gonytrichoides Shearer & J.L. Crane, Mycologia 63: 245, 1971.

 \equiv *Codinaeopsis gonytrichoides* (Shearer & J.L. Crane) Morgan-Jones, Mycotaxon 4: 167, 1976.

≡ *Dictyochaeta gonytrichoides* (Shearer & J.L. Crane) Kuthub. & Nawawi, Mycol. Res. 94: 845, 1990.

≡ *Dictyochaetopsis gonytrichoides* (Shearer & J.L Crane) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 156, 2000.

Description on the natural substrate: Colony effuse, whitish or cream to brown. Mycelium partly superficial and partly immersed, composed of branched, septate, pale brown to brown, smooth, thick-walled hyphae, 2-4 µm wide, from which conidiophores are formed. Teleomorph: Unknown. Anamorph: Setae scattered or gregarious in large group, erect, straight or slightly curved, dark brown, paler towards the very pale brown apex, dark brown towards the base, smooth, thick-walled, 15-20-septate, $230-470 \times 5-7 \mu m$; apical cell sterile and rounded or obtuse, up to 2 µm wide; basal cell thick-walled, swollen, up to 12 µm wide. Conidiophores macronematous, mononematous, arising from encircling hyphae formed right below each septum in the lower 2/3 part of the setae, consisting of short lateral branches from the setae or short phialides from the superficial hyphae, 0-1 septate, 2-3 in clusters. Conidiogenous cells integrated, monophialidic, borne terminally and laterally on encircling hyphae, pale brown, smooth, thin-walled, cylindrical to lageniform, tapered to the apex, apex narrow with a funnelshaped collarette, $12-20 \times 3-4 \mu m$, collarette up to 1 μm high and 2-2.5 µm wide. Conidia aggregated into a moist, slimy mass at the apex of the conidiogenous cells, hyaline, aseptate, smooth, thin walled, falcate, typically curved, both ends attenuated, obtuse and with one setulae, $10-12 \times 1-2.5 \mu m$; setula 7.5–8.5 µm long.

Materials examined: China, Guangdong Province, Shenzhen, Lianhuashan Park, on rotten seed of Liquidambar formosana, 23 November 2019, W.P. Wu (Wu17140, 16,795); Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead seed of Liquidambar formosana, 25 August 2019, W.P. Wu (Wu16798); Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead seed of Cyclobalanopsis sp., 25 August 2019, W.P. Wu (Wu16873, 16,807); Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead leaves of Cyclobalanopsis sp., 25 August 2019, W.P. Wu (Wu16844); Shanghai, Shanghai Botanical Garden, on dead leaves of unidentified tree, 22 May 2015, W.P. Wu (Wu13303); Sichuan Province, Chengdu, Qingchengshan, on dead leaves of unidentified tree, 9 November 2019, W.P. Wu (Wu17209); Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead fruit of Diospyros kaki, 16 October 2019, W.P. Wu (Wu16985); Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead fruit of Ficus sp., 16 October 2019, W.P. Wu (Wu16995); Zhejiang Province, Huaan County, Qiandaohu, on dead leaves of Camellia

japonica, 18 October 2018, W.P. Wu (Wu16031); China: Zhejiang Province, Huaan County, Qiandaohu, on rotten cone of Pinus sp., 18 October 2018, W.P. Wu (Wu16154); Zhejiang Province, Huaan County, Qiandaohu, on dead leaves of Platanus occidentalis, 18 October 2018, W.P. Wu (Wu16019); Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead fruit of Platanus sp., 16 October 2019, W.P. Wu (Wu17014); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of unidentified tree, June 12 2015, Wu W.P. (Wu13332a,b, Wu13333a,b); Zhejiang Province, Huaan County, Qiandaohu, on rotten seed of unidentified tree, 18 October 2018, W.P. Wu (Wu16077); Zhejiang Province, Huaan County, Qiandaohu, on rotten wood, 18 October 2018, W.P. Wu (Wu16086); Japan, Mie Prefecture, Tsu, Mie Center for the Arts, on rotten fruit of unidentified tree, 3 Oct 2019, W.P. Wu (Wu16902). Living strains: 59068 (13332a); 58996 (13332b), 58995 (13333a), 58994 (13333b), 77,536 (from Wu17140), 77,568 (from Wu17209), 59069 (from Wu13303), 76.202 and 76.203 (from Wu16019), 76,206 (from Wu16031), 76,213 and 76,214 (from Wu16077), 76,319 and 76,320 (from Wu16086), 76,342 and 76,343 (from Wu16154), 77,113 and 77,114 (from Wu16795), 77,116 (from Wu16798), 77,117 and 77,118 (from Wu16807), 77,126 and 77,127 (from Wu16844), 77,208 (from Wu16873), 77,364 (from Wu16985), 77,370 and 77,299 (from Wu16995), 77,313 (from Wu16902) and 77,337 (from Wu17014).

Ecology/Substrate/Host: Saprobes on dead leaves, seed of different plants, including *Camellia japonica*, *Cyclobalanopsis* sp., *Diospyros kaki*, *Ficus* sp., *Liquidambar formosana*, *Platanus occidentalis* and *Pinus* sp.

Geographical distribution: China, Japan, North America, and many other countries (Réblová et al. 2021e).

Description and illustration: Shearer and Crane (1971); Morgan-Jones (1976); Kuthubutheen and Nawawi (1990); Whitton et al. (2000); Réblová et al. (2021a, b, c, d, e).

Notes: *Codinaea gonytrichoides* differs from other species in the genus by exhibiting *Gonytrichum*-like arrangement of conidiogenous cells on short collar hyphae which encircle a central setose at intervals and hyaline, aseptate, allantoid-shaped conidia bearing a single setula at each end (Shearer and Crane 1971; Pirozynski and Patil 1970; Morgan-Jones 1976; Whitton et al. 2000; Seifert et al. 2011). This species seems to be a rather broadly distributed species that has been found on dead leaves, fruit, seed, wood, stem etc. of many plants in the world. Its occurrence in Taiwan was also recorded.

Under the *Codinaeopsis* and *Dictyochaetopsis*, both with setiform and branched conidiophores, there are 17 species and revision based on molecular phylogeny is needed in future (Réblová et al. 2021e). These 17 species (including two invalidly published ones) are known with branched conidiophores and/or lateral phialides and setulate or asetulate

conidia, and most of them are now assigned to the genus *Dictyochaetopsis* Aramb. & Cabello, including 5 species with asetulate conidia (*Codinaeopsis maharashtrensis*, *Dictyochaetopsis antillana*, *D. apicalis*, *D. glauconigra* and *D. hamata*) and 12 species with setulate conidia (*Codinaea sinensis*, *Codinaeopsis filamentosa*, *C. gonytrichodes*, *Dictyochaeta santa-barbarensis* (invalid), *Dictyochaetopsis brasiliensis*, *D. dingleyae* (invalid), *D. elegantissima*, *D. intermedia*, *D. menisporoides*, *D. pahangensis*, *D. polysetosa*, and *Menispora amazoneis* (Whitton et al. 2000). Including more species in future phylogenetic analysis can support to elucidate their generic delimitation and phylogenetic relationship (Morgan-Jones 1976; Arambarri and Cabello 1989; Seifert et al. 2011; Whitton et al. 2000; Calduch et al. 2002b; Castañeda-Ruíz et al. 2008; Li et al. 2021).

Codinaea kendrickii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 54, MycoBank MB841559.

Etymology: Named after the mycologist B.W. Kendrick. Diagnosis: Setae fertile, $180-235 \times 4-6 \mu m$. Conidiophores $55-110 \times 4-5 \mu m$, with mono- or poly-phialidic terminal conidiogenous cells bearing funnel-shaped collarette. Conidia falcate, fusiform, $13-15 \times 2-2.8 \mu m$, setulae $8-12 \mu m$ long.

Typification: **China**, Sichuan Province, Ya An, Yucheng, Bifengxia, on dead leaf sheath of bamboo, 15 December 2013, W.P. Wu, Holotype HMAS 351982 (=Wu13208) ex-type strain CGMCC 3.20718 (=NN57551).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2.5–3.5 µm wide. Basal stroma dark brown, composed of several irregular, thick-walled cells, 20-30 µm side, from which the setae and conidiophores formed. Teleomorph: Unknown. Anamorph: Setae straight, arising mostly single, erect, straight or flexuous, cylindrical, smooth- and thick-walled, 180-235 µm long, 4-6 µm wide above the swollen base, 8-11-septate, dark brown in the lower part, becoming paler towards the apex; apical cells fertile, cylindrical, pale brown, thin- and smoothwalled, mono- or poly-phialidic, often with proliferations, $25-30 \times 3.5-4.5 \mu m$, with a conspicuous funnel-shaped collarette of 2-3.5 µm wide and up to 1.5 µm deep. Conidiophores macronematous, mononematous, simple, crowded, 4-6 in clusters around the base of one setae, formed from basal stroma, erect, straight or slightly flexuous, brown in the basal part, becoming paler towards the apex, 3-5-septate, thin- and smooth-walled, 55-110×3-5 µm. Conidiogenous cells integrated, terminal, mono- or poly-phialidic, with percurrent proliferations, cylindrical, $18-25 \times 3-4 \mu m$, pale brown, thin-walled, up to 3 funnel-shaped collarettes; collarette 2-3 µm wide, 1.5-2 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips



Fig. 54 Codinaea kendrickii (Wu13208, holotype). a Conidiophores and setae in cluster. c, d, e Fertile setae with terminal conidiogenous cells. b, f-h Conidiophores and conidiogenous cells with funnelshaped collarettes. i-k Part of conidiogenous cells showing the funnel-shaped collarettes. I-s Conidia. Scale bar: a-c 10 μm, d-s 5 μm

of conidiogenous cells, hyaline, smooth, curved, aseptate, falcate, slightly asymmetrical, bluntly pointed at the basal part and proximally somewhat tapered with a well-marked scar, apex rounded, (12-) 13–15×2–2.8 µm, with one setulae at each end and (6–) 8–12 µm long.

Culture characteristics: Colonies on PDA effuse, colonies up to 1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, yellow to light brown, reverse pale brown to brown (Fig. 48i, j).

Other materials examined: **China**, Sichuan Province, Ya An, Yucheng, Bifengxia Zhen, on dead leaf sheath of bamboo, 15 December 2013, W.P. Wu (Wu13253); Yunnan Province, Baoshan, Lujiang, Bawan, Gaoligongshan, on dead fruit of *Quercus* sp., 15 October 2003, W.P. Wu (Wu7244a). Living strains: 47741 (from Wu7244a) and 57,560 (from Wu13253).

Ecology/Substrate/Host: Saprobe on decaying leaves of plant, including bamboo and *Quercus* sp.

Geographical distribution: China.

Notes: Codinaea kendrickii differs from all known species in the genus Codinaea s. lat. and Dictyochaeta s. lat. by its fertile setae, mono- or poly-phialidic conidiogenous cells, aseptate and smaller conidia with one setulae at each end. In the phylogenetic tree, C. kendrickii is clustered together with C. latispora and C. terminalis. All these three species are with fertile setae and polyphialidic conidiogenous cells, but can be distinguished from each other by shape and size of conidia. Compared to C. kendrickii, Codinaea latispora has shorter but wider conidia $(11-13 \times 2.5-3.5 \,\mu\text{m})$, and C. terminalis has monophialidic conidiogenous cells. Morphologically C. kendrickii also resembles C. assamica, C. dinghushanensis, C. fertilis, C. pakhalensis, C. siamensis, and D. plovercovensis, in fertile setae, aseptate conidia with one setula at each end (Hughes and Kendrick 1968; Matsushima 1971; Holubová-Jechová 1984; Kuthubutheen 1987a, b, c, d, 1991; Kuthubutheen and Nawawi 1991b, d, e, f; Goh and Hyde 1999; Whitton et al. 2000; Liu et al. 2016). Codinaea pakhalensis (conidia 16.5-18×3.5-4.5 µm, setulae up to 9 μ m long) and C. siamensis (conidia 15.5–21 \times 2.5–4 μ m, setulae 7-12 µm long) produce significant longer conidia than C. kendrickii. In C. fertilis (conidia $9-15.3 \times 2-3 \mu m$, setulae 5-10 µm long), C. dinghushanensis (conidia $11-13 \times 2-2.5 \mu m$, setulae 4–6 μm long) and D. plovercovensis (conidia $13-15 \times 1.5-2 \mu m$, setulae $8-9 \mu m \log$), of which the conidia are slightly shorter and with shorter setulae than those in C. kendrickii. Codinaea assamica produces conidia with similar shape and size as in *C. kendrickii* but has sterile setae with blunted apical cells.

The ITS sequences from the studied strains are identical. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 57551 include *Codinaea paniculata* (GenBank NR_171755, 95% identity) and *C. terminalis* (NR_166297, 98% identity).

Codinaea latispora W.P. Wu & Y.Z. Diao, sp. nov., Fig. 55, MycoBank MB841560.

Etymology: Refers to its wide conidia.

Diagnosis: Setae fertile, $130-215 \times 4-6 \mu m$. Conidiophores $30-85 \times 3.5-5 \mu m$, with polyphialidic terminal conidiogenous cells bearing funnel-shaped collarette. Conidia falcate, fusiform, $11-13 \times 2.5-3 \mu m$, setulae $6-12 \mu m \log n$.

Typification: **China**, Zhejiang, Deqing, Moganshan, Luhuadang, on dead culm of bamboo, 16 October 2019, W.P. Wu, Holotype HMAS 351983 (=Wu17038), ex-type strain CGMCC 3.20739 (=NN77341).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2.5-3.5 µm wide. Basal stroma dark brown, composed of several irregular, thick-walled cells, $20-30 \ \mu m$ side, from which the setae and conidiophores formed. Teleomorph: Unknown. Anamorph: Setae straight, arising mostly single, erect, straight or flexuous, cylindrical, smooth- and thick-walled, 130-215 µm long, 4-6 µm wide above the swollen base, 8-11-septate, dark brown in the lower part, becoming paler towards the apex; apical cells fertile, cylindrical, pale brown, thin- and smoothwalled, poly-phialidic, often with percurrent proliferations, $22-30 \times 4-6 \mu m$, with a conspicuous funnel-shaped collarette of 3–3.5 μ m wide and up to 1–2 μ m deep. Conidiophores macronematous, mononematous, simple, crowded, 4–6 in clusters around the base of one setae, formed from basal stroma, erect, straight or slightly flexuous, brown in the basal part, becoming paler towards the apex, (1-)3-5-septate, thin- and smooth-walled, $30-85 \times 3.5-5 \mu m$. Conidiogenous cells integrated, terminal, mono- or poly-phialidic, with percurrent proliferations, cylindrical, $20-25 \times 4-4.6 \,\mu\text{m}$, pale brown, thin-walled, up to 4 funnel-shaped collarettes; collarette 2.5-3.5 µm wide, 1-2 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, hyaline, smooth, falcate, curved, aseptate, slightly symmetrical, bluntly pointed at the basal part and proximally somewhat tapered with a well-marked scar, apex rounded, $11-13 \times 2.5-3.5 \mu m$, with one setulae at each end and 6-12 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire,



Fig. 55 *Codinaea latispora* (Wu17038, holotype). **a–e** Fertile setae and conidiophores in clusters. **h**, **j** Upper part of fertile setae with polyphialidic conidiogenous cells. **i**, **g** Conidiophores and conidiogenous cells. **i**, **k–p** Conidia. Scale bar: **a–e** 10 μ m, **f–p** 5 μ m



Fig. 56 *Codinaea lignicola* (Wu4527). **a, b** Setae and conidiophores in clusters. **c–f** Setae bearing apical phialidic conidiogenous cells. **g–m** Conidiophores and conidiogenous cells with funnel-shaped collarettes. **n–w** Conidia. Scale bar: **a, b** 20, **c–w** 5 µm

aerial mycelium poorly developed, white to pale brown, with pale colored margin, reverse pale-yellow brown (Fig. 48m, n).

Other material examined: China, Zhejiang, Deqing, Moganshan, Luhuadang, on dead culm of bamboo, 16



Fig. 57 *Codinaea lithocarpi* (**a–c**, **g–m** Wu17510; d, e Wu17573). **a**, **b** Setae and conidiophores in clusters. **c**, **d** Upper part of setae with sterile or fertile apex. **e**, **f** Conidiogenous cells with funnel-shaped collarette. **g–m** Conidia. Scale bar: **a–b**, **e** 10 μm, **c**, **d**, **f–m** 5 μm

October 2019, W.P. Wu (Wu17037). Living strains: 77,382 and 77,340 (from Wu17037).

Ecology/Substrate/Host: Saprobe on dead leaf sheath of bamboo.

Geographical distribution: China.

Notes: In the phylogenetic tree, *C. latispora* is clustered together with *C. kendrickii* and *C. terminalis*. Morphologically *C. latispora* differs from other two species by its shorter but wider conidia $(11-13 \times 2.5-3.5 \ \mu\text{m})$.

Codinaea lignicola (Z.L. Luo, H.Y. Su & K.D. Hyde) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 39, 2021. Figure 56

 \equiv *Dictyochaeta lignicola* Z.L. Luo, H.Y. Su & K.D. Hyde, Fungal Divers. 99: 595, 2019.

Description on the natural substrate: Saprobic on submerged decaying wood. Colonies on natural substrate, effuse, superficial, hairy, greyish brown, in groups. Mycelium immersed, composed of branched septate, smooth hyphae. Teleomorph: Unknown. Anamorph: Setae cylindrical, dark brown, straight or flexuous, 8-11-septate, smooth, thick-walled at the base, becoming paler and thin-walled towards the upper part, fertile at the apex, $240-315 \times 4.5-6 \mu m$ Conidiophores 3-6 in clusters with one setae,, macronematous, mononematous, solitary, cylindrical, erect, straight, or slightly flexuous, unbranched, mid brown at the lower part, becoming paler towards the apex, 3-5-septate, $45-105 \times 23-5 \mu m$, terminated with polyphialidic conidiogenous cell. wide septate, brown, becoming pale brown towards the apex, smooth. Conidiogenous cells poly-phialidic, determinate, terminal, subhyaline, $25-30 \times 5-6 \mu m$, with funnel-shaped collarettes. Conidia $12-13.7 \times 3-3.5 \,\mu\text{m}$, solitary, guttulate, aggregating in a globose mass at apex of conidiophore, aseptate, navicular to fusiform, curved, no appendages observed, hyaline, smooth-walled.

Material examined: **China**, Hunan Province, Zhangjiajie, on decaying wood, September 2000, W.P. Wu (Wu4527c). Living strain: 46,470.

Ecology/substrate/host: Saprobe on submerged decaying wood.

Geographical distribution: China (Luo et al. 2019; Réblová et al. 2021e).

Description and illustration: Luo et al. (2019).

Notes: *Codinaea lignicola* is a recently described species from submerged wood in China. It resembles *Dictyochaeta renispora* in absence of setae, long cylindrical conidiophore with monophialidic conidiogenous cell, and hyaline, aseptate, setulate conidia aggregating in a mucoid mass, but having longer conidiophores (204–276 μ m in *C. lignicola* vs. 95–220 μ m in *D. tenispora*), polyphialidic conidiogenous cells, and larger conidia (13–15×4.5–5.5 vs. 6–8.5×3–4.5 μ m) (Whitton et al. 2000; Lin et al. 2019; Luo et al. 2019).

Codinaea lithocarpi (R.H. Perera, E.B.G. Jones & K.D. Hyde) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 57, Mycobank MB841690.

≡ *Dictyochaeta lithocarpi* R.H. Perera, E.B.G. Jones & K.D. Hyde, Mycosphere 11: 2124, 2020.

Description on the natural substrate: Saprobe on dead leaves and fruit. Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2-3 µm wide. Teleomorph: Unknown. Anamorph: Setae straight, arising mostly single, erect, straight or flexuous, cylindrical, smooth- and thick-walled, $(150-)260-450 \times 5-6.5 \mu m$, 6-8 µm wide above the swollen base, tapering gradually towards the rounded apex, (5-)12-18-septate, dark brown in the lower part, becoming paler towards the rounded apex, sterile or fertile at the apex. Conidiophores macronematous, mononematous, simple, crowded, up to 5 around the base of 1 setae, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, 3–8-septate, thin- and smooth-walled, $40-130 \times 3-4 \mu m$. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, cylindrical, $15-20 \times 3.5-4 \mu m$, pale brown, thin-walled, collarette funnel-shaped, 2.5-3.5 µm wide, 1.5-2.5 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, fusiform, falcate, slightly curved, (11-)13-16×2.2-2.5 µm, aseptate, hyaline, smooth, apex rounded, base slightly truncate to rounded, with one setula at each end, $7-11(-13) \mu m \log$.

Culture characteristics: Colonies on PDA effuse, colonies 2–3 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, grey to dark brown, reverse brown to dark brown (Fig. 66a–d).

Materials examined: **China**, Guangdong Province, Dinghushan, on dead culm of *Arundo donax*, 9 October 1998, W.P. Wu (Wu1888b); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead fruit of *Camellia* sp., 17 October 2020, W.P. Wu (Wu17510); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead fruit of unidentified tree, 17 October 2020, W.P. Wu (Wu17572, 17573, 17519); Guangxi Province, Shiwandashan, on dead leaves of palm, 31 December 1997, W.P. Wu (Wu1574a). Living strains: 44,671 (from Wu1888b), 78,264 and 78,265 (from Wu17510), 78,272 and 78,349 (from Wu17519) and 78,375 (from Wu17572).

Ecology/Substrate/Host: Saprobe on dead fruit of plants including *Camellia* sp., *Lithocarpus* sp. and palm, and dead culm of *Arundo donax*.

Geographical distribution: China and Thailand (Perera et al. 2020).

Description and illustration: Perera et al. (2020).

Notes: *Codinaea lithocarpi* was originally described on dead fruit of *Lithocarpus* sp. from Thailand. It resembles *C. assamica* and *C. pandanicola*, but differs from *C.*



Fig. 58 *Codinaea oxenbolliae* (Wu17179, holotype). **a, b** Setae and conidiophores in clusters. **c, d** Setae. **e–i** Conidiophores and conidiogenous cells. **j–q** Conidia. Scale bar: **a–d** 10 μm, **e–q** 5 μm

pandanicola by having smaller conidia $(14-17 \times 1.5-2.8 \text{ vs.} 16-26 \times 4-6 \mu\text{m})$ and presence of setae and from *C. assamica* by the ITS sequences (Kuthubutheen and Nawawi 1991a, b, c, d, e; Whitton et al. 2000; Cruz and Gusmão 2009; Tibpromma et al. 2018).

Codinaea minima W.P. Wu & Y.Z. Diao, sp. nov., Fig. 49a– d, MycoBank MB841561.

Etymology: Refers to its small conidia.

Diagnosis: Differs from all other species in very small sized conidia $(6-8 \times 1.5-2 \ \mu\text{m})$ and short setulae $(5-7 \ \mu\text{m} \ \text{long})$.

Typification: **China**, Guangdong Province, Dinghushan, on dead stem of *Arundo donax*, 10 October 1998, W.P. Wu, Holotype HMAS 351984 (=Wu1942b).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2.5-4 µm wide. Teleomorph: Unknown. Anamorph: Setae straight, arising mostly single, erect, straight, or flexuous, cylindrical, smooth- and thick-walled, up to 200 µm long, 3–4 µm wide above the swollen base, 6-8-septate, dark brown in the lower part, apex acute and sterile. Conidiophores macronematous, mononematous, simple, crowded, up to 3 around the base of one setae, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, 2-4-septate, thin- and smooth-walled, $30-60 \times 2-3 \mu m$. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, cylindrical, $10-20 \times 2.5-3.5 \mu m$, pale brown, thin-walled, collarette funnel-shaped, 1.5–2 µm wide, 1–1.5 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, slightly curved, $6-8 \times 1.5-2 \mu m$, aseptate, hyaline, smooth, both ends acute, with one setula at each end, $5-7 \mu m \log$.

Other material examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead culms of bamboo, 2 January 1997, W.P. Wu (Wu1266d).

Ecology/Substrate/Host: Saprobe on dead culm of *Arundo donax* and bamboo.

Geographical distribution: China.

Notes: *Codinaea minima* differs from all known species in the genus *Codinaea* s. lat. and *Dictyochaeta* s. lat. by the clustered conidiophores and sterile setae, monophialidic conidiogenous cells, and very small conidia with one short setula at each end (Hughes and Kendrick 1968; Kuthubutheen and Nawawi 1991b, d, e; Whitton et al. 2000; Liu et al. 2016; Lin et al. 2019; Luo et al. 2019). No living strain was obtained.

Codinaea oxenbolliae W.P. Wu & Y.Z. Diao, sp. nov., Fig. 58, MycoBank MB841562.

Etymology: Named after the former mycologist and also senior leader of Novozymes A/S, Karen Oxenboll, who introduced the author Wu into Novozymes and also gave strong support to this work.

Diagnosis: Setae $230-300 \times 4-5 \mu m$. Conidiophores $60-110 \times 2.5-3.5$, with terminal polyphialidic conidiogenous cells bearing funnel-shaped collarette. Conidia falcate, fusiform, $13-15 \times 2 \mu m$, setulae 5–7 μm long.

Typification: **China**, Sichuan, Chengdu, Qingchengshan, on dead leaves of unidentified tree, 9 November 2019, W.P. Wu, Holotype HMAS 351985 (=Wu17179), ex-type strain CGMCC 3.20747 (=NN77595).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2-5 µm wide. Teleomorph: Unknown. Anamorph: Basal stroma 20-30 µm diam, formed by irregular, dark brown, thick-walled cells, with one long setae in the middle and 3-5 short conidiophores. Setae straight, single, erect, straight or flexuous, cylindrical, smooth- and thickwalled, with a basal cell up to 13 µm wide, 230-300 µm long, 4–5 µm wide, tapering gradually towards the apex, multiseptate, dark brown to black, becoming paler towards the apex, terminated with a fertile conidiogenous cell. Conidiophores macronematous, mononematous, simple, in cluster, up to 5 around the base of one setae, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, cylindrical, 4-7-septate, wall thick and slightly vertuculose, $60-110 \times 2.5-3.5 \mu m$. Conidiogenous cells integrated, terminal, mono- or poly-phialidic, cylindrical to clavate, $25-32 \times 4-5 \mu m$, pale brown to brown, thinwalled, collarette funnel-shaped, 2-3 µm wide, 1.5-2 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, fusiform, curved, $13-15 \times 2-2.5 \,\mu\text{m}$, aseptate, hyaline, smooth, apex acute to rounded, with one setulae at each end, 5-8 µm long.

Culture characteristics: Colonies on PDA effuse, colonies up to 1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown.

Other materials examined: **China**, Hubei Province, Shennongjia, on dead leaves of unidentified tree, 12 September 2004, W.P. Wu (Wu8269b); Sichuan, Chengdu, Qingchengshan, 9 November 2019, on dead leaves of unidentified tree, W.P. Wu (Wu17183, Wu17185, Wu17183). Living strains: CGMCC 3.20643 (= 50,631, from Wu8269b), 77,595 (from Wu17179), 77,598 (from Wu17183), 77,599 (from Wu17185) and 77,600 (from Wu17187).

Ecology/Substrate/Host: Saprobes on dead leaves. Geographical distribution: China.

Notes: *Codinaea oxenbolliae* is characterized by clustered conidiophores and fertile setae formed from basal stroma,



Fig. 59 Codinaea paniculata (Wu17167). a-d Setae and conidiophores in clusters. e, f Fertile setae with terminal mono- or polyphialidic conidiogenous cells. g-i Conidiophores and conidiogenous cells

with funnel-shaped collarettes. j, k Upper part of fertile setae with polyphialidic conidiogenous cells. l-t Conidia. Scale bar: a, b 20 μ m, c-f 10 μ m, g-t 5 μ m

mono- or poly-phialidic conidiogenous cells, and hyaline, aseptate conidia with one setulae at each end. In the phylogenetic tree (Fig. 48), *C. oxenbolliae* is clustered together *C. pyriformis* and *C. simaoensis*, but differs from them by shape and size of conidia. In *C. pyriformis*, the conidia are pyriform and with three setulae, one apical and two lateral, thus can be easily distinguished from *C. oxenbolliae*. *Codinaea simaoensis* differs from *C. oxenbolliae* by its fusiform conidia which are only slightly curved, tapering to a pointed end, and in longer size (15–17×2.2–2.5 µm).

Among the Codinaea/Dictyochaeta species with clustered conidiophores and fertile setae, several other species produce aseptate conidia with setulae at both ends and they are C. dinghushanensis, C. fertilis, C. pakhalensis, C. siamensis and D. plovercovensis (Hughes and Kendrick 1968; Holubová-Jechová 1984; Kuthubutheen and Nawawi 1991b, d, e, f; Goh and Hyde 1999; Whitton et al. 2000; Liu et al. 2016). C. pakhalensis (conidia $16.5-18 \times 3.5-4.5 \mu m$, setulae up to 9 μ m long), C. siamensis (conidia 15.5–21 \times 2.5–4 μ m, setulae 7-12 µm long) and D. plovercovensis (conidia $13-15 \times 1.5-2$ µm, setulae 8-9 µm long) produce significantly longer conidia than C. oxenbolliae. Codinaea fertilis (conidia 9–15.3 \times 2–3 µm, setulae 5–10 µm long) and C. dinghushanensis (conidia $11-13 \times 2-2.5 \,\mu\text{m}$, setulae $4-6 \,\mu\text{m}$ long) also produce conidia in small size as in C. oxenbolliae, however C. dinghushanensis has shorter setae (up to 200 µm long) and conidiophores (50-80 µm long), and monophialidic conidiogenous cells; while C. fertile has slightly longer conidia and setulae.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 50631 include *Codinaea lithocarpi* (GenBank NR_171095, 94% identity) and *C. siamensis* (GenBank OL654082, 94% identity).

Codinaea pandanicola (Tibpromma & K.D. Hyde) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 39, 2021.

≡ *Dictyochaeta pandanicola* Tibpromma & K.D. Hyde, Fungal Divers. 93: 127, 2018.

Ecology/Substrate/Host: Saprobe on decaying leaves of Pandanus sp.

Geographical distribution: China (Tibpromma et al. 2018).

Description and illustration: Tibpromma et al. (2018).

Notes: In the phylogenetic analysis, *Codinaea pandanicola* is well-separated from other *Codinaea* s. lat. and *Dictyochaeta* s. lat. species. Morphologically, *Codinaea pandanicola* is similar to *C. siamensis*, but differs in that *D. siamensis* has longer conidia $(17.5 \times 3 \ \mu\text{m})$ and setulae $(7-12 \ \mu\text{m} \log)$ (Liu et al. 2016; Tibpromma et al. 2018).

Codinaea paniculata Réblová & J. Fourn., MycoKeys 74: 30, 2020, Fig. 59

Description on the natural substrate: Colonies on the nature substrate effuse, hairy, greyish brown. Teleomorph: Unknown. Anamorph: Setae erect, straight or slightly flexuous, smooth-walled, dark brown and thick-walled, becoming pale brown to subhyaline and thin-walled towards the apex, (7-)10-16-septate, (130-)250-310 µm long, 4-5.5 µm wide above the base, tapering gradually towards the apex, sterile or fertile with a mono- or poly-phialide. Conidiophores macronematous, mononematous, 50-60×3-4 µm, 2-5-septate, erect, straight, or flexuous, arising singly or in groups of 2-5 from hyphal cells associated with setae, mid-brown to pale brown becoming gradually paler towards the apex, basal cell swollen and 9-11 µm wide. Conidiogenous cells 11-20 µm long (20-30 µm long for the terminal conidiogenous cells from the setae), $3-4 \mu m$ wide, tapering to $2 \mu m$ just below the collarette, integrated, terminal, mono- or polyphialidic, cylindrical to cylindrical-lageniform, pale brown at the base becoming subhyaline towards the apex, smoothwalled; collarettes funnel-shaped, 3-3.6 µm wide, 1-2 µm deep. Conidia in slimy droplets, hyaline in mass, of two types: narrower and longer conidia $14.5-17.5 \times 2.2-2.5 \mu m$; and shorter and usually wider one usually from the setiform conidiophores, $11.5-13 \times 3 \mu m$; falcate, asymmetrical, rounded at the apical end, with an inconspicuous scar at the basal end, hyaline, aseptate, smooth-walled, with simple, straight, or gently curved setulae at both ends, $6-7.5 \ \mu m$ long.

Materials examined: **China**, Sichuan, Chengdu, Qingchengshan, on dead leaves of unidentified tree, 9 November 2019, W.P. Wu (Wu17166, Wu17167a). Living strains: 77,592 and 77,719 (from Wu17166), 77,593 (from Wu17167b) and 77,738 (from Wu17167a).

Ecology/Substrate/Host: Saprobes on dead leaf and branch.

Geographical distribution: China and France (Réblová et al. 2021e).

Description and illustration: Réblová et al. (2020); Réblová et al. (2021e).

Notes: *Codinaea paniculata* characterized by two different types of conidia, is a recently described species with comparison to *Codinaea assamica* and *C. terminalis* (Réblová et al. 2020). *Codinaea assamica* differs from *C. paniculata* by slightly longer conidia (14.6–16.8×2.6–2.8 µm) and setulae (9.6–12.8 µm) (Hughes and Kendrick 1968). *Codinaea terminalis* also produces the monophialidic conidiogenous cells and aseptate conidia, but the conidia in this species are slightly longer and wider (14.7–20.7×2.9–4.2 µm) (Lin et al. 2019). The ITS sequences obtained from the two Chinese strains are almost identical to those obtained from the European material.

Codinaea phasma Hern.-Restr. & Réblová, J. Fungi 7 (12, no. 1097): 41, 2021. Figure 60



Fig. 60 *Codinaea phasma* (Wu15148). **a–c** Conidiophores. **d–g** Apical part of setae with conidiogenous cells bearing funnel-shaped collarettes. **h–p** Conidia. Scale bar: **a, b** 20 μm, **c** 10 μm, **d–p** 5 μm



Fig.61 Codinaea pyriformia (Wu2746b1, holotype). a Conidia. b Conidiophores and conidia with setulae. Codinaea trisetula (Wu1930c, holotype). c Conidiophores, conidiogenous cells and

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3–5 µm wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, mononematous, simple, solitary or in small groups, cylindrical, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, 8-12-septate, thick- and smoothwalled, $200-300 \times 6-8 \,\mu\text{m}$, terminated with a monophialidic conidiogenous cell. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, $30-40 \times 3.5-4.5 \mu m$, pale brown to brown, thin-walled, collarette funnel-shaped, 2–2.5 µm wide, 1.5–2.5 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, fusiform, slightly curved, $14-16.5 \times 2.8-3.5 \mu m$, aseptate, hyaline, smooth, apex rounded, base slightly truncate to rounded, with one setula at each end, 6-8 µm long.

Culture characteristics: Colonies on PDA effuse, colonies up to 1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, grey-brown to dark brown, with brown colored margin, reverse brown to dark brown (Fig. 48g, h).

Materials examined: **China**, Yunnan Province, Pu Er, on dead leaves of unidentified tree, 12 June 2018, Y. Zhang (HMAS 351986 (= Wu15148). Living strain: 75,986.

Ecology/Substrate/Host: Saprobe on dead leaves.

conidia. **d** Upper part of conidiophores and conidiogenous cells bearing funnel-shaped collarettes. **e** Conidia. Scale bar: **c** 40 μm, **a, b, d, e** 20 μm, **b–c** 20 μm

С

d

Geographical distribution: China and Puerto Rico (Réblová et al. 2021e).

Description and illustration: Réblová et al. (2021e).

Notes: *Codinaea phasma* is a recently described species which differs from other species in the genus by oblong to falcate conidia with one simple setula at each end (Réblová et al. 2021e). In pure culture the fungus also forms irregularly ellipsoidal conidia with both terminal and lateral setulae. Compared with the original description (on the natural substrate, conidia 13.5–18×3–4 µm, setulae 5–13 µm long), the fungus fround in China bears no shorter conidiophores and slightly shorter conidial setulae. The ITS sequence obtained from the studied strain is identical to the one from the ex-type strain.

Codinaea plovercovensis (Goh and K.D. Hyde) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841692.

 \equiv Dictyochaeta plovercovensis Goh and K.D. Hyde, Fungal Divers. 3: 69, 1999.

Ecology/Substrate/Host: Saprobe on submerged wood.

Geographical distribution: China and Mexico (Goh and Hyde 1999; Luo et al. 2004, 2019; Becerra-Hernández et al. 2011).

Description and illustration: Goh and Hyde (1999); Becerra-Hernández et al. (2011).

Notes: *Codinaea plovercovensis* resembles *C. fertilis* S. Hughes and W.B. Kendr., which also has long fertile setae,

fasciculate conidiophores, and unicellular conidia with one setulae at each end (Holubová-Jechová 1984; Arambarri et al. 1987a, b; Kuthubutheen and Nawawi 1991a). Although *C. fertilis* has conidia of about the same size as those of *C. plovercovensis*, the former species differs in lacking a stroma and in having dense fascicles of long conidiophores (up to $300 \,\mu\text{m}$) which end in a polyphialide with up to 8 successive proliferations. Its occurrence on submerged wood in China, including Hong Kong and Yunnan, was reported by Goh and Hyde (1999) and Luo et al. (2004, 2019).

Codinaea pyriformis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 61a, b, MycoBank MB841564.

Etymology: refers to its pyriform conidia.

Diagnosis: Similar to *Bahusutrabeeja manoharacharii* but differs in larger conidia with 4–5 setulae. Also similar to *Codinaea dwaya*, *C. phasma*, *C. pyriformis* and *C. trisetula* in wider conidia with both apical and lateral setulae, but differs from them in monophialidic conidiogenous cells and pyriform conidia with one apical and two lateral setulae.

Typification: **China**, Yunnan Province, Xishuangbanna, on dead leaves of unidentified plant, 16 October 1999, W.P. Wu & Yan Huang, Holotype HMAS 351987 (=Wu2746b1), ex-type strain CGMCC 3.20707 (=NN45929).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly superficial and partly immersed, composed of pale brown to brown, branched and septate hyphae, 2–4 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, solitary, simple, erect, straight or slightly flexuous, medium brown, 1–2-septate, smooth- and thin-walled, 55–60×4–5 μ m. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, with a broad sporulating loci and funnel-shaped collarette, 22–35×5–6 μ m, pale brown, smooth, collarette funnel-shaped, up to 5 μ m wide, 2–2.5 μ m deep. Conidia holoblastic, acrogenous, solitary, formed in wet spore mass, globose to subglobose, ellipsoidal, aseptate, hyaline, smooth, 8–11×6.5–7.5 μ m, with one apical and two lateral setulae of 2–3 μ m long.

Culture characteristics: Colonies on PDA effuse, colonies up to 1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with white colored margin, reverse brown to dark brown (Fig. 48k, 1).

Ecology and substrate: Saprobe on dead leave of unidentified broad leaf tree.

Geographical distribution: China.

Notes: *Codinaea pyriformis* phylogenetically belongs to *Codinaea* s. str., but differs from other species in monophialidic conidiogenous cells and pyriform conidia with both apical and lateral setulae (Réblová et al. 2021e). Among the accepted species of *Codinaea* s. str., *C. dwaya* and *C. phasma* also produce the wider conidia with both terminal and lateral setulae, but differs from *C. pyriformis* in shape and size of conidia and number of conidial setulae. In *C. dwaya*, the conidia are oblong to pyriform, bigger in size $(15.5-22 \times 10.5-14.5 \mu m)$, and bearing 6–10 setulae; while in *C. phasma*, the conidia with both terminal and lateral setulae are only produced in pure culture and they are irregularly ellipsoidal, tapering toward both ends, in bigger size $(12.5-18.5 \times 4.5-8 \text{ um})$ and bearing 3(–5) setulae, one at each end and 1–3 as lateral (Réblová et al. 2021e). *Codinaea pyriformis* morphologically also resemble *Bahusutrabeeja manoharacharii*, but can be distinguished by the smaller conidia with 4 appendages in *B. manoharacharii* (Subramanian and Bhat 1977; Rao and de Hoog 1986; Bhat and Kendrick 1993; Bhat 1994; McKenzie 1997; Pratibha and Bhat 2005).

Codinaea siamensis (J. Yang, K.D. Hyde & J.K. Liu) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 43, 2021. Figure 62

 \equiv Dictyochaeta siamensis J. Yang, K.D. Hyde & J.K. Liu, Mycol. Prog. 15: 1159, 2016.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3-5 µm wide. Teleomorph: Unknown. Anamorph: Setae straight, arising mostly single, erect, straight or flexuous, cylindrical, smooth- and thick-walled, 300-400 µm long, 5–6 µm wide above the swollen base, tapering gradually towards the rounded apex, 10-18-septate, dark brown in the lower part, becoming paler towards the apex, apex fertile with a funnel-shaped collarette. Conidiophores macronematous, mononematous, simple, crowded, up to 3 around the base of one setae, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, 3–7-septate, thin– and smooth-walled, $60-100 \times 3-4 \mu m$. Conidiogenous cells integrated, terminal, polyphialidic, cylindrical, $15-25 \times 3.5-4.5 \mu m$, pale brown, thin-walled, collarette funnel-shaped, around 3 µm wide, 2-3 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, slightly curved, $12-16 \times 2-2.5 \,\mu\text{m}$, aseptate, hyaline, smooth, apex rounded, base slightly truncate to rounded, with one setula at each end, 8–10 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 2–3 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, grey to greybrown, reverse pale brown to dark brown (Fig. 66e–j).

Materials examined: **China**, Guangdong Province, Dinghushan, on dead fruit of unidentified plant, 10 October 1998, W.P. Wu (Wu1965); Guangdong Province, Dinghushan, on dead leaves of *?Smilax* sp., 10 October 1998, W.P. Wu (Wu1935b); Guangdong Province, Dinghushan, on dead branches of unidentified plant, 9 October 1998,



Fig. 62 *Codinaea siamensis* (Wu12670). **a**, **b** Setae and conidiophores in clusters. **c**, **d** Fertile setae with terminal polyphialidic conidiogenous cells. **e–g** Conidiophores and conidiogenous cells with funnel-shaped collarettes. **h–q** Conidia. Scale bar: **a–d** 10 μm, **e–q** 5 μm



Fig. 63 *Codinaea simaoensis* (Wu15241, holotype). **a**, **b** Setae and conidiophores in cluster from basal stroma. **c** Apical part of conidiogenous cell. **d–f** Setae, conidiophores and conidiogenous cells from basal stroma. **g–j** Conidia. Scale bar: **a**, **b** 20 μm, **c–j** 5 μm

W.P. Wu (Wu1872d); Guangdong Province, isolated from leaf litter, 9 October 1998, W.P. Wu (Wu2068); Guangdong Province, Shaoguan, Danxiashan, on dead branches of unidentified tree, 25 December 2012, W.P. Wu (Wu12645); Guangdong Province, Guangzhou, Sough China Botanical Garden, on dead seed of Arecoideae, 10 December 2013, W.P. Wu (Wu 12,670); Guangdong Province, Shenzhen, Lianhuashan Park, on dead leaves of unidentified tree, 11 November 2019, W.P. Wu (Wu17112, Wu17249); Guangdong Province, Shenzhen, Lianhuashan Park, on decaying seed of Acacia sp., 18 October 2020, W.P. Wu (Wu17484); Guangdong Province, Shenzhen, Lianhuashan Park, on decaying petiole of palm, 18 October 2020, W.P. Wu (Wu17455, Wu17464, Wu17471, Wu17472, Wu17562); Guangdong Province, Shenzhen, Lianhuashan Park, on decaying leaves of unidentified tree, 18 October 2020, W.P. Wu (Wu17546); China, Guangdong, Guangzhou, South China Agriculture University, on dead leaves of unidentified tree, 3 December 2018, W.P. Wu (Wu16287, Wu16365); Guangxi Province, Damingshan, on dead culms of bamboo, 18 December 1997, W.P. Wu (Wu1392d); Guangxi, on dead leaves of unidentified plant, 23 December 1997, W.P. Wu (Wu2203); Sichuan Province, Huanglong Nature Reserve, on dead culm of bamboo, 8 August 2000, W.P. Wu (Wu3525); Yunnan Province, Shilin, on dead leaves, 12 June 2004, W.P. Wu (Wu7244d); Yunnan Province, Xishuangbanna, on dead leaves of unidentified plant, 16 October 1999, W.P. Wu & Yan Huang (Wu2737d). Living strains: 44,644 (from Wu1872d), 44,718 (from Wu1935b), 57,699 (from Wu12645), 57,681 (from 12,670), 76,615 and 76,616 (from Wu16287), 76,665 and 76,666 (from Wu16365), 77,648 (from Wu17112b), 77,663, 77,664 and 77,665 (from Wu17249), 78,223 (from Wu17455a), 78,227 and 78,228 (from Wu17464), 78,232 (from Wu17472), 78,243 (from Wu17484), 78,298 and 78,299 (from Wu17546), 78,339 (from Wu17471) and 78,365 (from Wu175862a).

Ecology/Substrate/Host: Saprobe on dead leaves, branches, culm, fruit of different plants, including bamboo.

Geographical distribution: China and Thailand (Liu et al. 2016; Réblová et al. 2021e).

Description and illustration: Liu et al. (2016); Réblová et al. (2021e).

Notes: *Codinaea siamensis* is another commonly found species in China. Morphologically, the fungus from different specimens shows some variations on the size of setae and conidia, number of proliferations in conidiogenous cells (Hughes and Kendrick 1968; Ellis 1976; Whitton et al. 2000; Liu et al. 2016).

Codinaea simaoensis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 63, MycoBank MB841565.

Etymology: Refers to the locality where this fungus was originally discovered.

Diagnosis: Setae $195-240 \times 4.5-5 \mu m$, fertile at the apex. Conidiophores $50-85 \times 3-3.5 \mu m$, with a terminal mono- or poly-phialidic conidiogenous cell bearing a funnel-shaped collarette. Conidia fusiform, slightly curved, tapering to a pointed end at both sides, $15-17 \times 2.2-2.5 \mu m$, setulae $6-7 \mu m \log n$.

Typification: **China**, Yunnan Province, Pu Er, on dead leaves of unidentified plant, 12 June 2018, Yu Zhang, Holotype HMAS 351988 (=Wu15214), ex-type strain CGMCC 3.20800 (=NN76046).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3-5 µm wide. Stroma dark brown, composed of a few dark brown, irregular cells, from which the setae and conidiogenous cells formed. Teleomorph: Unknown. Anamorph: Setae straight, arising mostly single, erect, straight or flexuous, cylindrical, smooth- and thick-walled, $195-240 \ \mu m \log_{10} 4.5-5 \ \mu m wide above the swollen base,$ tapering gradually towards the rounded apex, upper part 3.5–4 µm wide, 6–8-septate, dark brown in the lower part, becoming paler towards the apex, apex terminated with a fertile mono-phialidic conidiogenous cells, collarette conspicuous and funnel-shaped. Conidiophores macronematous, mononematous, simple, crowded, up to 2-4 around the base of one setae, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, 2–5-septate, thin- and smooth-walled, $50-85 \times 3-3.5 \ \mu m$. Conidiogenous cells integrated, terminal, mono- or poly-phialidic, subcylindrical, clavate, ellipsoidal, slightly obclavate, $19-29 \times 4-4.5 \mu m$, pale brown to brown, becoming paler towards the apex, thin-walled, collarette inconspicuous or funnel-shaped, around 2.5 µm wide, 1.5-2 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, fusiform, slightly curved, $(12-)15-17 \times 2.2-2.5 \mu m$, aseptate, hyaline, smooth, guttulate, tapering to a pointed end at both sides, with one setula at each end, 6–7 µm long.

Ecology/Substrate/Host: Saprobe on dead leaves of plant. Geographical distribution: China.

Notes: In the phylogenetic tree (Fig. 48), *C. simaoensis* is clustered together *C. oxenbolliae* and *C. pyriformis*, but differs from them by shape and size of conidia. In *C. pyriformis*, the conidia are pyriform and with three setulae, one apical and two lateral, thus can be easily distinguished from *C. simaoensis*. *Codinaea simaoensis* differs from *C. oxenbolliae* by its fusiform conidia which are only slightly curved, tapering to a pointed end, and in longer size $(15-17 \times 2.2-2.5 \,\mu\text{m})$.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 76,046 include and *Codinaea acaciae* (GenBank NR_137898, 94% identity), *C. ellipsoidea* (GenBank MK828629, 95% identity), *C. lithocarpi*



Fig. 64 Codinaea terminalis (Wu17210). a, b Setae and conidiophores in cluster. c-e Setae with sterile or fertile apex. f-k Conidiophores and conidiogenous cells with funnel-shaped collarettes. l-t Conidia. Scale bar: a-d, f, g, j, k 20 μm, e, h, i, l-t 5 μm

(GenBank NR_171095, 95% identity) and *C. vermispora* (GenBank MK165444, 97% identity).

Codinaea tengii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 49h-j, MycoBank MB841566.

Etymology: Named after the former Chinese mycologist S.C. Teng.

Diagnosis: Setae fertile, up to 420 μ m long. Conidiophore 45–80×3.5–5 μ m, terminated with a polyphialidic conidiogenous cell bearing up to 10 funnel-shaped collarette. Conidia falcate, 10–11×2–3 μ m, setulae 4–5 μ m long.

Typification: **China**, Guangxi Province, Nanning, on dead stem of palm, 3 January 1998, W.P. Wu, Holotype HMAS 351989 (=Wu1645c).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2.5-3.5 µm wide. Teleomorph: Unknown. Anamorph: Setae straight, arising mostly single, erect, straight or flexuous, cylindrical, smooth- and thick-walled, up to 420 µm long, 6-7 µm wide above the swollen base, 13-16-septate, dark brown in the lower part, becoming paler towards the apex, apex fertile with a few funnelshaped collarettes. Conidiophores macronematous, mononematous, simple, crowded, up to 3 around the base of one setae, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, 3-5-septate, thin- and smooth-walled, 45-80×3.5-5 µm. Conidiogenous cells integrated, terminal, polyphialidic with up to 10 funnel-shaped collarettes, cylindrical, $15-45 \times 3.5-5 \mu m$, pale brown, thin-walled; collarette 3-4 µm wide, 2-2.5 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, slightly curved, $10-11 \times 2-3 \mu m$, aseptate, hyaline, smooth, both ends rounded, with one setula at each end, 4-5 µm long.

Ecology/Substrate/Host: Saprobe on dead stem of palm. Geographical distribution: China.

Notes: *Codinaea tengii* differs from all known species in the genus *Codinaea* s. lat. and *Dictyochaeta* s. lat. by its fertile setae, polyphialidic conidiogenous cell, and lunate, aseptate conidia in smaller size and with shorter setulae at each end (Hughes and Kendrick 1968; Matsushima 1971; Kuthubutheen 1987a, b, c, d, 1991; Whitton et al. 2000; Lin et al. 2019; Luo et al. 2019; Réblová et al. 2020). Morphologically *C. tengii* resembles *C. fertilis, C. pakhalensis C. siamensis*, and *D. plovercovensis*. However, in all these known species, their conidia are significantly longer than 13 μ m in average, thus can easily be distinguished from *C*. *tengii*. No living strain was obtained.

Codinaea terminalis (C.G. Lin & K.D. Hyde) Réblová &

Hern.-Restr., J. Fungi 7 (12, no 1097): 44, 2021. Figure 64 ≡ *Dictyochaeta terminalis* C.G. Lin & K.D. Hyde, Mycosphere 10: 672, 2019.

Description on the natural substrate: Colonies effuse, gregarious, brown, shining. Mycelium mostly immersed, composed of branched, septate, smooth, thin-walled, brown hyphae. Teleomorph: Unknown. Anamorph: Setae fertile, erect, dark brown at the base, paler towards the apex, septate, thick-walled, unbranched, smooth, cylindrical, 6-10-septate, (120-)180-320 µm long, 4-5.5 µm wide at the base, terminating with a monophialidic conidiogenous cell. Conidiophores mononematous, macronematous, in groups of 2–9 arising from the mycelial knots from the base of setae, short, cylindrical, $60-95 \times 3-4.3 \,\mu\text{m}$, sometimes percurrent, dark brown at the base becoming pale brown towards the apex, straight or slightly flexuous, 3-6-septate, thick-walled, smooth. Conidiogenous cells 25-38 × 3.5-3.2 µm, terminal, integrated, monophialidic, clavate, subcylindrical, with flared collarette up to 3.5 µm wide, 1.5-2 µm deep. Conidia aggregating in a globose mass at apex of conidiophores and setae, acrogenous, aseptate, long fusiform, straight to curved, hyaline, smooth, $13-16 \times 2.5-3 \mu m$, with a hair-like, 8–10.5 µm long appendage at both ends.

Culture characteristics: Colonies on PDA effuse, colonies up to 2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white to pale brown, reverse white to pale brown (Fig. 66k, 1).

Materials examined: **China**, Sichuan, Chengdu, Qingcheng Shan, on dead cone of *Picea* sp. 9 November 2019, W.P. Wu (Wu17210); Sichuan, Chengdu, Qingcheng Shan, on dead leaves of unidentified tree 9 November 2019, W.P. Wu (Wu17203, Wu17207, 17,208); Yunnan, Baoshan, Teng Chong, Gaoligongshan, on dead leaves of unidentified tree, 15 Oct 2003, W.P. Wu (Wu7105b). Living strains: 47726 (from Wu7105b), 77,563 (from Wu17203), 77,566 (from Wu17207), 77,567 (from Wu17208) and 77,669 (from Wu17210).

Ecology/Substrate/Host: Saprobes on dead leave and fruit of *Picea* sp. and other trees.

Geographical distribution: China (Lin et al. 2019; Réblová et al. 2021e; Zhang et al. 2022).

Description and illustraton: Lin et al. (2019); Réblová et al. (2021e); Zhang et al. (2022).

Notes: *Codinaea terminalis* is a recently described species and similar toto *C. pakhalensis*, *C. assamica*, *C. fertilis*, *Dictyochaeta gamundiae* and *D. plovercovensis* in producing fertile setae, mononematous conidiophores, and aseptate conidia with setulae at each end (Agnihothrudu 1962a, b; Hughes and Kendrick 1968; Reddy and Reddy 1977; Arambarri et al. 1987a, b; Kuthubutheen and Nawawi 1991b; Goh and Hyde 1999; Whitton et al. 2000). *Codinaea terminalis* differs from these species by fertile setae, monophialidic conidiogenous cells, and longer conidia. The conidia from the Chinese collections are somewhat smaller than those in the original description.

Codinaea trisetula W.P. Wu & Y.Z. Diao, sp. nov., Figs. 61c-e, MycoBank MB841554.

Etymology: Refers to its conidia with three setulae.

Diagnosis: Setae absent. Conidiophores cylindrical, solitary or aggregated, 7–10-septate, $200-300 \times 6-8 \mu m$. Conidiogenous cells polyphialidic, $15-20 \times 6-7 \mu m$ with up to 10 funnel-shaped collarettes. Conidia ellipsoidal, slightly papillate at the apex, obtuse or truncate at the base, $13-15 \times 8-10 \mu m$, aseptate, with one setulae at the apex and 2–3 setulae in the middle part of the conidial body, 5–10 μm long.

Typification: **China**, Guangdong Province, Dinghushan, on dead branches of unidentified plant, 10 October 1998, W.P. Wu, Holotype HMAS 351990 (=Wu1930c), ex-type strain CGMCC 3.20636 (=NN44720).

Description on the natural substrate: Saprobe on dead branches of broad leaf tree. Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3-5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, scattered or aggregated, simple, erect, straight, or slightly flexuous, 7-10-septate, dark brown at the lower part, becoming paler towards the apex, smooth, $200-300 \times 6-8 \mu m$, base with a swollen and lobbed cell up to 10 µm wide, proliferation percurrent. Conidiogenous cells integrated, terminal or intercalary due to percurrent proliferation, polyphialidic with up to 10 collarettes, cylindrical, $15-20 \times 6-7 \mu m$, pale brown, thin- and smooth-walled, collarette funnel-shaped, 2-3 µm wide, 2-2.5 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, ellipsoidal, slightly papillate at the apex, obtuse or truncate at the base, $13-15 \times 8-10 \mu m$, aseptate, hyaline, smooth, with one setulae at the apex and 2-3 setulae in the middle part of the conidial body, 5–10 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse of the same color or slightly darker (Figs. 48c, d).

Other material examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead branches of unidentified plant, 2 January 1997, W.P. Wu (Wu1324a). Living strain: 44,490 (from Wu1324a).

Ecology/Substrate/Host: Saprobe on dead branches of broad leaf tree.

Geographical distribution: China.

Notes: Codinaea trisetula phylogenetically belongs to Codinaea s. str., but differs from other species in absence of setae, polyphialidic conidiogenous cells with up to 10 condensed sporulating loci, and ellipsoidal, slightly papillate conidia with both one apical and two to three lateral setulae (Subramanian and Bhat 1977; Rao and de Hoog 1986; Bhat and Kendrick 1993; McKenzie 1997; Li et al. 2012; Réblová et al. 2021e). Among the accepted species of Codinaea s. str., C. dwaya, C. phasma and C. pyriformis also produce the wider conidia with both terminal and lateral setulae, but differs from C. trisetula in shape and size of conidia and number of conidial setulae. In C. dwaya, the conidiogenous cells are mono-phialidic and with only one wider funnelshaped collarette, and the conidia are oblong to pyriform, bigger in size $(15.5-22 \times 10.5-14.5 \,\mu\text{m})$, and bearing 6-10 setulae. In C. phasma, the conidia with both terminal and lateral setulae are only produced in pure culture and they are irregularly ellipsoidal, tapering toward both ends, in bigger size $(12.5-18.5 \times 4.5-8 \text{ um})$ and bearing 3(-5) setulae, one at each end and 1-3 as lateral (Réblová et al. 2021e). While C. pyriformis has monophialidic conidiogenous cells and smaller conidia $(8-11 \times 6.5-7.5 \,\mu\text{m})$ with one apical and two lateral setulae of 2–3 µm long.

On conidial morphology, *Codinaea trisetula* also resembles *Dictyochaeta fimbriaspora* in having ellipsoidal conidia with multisetulae. However, the conidial setulae in the latter species are inserted only at the ends and no lateral appendages formed (Whitton et al. 2000).

Both LSU and ITS sequences were obtained from the two studied strains. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 44720 include *Codinaea acaciae* (GenBank MN560147, 95% identity), *C. assamica* (GenBank MH858788, 95% identity and *C. lithocarpi* (GenBank MT215492, 95% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the ex-type strain 44720 include *Codinaea dwaya* (GenBank OL654135, 99% identity) and *C. siamensis* (GenBank OL654139, 99%).

Codinaea vermispora (Z.F. Yu & R.F. Castañeda) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 45, 2021.

≡ *Phialolunulospora vermispora* Z.F. Yu & R.F. Castañeda, MycoKeys 76: 23. 2020.

Ecology/Substrate/Host: isolated from plant leaves. Geographical distribution: China (Zheng et al. 2020). Description and illustration: Zheng et al. (2020).

Notes: *Phialolunulospora* is a recently described genus with the freshwater fungus *P. vermispora* as type species from China. It is morphologically similar to some other genera of Chaetosphaeriaceae in hyaline conidia with basal eccentric cellular appendages, including *Rattania* (Prabhugaonkar and Bhat 2009). Based on the phylogenetic analysis

this fungus was transferred into *Codinaea* (Réblová et al. 2021e).

Codinaea zhangii W.P. Wu & Y.Z. Diao, nom. nov., Myco-Bank MB841687.

= Dictyochaeta chinensis Y.L. Jiang & T.Y. Zhang, Mycotaxon 131: 387, 2016.

Etymology: Named after the Chinese mycologist Prof. T.Y. Zhang, who made great contribution to hyphomycetes taxonomy and also discovered this fungus.

Teleomorph: Unknown. Anamorph: Setae straight or curved, septate, pale brown to brown, paler and almost always fertile towards the apex where there are persistent collarettes, smooth, up to 320 μ m long, 2.5–5 μ m thick. Conidiophores solitary or in small groups often associated with setae, straight or flexuous, septate, pale brown to brown, smooth, 50–200×2.5–4 μ m, polyphialidic; collarettes funnel-shaped with thick walls. Conidia fusiform or sometimes cylindrical, mostly curved, hyaline, smooth, aseptate, 10–20×2–4 μ m (commonly 14×3 μ m), usually with a setula at each end, sometimes without setulae or only on one end, setulae 1.5–8 μ m long (Jiang et al. 2016).

Material examined: China: Guizhou Province, Leishan County, isolated from soil sample, 18 September 2005, Y.L. Jiang (Isotype HMAS 196,299).

Geographical distribution: China (Jiang et al. 2016).

Description and illustration: Jiang et al. (2016).

Notes: The isotype material was examined by us and it fits well to *Codinaea* concept (Holubová-Jechová 1984; Arambarri et al. 1987a, b; Kuthubutheen and Nawawi 1991a, b, c, d, e; Whitton et al. 2000). According to the CGMCC, the ex-type strain CGMCC3.13766 of *C. chinensis* was contaminated and reisolation of the original strain was not successful.

Apart from those accepted species by Réblová et al. (2021e) and this study, the following species should also be included under *Codinaea* s. str.

Codinaea aristata Maire, Publ. Inst. Bot. Barcelona 3: 15, 1937.

Description and illustration: Maire (1937); Hughes and Kendrick (1968).

Notes: *Codinaea aristata* is the type species of the genus *Codinaea*. It differs from other species of *Codinaea* by sterile setae, and falcate and aseptate conidia $(12-14 \times 2 \ \mu m)$ with a terminal setula 4–6 μm long and a basal setula about 1 μm long (Hughes & Kendrick, 1976).

Codinaea australiensis B. Sutton, Proc. Royal Soc. Queensland 91: 14, 1980.

= Dictyochaeta australiensis (B. Sutton) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 137, 2000. Geographical distribution: Australia (Sutton 1980a, b;

Matsushima 1989). Description and illustration: Sutton (1980a, b); Matsu-

shima (1989). Notes: *Codinaea australiensis* is similar to *Tainosphaeria*

simplex but with bigger and symmetrical conidia.

Codinaea pakhalensis S.M. Reddy & S.S. Reddy, Sydowia 30: 186, 1978.

≡ *Dictyochaeta pakhalensis* (S.M. Reddy & S.S. Reddy) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 145, 2000.

Geographical distribution: India (Reddy and Reddy 1977).

Description and illustration: Reddy and Reddy (1977).

Notes: Based on the original description and illustration, *Codinaea pakhalensis* should be kept in the genus *Codinaea* s. str. It differs from other species by producing fertile setae, polyphialidic conidiogenous cells with funnel-shaped collarette, and fusiform, aseptate conidia with one short setula at each end.

Dictyochaeta gamundiae Aramb. & Cabello, Mycotaxon 29: 29, 1987.

Geographical distribution: Argentina (Arambarri et al. 1987a, b).

Description and illustration: Arambarri et al. (1987a, b). Notes: *Dictyochaeta gamundiae* is well described and illustrated in the original publication and fits well to the genus *Codinaea*. This fungus has fertile setae, terminal mono- or poly-phialidic conidiogenous cells with funnelshaped collarettes, and fusiform, symmetrical and aseptate conidia ($16-20 \times 2-3 \mu m$) with a simple setula $10-15 \mu m$ long at each end (Arambarri et al. 1987a, b). No molecular data is available for phylogenetic analyses.

Dictyochaeta gyrosetula Kuthub., Nawawi & G.M. Liew, Mycol. Res. 95: 1211, 1991.

Geographical distribution: Malaysia (Kuthubutheen and Nawawi 1991a, b, c, d, e).

Description and illustration: Kuthubutheen and Nawawi (1991a, b, c, d, e).

Notes: Dictyochaeta gyrosetula is unique is producing fertile setae, monophialidic conidiogenous cell with funnel-shaped collarette, and fusiform, aseptate conidia $(24-26\times6-8 \ \mu\text{m})$ with a single and spiral setulae $65-135 \ \mu\text{m}$ long borne only at the apical end (Kuthubutheen and Nawawi 1991a, b, c, d, e). Except for the conidia with only one apical setula, D. gyrosetula fits well to the concept of Codinaea.

Dictyochaeta tilikfrei Bhat & B. Sutton, Trans. Br. Mycol. Soc. 84: 725, 1985.



140

◄ Fig. 65 Maximum likelihood (ML) tree based on ITS sequence data for the genus *Codinaeella*. Bootstrap support values ≥ 60%, Bayesian posterior probability values ≥ 0.95 are shown at the nodes. *Paragaeumannomyces garethjonesii* 1019 was chosen as the outgroup. Extype strains are indicated with "T" in the end of the taxa labels. Latin names and ex-type strain numbers of the new species described in the current study are shown in font

Geographical distribution: Ethiopia (Bhat & Sutton 1985a, b).

Description and illustration: Bhat & Sutton (1985a, b).

Notes: *Dictyochaeta tilikfrei* produces fertile setae and conidiophores in clusters, mono- or poly-phialidic conidiogenous cells with funnel-shaped collarette, and broadly fusiform, falcate, aseptate conidia $(20-25 \times 10-12.5 \ \mu\text{m})$ with a simple setula 5–6 μm long at each end. It differs from other species by its big conidia (Bhat and Sutton 1985b; Kuthubutheen and Nawawi 1990; Whitton et al. 2000).

Codinaeella Réblová & Hern.-Restr., J. Fungi 7 (12, no 1097): 45, 2021.

Colonies on natural substrate effuse, lanose, brown to reddish-brown. Teleomorph: Unknown. Anamorph: Setae present or occasionally absent, grow singly or in small groups, erect, straight or flexuous, septate, brown, unbranched, always fertile with a terminal or several lateral phialidic openings, setae rarely absent. Conidiophores macronematous, mononematous, crowded, arise singly or in groups,



scattered among the setae if present, unbranched, occasionally branched, erect, straight or flexuous, sometimes geniculate, brown, septate, smooth. Conidiogenous cells integrated, terminal on conidiophores or short phialide-bearing branches, or discrete, lateral on conidiophores or 1–2-celled stalks, mono-and poly-phialidic, extending percurrently and sympodially, pigmented, often with persistent remnants of the collarettes; collarettes flared, funnel-shaped, the apical part may become soon evanescent. Conidia falcate, cylindrical-fusiform, curved, slightly asymmetrical, tapering toward both ends, slightly truncate at the base with an inconspicuous scar, aseptate, hyaline, with straight or gently curved setula at each end inserted terminally at the apex and subterminally at the base, accumulate in slimy fascicles (Adapted from Réblová et al. 2021e).

Type species: *Codinaeella minuta* (Tubaki) Réblová & Hern.-Restr.

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: Broadly distributed (Réblová et al. 2021e).

Description and illustration: Réblová et al. (2021e).

Notes: Codinaeella was recently created to accommodate eight Codinaea-like fungi with two layers of conidiophores, terminal mono- or poly-phialidic conidiogenous cells with percurrent and sympodial proliferation, and cylindrical fusiform and aseptate conidia bearing one setulae at each end (Réblová et al. 2021e). The eight accepted species include: Codinaeella filamentosa, C. lambertiae, C. lutea, C. mimusopis, C. minuta, C. parvilobata, C. pini and C. yunnanensis. Codinaeella is separated from Codinaea s. str. by molecular and morphological characters. The two genera differ in the arrangement of setae (if present) and conidiophores on the natural substrate, and partly also in the production of pigments in vitro. The morphology of Codinaea s. str. is more complex and consists of four morphotypes (C1–C4), but none of them is comparable with those of Codinaeella (CA1 and CA2) (Réblová et al. 2021e).

In our phylogenetic tree generated by the combined ITS and LSU dataset (Figs. 3 and 65), a total of 14 species formed a strongly supported clade and different from other *Codinaea* s. str. and *Dictyochaeta* s. lat. species. The group is consisting of *Codinaeella coryli*, *C. lambertiae*, *C. mimusopis*, *C. sinensis*, *C. yunnanensis*, and several new species. All these species share very similar morphological characters as *Codinaeella. pini*, including forming two layers of conidiophores but not in clusters, solitary or clustered conidiophores, terminal mono- or poly-phialidic conidiogenous cells with sympodial and percurrent extension, funnel-shaped collarettes, and hyaline, aseptate, fusiform to falcate conidia with setulae at both ends. None of these species is known with teleomorph. The recently established new genus *Codinaeella* is adapted to accommodate all these species. Based on both morphological and phylogenetic analysis, nine new species, all with ITS barcodes, are added into the genus.

Réblová et al. (2021e) recognized two morphotypes among Codinaeella species, which is further supported from our study with inclusion of additional species. Species with the predominant morphotype CA1 (e.g., C. lutea, C. minuta, C. parvilobata) form unbranched conidiophores that grow singly or in small groups from repent hyphae or knots of hyphal cells and are usually scattered among longer, darker and thicker-walled unbranched setae. The setae resemble conidiophores; they are always fertile and terminate into a mono- or poly-phialide. The other morphotype CA2 is less common, and it is represented by C. filamentosa and C. sinensis only. It is characterized by solitary, branched conidiophores with a sterile setiform extension and lower fertile part, and they are accompanied by shorter, unbranched conidiophores. Conidiogenous cells are monophialidic, discrete, lateral and also integrated, terminal on stalks or short phialide-bearing branches and shorter conidiophores.

Morphologically several known species in *Chalara* s. lat. and *Dictyochaeta* s. lat., including *Codinaea coffeae*, *C. longispora*, *C. unisetula*, *D. taiwanensis*, and several species of *Dictyochaetopsis* might also belong to this group. However, they might also be the anamorphs of *Tainosphaeria* and need to be studied with molecular phylogenetic analysis for reclassification (Hughes and Kendrick 1968; Morgan-Jones and Ingram 1976; Sutton 1980a, b; Maggi and Persiani 1984; Arambarri et al. 1987a, b; Matsushima 1987; Crous et al. 2014; Lin et al. 2019; Luo et al. 2019; Réblová et al. 2021e).

Living strains of many studied species were also studied on PDA (Figs. 66, 67), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Key to accepted species of *Codinaeella* (*Ca.*) and morphologically similar species known under *Codinaea* (*C.*), *Dictyochaeta* (*D.*) and *Tainosphaeria* (*T.*)

Conidiophores synnematous......2 1. 1. Conidiophores solitary, mononematous......5 2. Synnemata comprising up to 10 unbranched conidiophores; conidia $6-7 \times 4-5$ µm with a single setula 7–9 μm long.....*C. delicata* 2. Synnemata comprising more than 10 conidiophores; conidia more than 10 µm long......3 Conidia 0–1-septate, $21-30 \times 3-6 \mu m$, setulae 7.5– 3. 12 µm long.....C. pindobacuensis 3. Conidia 0-septate, less than 20 µm long......4 4. Synnemata comprising up to 45 individual unbranched conidiophores; conidia $17-21 \times 5.4-6.2 \ \mu m$ with a single setula up to 6.4 µm long at each end.....C. obesispora



Fig. 66 Colony of Codinaea, Codinaeella and Nimesporella species on PDA after 20 days at 25 °C. a-d Codinaea lithocarpi (44671).
e-j C. siamensis (e-h 44,644, i-j 44,718). k-l C. terminalis (47726).
m-p Codinaeella kuthubutheenii (m 44891, n 43775, o 42898, p 44,410). p Ca. minuta (47771). r Ca. yunnanensis (44,495). s, t Ca.

4.	Synnemata comprising up to 25 individual unbranched
	contatophotes, contata $12.3-10 \times 2.4-5.2 \ \mu m$ with a
	single setura up to 6 µm long at each end
	C. dendroidea
5.	Apex of setae sterile
5.	Apex of setae always fertile7
6.	Setae with lateral phialides; conidia 12.5-
	$15.5 \times 2-2.5 \mu m$; setulae 5–6 $\mu m \log$ <i>Ca. sinensis</i>
6.	Setae with or without lateral branches; conidia 14.5–
	$17.5 \times 2-2.5 \ \mu\text{m}$; setulae 5–8 μm long
	Ca. filamentosa
7.	Conidia with only one setula 13–15 µm long; conidia
	$6-7 \times 1 \mu\text{m}$ <i>C. unisetula</i>
7.	Conidia with setulae at both ends or multisetulate8
8.	Conidia broadly ellipsoidal, aseptate, one setula at
	either end, $6.5-10.5 \times 6-8 \mu m$; conidiophores up to
	160 µm long, apex coarsely verrucoseD. ciliata
8.	Conidia otherwise
9.	One setula at each end of conidium10
9.	Number of setulae otherwise, or variable

multisporuloca (ex-type strain 78,175). **u** Nimesporella aunstrupii (ex-type strain 54329). **v** N. riisgaardii (ex-type strain 59021). **w** Multiguttulispora paratriseptata (ex-type strain 55338). **x** Codinaea clavatophora (ex-type strain 47943)

10.	Conidia reniform, both ends rounded, aseptate,
	6–8.5×3–4.5 μmD. renispora
10.	Conidia fusiform, falcate, lunate, curved11
11.	Setulae not exceeding 5 µm long in average12
11.	Setulae exceeding 5 µm long in average13
12.	Conidia $11-17 \times 2.5-3.1 \mu\text{m}$; setulae $2-4 \mu\text{m}$
	T. parva
12.	Conidia 17–23×2–2.7 μm; setulae 3–5 μm
	T. vulgaris
13.	Conidia less than 20 µm long14
13.	Conidia more than 20 µm long27
14.	Conidia more than 3 µm wide in average15
14.	Conidia less than 3 µm wide in average16
15.	Conidia 10.8–18×3.4–5 μm; setulae 4.5–9 μm
	C. coffeae
15.	Conidia lunate, $13.5-16.5 \times 3.3-3.6 \mu m$; setulae
	5–5.5 µm long <i>Ca. latispora</i>
16.	Conidia mostly 13–15 µm long17
16.	Conidia with broad range in length22



Fig.67 Colony of *Codinaeella* species on PDA after 20 days at 25 °C. **a**, **b** *Ca. brevissima* (ex-type strain 77,622). **c**, **d** *Ca. lamber-tiae* (76,781). **e**, **f** *Ca. cinnamomi* (ex-type strain 57549). **a**, **h** *Ca.*

cannonii (ex-type strain 76,040). i, j Ca. kuthubutheenii (ex-type strain 78,279). k, l Ca. minuta (ex-type strain 58997). m, n Ca. filamentosa (77,422). o, p Ca. latispora (ex-type strain 47478)

- 17. Conidiogenous cells polyphialidic.....18
- 17. Conidiogenous cells monophialidic.....19
- 18. Conidia 10.5–13.5×2–2.5 (–3) μm.....

.....Ca. multisporuloca

- 19. Conidia $13-15 \times 2-3$ (2.5) µm; setulae 8–9 µm long...
-Ca. pini
- 19. Conidial setulae less than 8 µm long.....20
- 20. Conidia (13–)14–15(–18)×(2.5–)3 μm; setulae 5–8 μm long.....Ca. lambertiae
- 20. Conidia 2–2.5 μm wide and with shorter setulae.....21
| 21. | Conidiophores 0–2-septate, 20–40 μ m long; conidiog-
enous cells 13–16×3–3.5 μ m; conidia naviculate to
lo-ng fusiform, 12.5–15×2–2.5 μ m; setulae 5–6 μ m
long |
|-----|--|
| 21. | Conidiophores 0–5-septate, 30–80 μ m long; conid-
iogenous cells 15–30 × 3–3.5 μ m; Conidia navicu-
late to lo-ng fusiform, 12.5–14.5 × 2–2.5 μ m; setulae
4–5.5 μ m long <i>Ca. brevissima</i> |
| 22. | Conidia $15-17 \times 2.5-3.5 \ \mu\text{m}$; setulae $6-7 \ \mu\text{m}$
long <i>Ca. yunnanensis</i> |
| 22. | Conidia 2–3 um wide |
| 23 | Conidiophores 1–6-septate $40–150 \times 3-4$ µm ² conid- |
| -01 | iogenous cells monophialidic $30-55 \times 3-4$ µm; conidia |
| | $(11-)16-18(-20) \times 25-3(-35)$ µm: setulae 6-8 µm |
| | long |
| 23. | Conidiogenous cell polyphialidic, with several funnel- |
| | shaped collarettes25 |
| 24. | Conidiophores up to 60 µm long26 |
| 24. | Conidiophores up to 115 µm long27 |
| 25. | Conidiophores 5-septate, up to 115 µm long; conidia |
| | $14-19 \times 2.1-2.7 \mu$ m; setulae 6-8 μ m long |
| | T. simplex |
| 25. | Conidiophores 2–8-septate, 50–110 µm long; conidia |
| | falcate, curved, $15-20 \times 2-2.7 \mu m$; setulae 6–8 μm lo- |
| • - | ngCa. kuthubutheenii |
| 26. | Conidia $14-18 \times 2-2.3 \ \mu\text{m}$; setulae 5.5–7.5 μm |
| 26 | long |
| 20. | Confidia 14–10.2 x 2–2.5 μ m; seturae 5.5–7.5 μ m |
| 27 | Conidianharas repeatedly coniculates conidia 22, 28 x |
| 27. | 2.5.3 um; setulae 8, 10 um long <i>C longisporg</i> |
| 27 | Conidiophores not repeatedly geniculate: conidia 30-45× |
| 27. | 2 5_4 um: setulae 5_12 um long Ca taiwanensis |
| 28 | Conidia with 2–6 sub-basal setulae and 2–4 anical setu- |
| 20. | lae: reniform asentate $11-13 \times 6-7$ µm: conidionhores |
| | 120–450 µm long D multifimbriata |
| 28. | Conidia otherwise 29 |
| 29. | Conidia with one apical setula and a fringe of basal set- |
| _,. | ulae, broadly ellipsoidal, aseptate, $14-19.5 \times 8-11$ µm; |
| | conidiophores 310–550 µm longD. fimbriaspora |
| 29. | Conidia with variable number of setulae at each end, |
| - | irregularly ellipsoidal, aseptate. $14-18.5 \times 5-6.5$ um: |
| | conidiophores 365–445 µm long |
| | D. multisetula |
| | |
| | |

Codinaeella brevissima W.P. Wu & Y.Z. Diao, sp. nov., Fig. 68, MycoBank MB841576.

Etymology: Refers to its short conidiophores.

Diagnosis: Setae absent. Coniodiophores in two layers, 0–5-septate, $30-80 \times 2.5-3.5 \mu m$. Conidiogenous cells monophialidic, $15-30 \times 3-3.5 \mu m$. Conidia naviculate to fusiform, curved, $12.5-14.5 \times 2-2.5 \mu m$; setulae 4–5.5 μm long.

Typification: **China**, Sichuan Province, Chengdu, Qingchengshan, on dead leaves of unidentified tree, 9 November 2019, W.P. Wu, Holotype HMAS 351991 (= Wu17241), ex-type strain CGMCC 3.20804 (=NN77622).

Description on the natural substrate: Saprobic on decaying leaves. Colonies effuse, hairy, greyish brown, shining, in groups. Mycelium immersed, consisting of greyish brown, branched, smooth hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, formed in two layers, cylindrical, unbranched, percurrently growing, erect, straight, or slightly flexible, smooth, 0-5-septate, brown, paler towards the apex, smooth, 30-80 µm long, 2.5-3.5 µm wide. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, pale brown, thin- and smoothwalled, $15-30 \times 3-3.5 \mu m$; collarette conspicuous, funnelshaped, 2-3 µm wide and 1-2 µm deep, occasionally with 1-2 percurrent proliferations. Conidia acrogenous, aggregating in a globose mucoid mass, naviculate to long fusiform, narrow at both of ends, $12.5-14.5 \times 2-2.5 \mu m$, bearing one setula at each end, 4–5.5 µm long.

On PDA, the colonies effuse, grey to dark brown, hairy, with both superficial and immersed hyphae; reverse blackish. Conidiophores directly formed from superficial hyphae, cylindrical, brown, thick-walled, smooth, up to 7-septate, up to 150 μ m long, 2.5–3.5 μ m wide. Conidiogenous cells monophialidic, terminal, integrated, cylindrical, lageniform, 20–30×3–3.8 μ m, with a conspicuous collarette. Conidia naviculate to fusiform, symmetrical, or asymmetrical, 12–14×2–2.5 μ m, base truncated, apex obtuse, both ends bearing a setula, 2–3.5 μ m long (Fig. 67a, b).

Other materials examined: **China**, Guangxi Province, Nanning, Nanning Subtropical Botanical Garden, on dead leaves of unidentified tree, 12 November 2013, W.P. Wu (Wu13076, Wu13142); Guangdong Province, Shenzhen, Lianhuashan, on dead leaves of unidentified tree, 11 November 2019, W.P. Wu (Wu17250); Guangxi Province, Nanning, Nanning Subtropical Botanical Garden, on dead leaves of *Acacia* sp., 12 November 2013, W.P. Wu (Wu13146). Living strains: 57,422 (from Wu13076), 57,452 (from Wu13142), 57,468 (from Wu13146) and 77,701 (from Wu17250).

Ecology/Substrate/Host: Saprobes on dead leave of trees. Geographical distribution: China.

Notes: The morphological observation and phylogentic analysis shows that *C. brevissima* is closely related to *C. coryli* (conidiogenous cells monophialidic; conidia $12-19.5 \times 2.3-3.5 \mu m$, setulae 4.7–8.4 μm long), *C. lutea* (conidiogenous cells mono- or polyphialidic;



Fig. 68 Codinaeella brevissima (Wu17241, holotype). a-f Conidiophores and conidiogenous cells with funnel-shaped collarettes. g-r Conidia. Scale bar: 5 µm

conidia $12.5-17.5 \times 2-2.5 \ \mu m$, setulae $5-8.5 \ \mu m \ long$), C. minuta (conidiogenous cells mono- or polyphialidic, 1–5 lateral openings; conidia $13-18 \times 2.5-3.5 \mu m$, setulae 5.5-8.5 µm long), C. parvilobata (conidiogenouc cells polyphialidic; conidia $12-15 \times 2.5 \mu m$, setulae 8-10 µm long), C. pini (Conidiogenous cells monophialidic; conidia $10.5-13.5 \times 2-2.5 \mu m$, setulae 6.5-9 μm long) and C. yunnanensis (conidiogenous cells monoor polyphialidic; conidia $15-17 \times 2.5-3.5 \mu m$, setulae 6-8 µm long) (Kuthubutheen and Nawawi 1991a; Whitton et al. 2000; Crous et al. 2014, 2018a, b; Réblová et al. 2021e). Codinaeella brevissima differs from them by the unique combination of morphological characters, such as the two-layered conidiophores, monophialidic conidiogenous cells, and naviculate to fusiform and smallsized conidia $(12-14 \times 2-2.5 \ \mu m)$ with shorter setulae (2-3.5 µm). In C. coryli, C. lutea, C. minuta, C. parvolpbata and C. yunnanensis, the condiogenous cells are usually polyphialidic and with several lateral openings, extending sympodically; and the conidia are much bigger in size and with longer setulat (5-10 µm). Codinaeella *coryli* also produces monophialidic conidiogenous cells, but its conidia are bigger in size and with longer setulae. *Codinaeella pini* has monophialidic condiogenous cells and similar sized conidia, but the conidial setulae are much longer ($6.5-9 \mu m$). Thus, all these species are be distinguished from *C. brevissima*.

Codinaeella cannonii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 69, MycoBank MB841577.

Etymology: Named after the mycologist Paul Cannon from UK.

Diagnosis: Conidiophores formed in one layer, 1–3-septate, 40–60 × 3–4.5 μ m. Conidiogenous cells polyphialidic, with 2–3 lateral openings, extending sympodially, 18–37 × 3–4.5 μ m. Conidia fusiform, slightly curved, aseptate, 14–18 × 2–2.3 μ m, with one setula at each end, 5.5–7.5 μ m long.

Typification: **China**, Yunnan Province, Pu Er, on dead leaves of unidentified tree, 18 June 2018, Yu Zhang, Holotype HMAS 351992 (=Wu15206), ex-type strain CGMCC 3.20728 (=NN 76,040).



Fig. 69 Codinaeella cannonii (Wu15206, holotype). a-e Conidiophores and conidiogenous cells. f-s Conidia. Scale bar: 5 µm

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of $3-4.5 \,\mu\text{m}$ wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, formed in one layer, scattered or aggregated, simple, erect, straight

or slightly flexuous, 1–3-septate, pale brown to medium brown, thin- and smooth-walled, $40-60 \times 3-4.5 \mu m$, base with a swollen and lobbed cell up to 10 μm wide, percurrently proliferating 2–3 times and with a sympodial appearance. Conidiogenous cells integrated, terminal, monophialidic, extending sympodially, cylindrical to subcylindrical,



Fig. 70 Codinaeella cinnamomi (Wu13202, holotype). a-e Conidiophores and conidiogenous cells. f-t Conidia. Scale bar: 5 µm

 $18-37 \times 3-4.5 \mu$ m, pale brown, thin- and smooth-walled, terminating in a funnel-shaped collarette; collarette 2–3 μ m wide, 1–2 μ m deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous

cells, fusiform, slightly curved, aseptate, hyaline, smooth, obtuse at the base, $14-18 \times 2-2.3 \mu m$, with one simple setula of 5.5–7.5 μm long at each end.

Other living strain: 76,041 (from Wu15206).

Ecology/Substrate/Host: Saprobes on dead leaves.

Geographical distribution: China.

Notes: The morphological observation and phylogentic analysis shows that C. cannonii is closely related to C. corvli (Conidiophores in one layer; conidiogenous cells monophialidic; conidia 12-19.5 × 2.3-3.5 µm, setulae 4.7-8.4 µm long), C. lutea (conidiophores in two layers; conidiogenous cells mono- or polyphialidic; conidia $12.5-17.5 \times 2-2.5 \mu m$, setulae 5-8.5 µm long), C. minuta (conidiophores in two layers; conidiogenous cells mono- or polyphialidic, 1-5 lateral openings; conidia $13-18 \times 2.5-3.5$ µm, setulae 5.5-8.5 µm long) and C. yunnanensis (conidiogenous cells mono- or polyphialidic; conidia $15-17 \times 2.5-3.5 \mu m$, setulae 6-8 µm long) (Hughes and Kendrick 1968; Kuthubutheen and Nawawi 1991a; Whitton et al. 2000; Crous et al. 2014, 2018a, b; Réblová et al. 2021e). Codinaeella cannonii differs from them by the unique combination of morphological characters, such as the one-layered conidiophores, polyphialidic conidiogenous cells with sympodial extension, and fusiform, only slightly curved conidia $(14-18 \times 2-2.3 \ \mu m)$ with one setula at each end $(5.5-7.5 \,\mu\text{m})$. In C. lutea, C. minuta and C. yunnanensis, the conidiophores are twolayered, condiogenous cells are usually polyphialidic, with several lateral openings and extending sympodically, but the lateral openings are consensed. Codinaeella coryli produces the monophialidic conidiogenous cells, thus can be distinguished from C. cannonii.

Codinaeella cinnamomi W.P. Wu & Y.Z. Diao, sp. nov., Fig. 70, MycoBank MB841578.

Etymology: refers to the plant name *Cinnamomum* sp. from which the fungus was found.

Diagnosis: Conidiophores formed in one layer, 0–2-septate, 20–40×2.8–3.5 μ m. Conidiogenous cells mono- or polyphialidic, 13–16×3–3.5 μ m, extending percurrently and rarely sympodially. Conidia falcate, slightly curved, 12.5–15×2–2.5 μ m; bearing one setula at each end, 5–6 μ m long.

Typification: **China**, Sichuan Province, Ya An, Wanguan, Bifengxia, on dead leaves of *Cinnamomum* sp., 15 December 2013, W.P. Wu, Holotype HMAS 351993 (= Wu13202), extype strain CGMCC 3.20717 (= NN57549).

Description on the natural substrate: Saprobic on decaying leaves. Colonies effuse, hairy, greyish brown, shining, in groups. Mycelium immersed, consisting of greyish brown, branched, smooth hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, formed in one layer, cylindrical, unbranched, percurrently growing, erect, straight, or slightly flexuous, smooth, 0–2-septate, brown, paler towards the apex, smooth, 20–40 μ m long, 2.8–3.5 μ m wide. Conidiogenous cells integrated, terminal, cylindrical, mono- or polyphialidic, with 1–2 lateral openings, pale brown, thin- and smooth-walled, $13-16 \times 3-3.5 \ \mu\text{m}$, extending percurrently and rarely sympodially; collarette conspicuous, funnel-shaped, 2–2.5 μm wide and 1–1.5 μm deep. Conidia acrogenous, aggregating in a globose mucoid mass, falcate, slightly curved, narrow at both ends, $12.5-15 \times 2-2.5 \ \mu\text{m}$; bearing one setula at each end, 5–6 μm long.

Culture characteristics: Colonies on PDA effuse, colonies 1.5–2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown in the middle, becoming paler towards margins, reverse dark yellow brown in the middle and yellow brown in the margin (Fig. 67e, f).

Other material examined: **China**: Sichuan Province, Ya An, Wanguan, Bifengxia, on dead leaves of *Cinnamomum* sp., 15 December 2013, W.P. Wu (Wu13201). Living strain: 57,550 (from Wu13201).

Ecology/Substrate/Host: Saprobes on dead leaves of plants, including *Cinnamomum* sp.

Geographical distribution: China.

Notes: The morphological observation and phylogentic analysis shows that C. cinnamoni is closely related to C. coryli, C. lutea, C. minuta and C. yunnanensis (Hughes and Kendrick 1976; Kuthubutheen and Nawawi 1991a; Whitton et al. 2000; Crous et al. 2014, 2018a, b; Réblová et al. 2021e). Codinaeella cinnamomi differs from them by the unique combination of morphological characters, such as the one-layered conidiophores with 0-2-septat and shorter in size (20-40 µm), mono- or polyphialidic conidiogenous cells with percurrent or rarely sympodial extension, and fusiform, slightly curved conidia ($12.5-15 \times 2-2.5 \mu m$) with one setula at each end (5-6 µm long). In C. lutea, C. minuta and C. yunnanensis, the conidiophores are typically two-layered, condiogenous cells are usually polyphialidic and with more lateral openings. In Codinaeella coryli, the conidiophores are longer and the conidiogenous cells are monophialidic, thus can be distinguished from C. cinnamonii.

Codinaeella coryli (R.H. Perera, E.B.G. Jones & K.D Hyde) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841695.

 \equiv *Dictyochaeta coryli* R.H. Perera, E.B.G. Jones & K.D Hyde, Mycosphere 11: 2120, 2020.

Geographical distribution: UK (Perera et al. 2020).

Description and illustration: Perera et al. (2020).

Notes: *Codinaeella coryli* is a recently described species on dry fruit of *Corylus avellana*. Both morphological and phylogenetic study confirmed its affinity to the genus *Codinaeella* (Perera et al. 2020).

Codinaeella filamentosa (Onofri) Réblová & Hern.-Restr., J. Fungi 7 (12, no 1097): 46, 2021, Fig. 71

≡ Codinaea filamentosa Onofri, Mycotaxon 14: 120, 1982.



Fig.71 *Codinaeella filamentosa* (a–h, j–m, o, p WuBJ142, i, n WuBJ13). a–f Setae. g–i, k, l Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. k Apical part of setae. m Basal part of setae. n, o, p Conidia. Scale bar: a, b 20 µm, c–f 10 µm, g–p 5 µm

 \equiv Dictyochaetopsis filamentosa (Onofri) Aramb. & Cabello, Mycotaxon 38: 12, 1990.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3-4.5 µm wide. Teleomorph: Unknown. Anamorph: Setae cylindrical, 5-7-septate, straight, or flexuous, brown, becoming paler towards the apex, smooth- and thickwalled, 195-300 µm long, 3-4 µm wide, tapering towards a rounded apex 1.5-1.7 µm wide, basal cell up to 5 µm wide. Conidiophores macronematous, mononematous, scattered or aggregated, simple, erect, straight, or slightly flexuous, 1-3-septate, pale brown to medium brown, thin- and smoothwalled, $45-65 \times 2.5-3.5 \mu m$, base with a slightly swollen cell up to 6 µm wide. Conidiogenous cells integrated, terminal, monophialidic or occasionally polyphialidic, cylindrical to subcylindrical, 13–20 (–24) \times 2.5–3.5 µm, pale brown, thin- and smooth-walled, terminating in a funnel-shaped collarette, collarette 2-3 µm wide, 1.5-1.8 µm deep. Conidia acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, curved, obtuse at the base, $12.5-15 \times 2.5-3 \mu m$, aseptate, hyaline, smooth, with a setulae of 5-8 µm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, reverse dark yellow brown to dark brown (Fig. 67m, n).

Materials examined: **China**, Beijing, Huairou, Hongluosi, on dead fruit of *Quercus* sp., 11 June 2020, W.P. Wu (WuBJ141); Beijing, Huairou, Hongluosi, on dead fruit of *Quercus* sp., 11 July 2020, W.P. Wu (WuBJ142); China: Beijing, Huairou, Hongluosi, on dead fruit of *Quercus* sp., 29 July 2020, W.P. Wu (Wu17357, 17,375, 17,378). Living strains: CGMCC 3.20672 (= NN77422), 77,423 (from WuBJ142), 77,949 and 77,950 (from Wu17357), 77,998 and 77,999 (from Wu17375), 78,045 and 78,046 (from 17,378).

Ecology/Substrate/Host: Saprobes on dead fruit of *Quercus* sp.

Geographical distribution: China, Ivory Coast (Lunghini et al. 1982) and USA (Réblová et al. 2021e).

Description and illustration: Onofri (1982); Réblová et al. (2021e).

Notes: Phylogenetically *Codinaeella filamentosa* is closely related to other species of *Codinaeella* species, including *Codinaeella lambertiae*, *C. coryli* and *C. pini*. It can be distinguished from them by presence of flexuous and long sterile setae among conidiophores. The setae are not clustered together with conidiophores at the base as seen in *Codinaea*. In the original description of *C. filamentosa*, the setae are described with lateral branches as conidiophores, which is not found at all among the several specimens examined by us. Its branched conidiophores also resemble some members of *Menispora* but the conidiogenous cells are without incurved collarettes in this species. Several specimens were collected from the same locality and the variation on length of setae and conidiophores was observed, but they share the same ITS sequences. The conidia from the Chinese collection are slightly smaller than those from the type specimen $(14.5-17.5 \times 2-2.5 \ \mu\text{m})$, however their ITS sequences are only with 1 bp difference (Réblová et al. 2021e).

Codinaeella hyalina J.Y. Zhang & Y.Z. Lu, J. Fungi 8, 643: 17, 2022.

Ecology/Substrate/Host: Saprobe on decaying wood in a freshwater stream.

Geographical distribution: China (Zhang et al. 2022). Description and illustration: Zhang et al. (2022).

Description and musuation. Zhang et al. (2022)

Notes: *Codinaeella hyalina* is an asexually typified species and characterized by solitary or aggregated conidiophores, mono- or poly-phialidic conidiogenous cells with funnel-shaped collarettes and proliferating sympodically, and hyaline, aseptate, often unilateral ventricose, reniform conidia $(15.9-21.6 \times 5.8-7 \ \mu m)$ and bearing one setula $(4-7 \ \mu m \ long)$ at each end.

Codinaeella kuthubutheenii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 72, MB841580.

Etymology: Named after the mycologist A.J. Kuthubutheen, who made significant contribution to taxonomy of *Dictyochaeta* and *Codinaea*.

Diagnosis: Conidiophores formed in one layer, 2–8-septate, $50-110 \times 3.5-4.5 \mu m$. Conidiogenous cells monoor polyphialidic, with 2–6 lateral openings, cylindrical, $20-40 \times 3.5-4.5 \mu m$, extending sympodially. Conidia falcate, curved, symmetrical, $15-20 \times 2-2.7 \mu m$, aseptate, with one setula of 6–8 µm long at each end.

Typification: **China**, Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead branches of unidentified tree, 17 October 2020, W.P. Wu, Holotype HMAS 351994 (= Wu17529), ex-type strain CGMCC 3.20758 (= NN78279).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3–4.5 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, formed in one layer, scattered or aggregated, simple, erect, straight, or slightly flexuous, 2–8-septate, brown to dark brown at the lower part, becoming paler towards the apex, smooth, 50–110×3.5–4.5 μ m, base with a swollen and lobbed cell up to 10 μ m wide. Conidiogenous cells integrated, terminal, mono- or polyphialidic, with 2–6 lateral openings, cylindrical, 20–40×3.5–4.5 μ m, pale brown, thin- and smoothwalled, extending sympodially; collarette funnel-shaped 3–3.5 μ m wide, 1–2 μ m deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of



Fig.72 Codinaeella kuthubutheenii (Wu17529, holotype). a-h Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. i-r Conidia. Scale bar: $5 \,\mu m$

conidiogenous cells, falcate, curved, symmetrical, obtuse at the base, $15-20 \times 2-2.7 \mu m$, aseptate, hyaline, smooth, with one setula of $6-8 \mu m \log at$ each end.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, freshly isolated culture often with purple to brown color appearance, reverse pale brown to dark brown and with yellow margin (Fig. 66m–p).

Other materials examined: China Guangdong Province, Zhaoqing, Dinghushan, on dead branches of unidentified plant, 3 March 2012, W.P. Wu (Wu12095); Guangdong Province, Zhaoqing, Dinghushan, on dead leaves of unidentified plant, 2 March 2012, W.P. Wu (Wu 12,101); Guangdong Province, Zhaoqing, Dinghushan, on dead leaves of unidentified plant, 3 March 2012, W.P. Wu (Wu12120); Guangdong Province, Guangzhou, Yuexiu Park, on dead culm of grass, 3 March 2012, W.P. Wu (12,146); Guangdong Province, Zhaoqing, Dinghushan, on dead culm of bamboo, 3 March 2012, W.P. Wu (Wu 12,197); Guangdong Province, Guangzhou, Yuexiu Park, on dead leave of unidentified tree, 3 March 2012, W.P. Wu (Wu12201); Guangdong Province, Zhaoqing, Dinghushan, on dead leaves of unidentified plant, 3 March 2012, W.P. Wu (Wu12202, 12202b); Guangdong Province, Guangzhou, Yuexiu Park, on dead leave of unidentified tree, 2 March 2012, W.P. Wu (Wu12238); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu (Wu12296); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of Macadamia ternifolia, 3 March 2012, W.P. Wu (Wu12316); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu (Wu 12,331); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu (12,362); Guangdong Province, Shaoguan, Danxiashan, on dead branches of unidentified tree, 25 December 2012, W.P. Wu (Wu12461, Wu12481); Guangdong Province, Shaoguan, Danxiashan, on dead branches of unidentified tree, 25 December 2012, W.P. Wu (Wu12465); Guangdong Province, Shaoguan, Danxiashan, on dead branches of unidentified tree, 25 December 2012, W.P. Wu (Wu12479); Guangdong Province, Guangzhou, on dead leaves of unidentified tree, 10 December 2013, W.P. Wu (Wu12603); Guangdong Province, Shenzhen, Lianhuashan, on decaying seed of unidentified tree, 11 November 2019, W.P. Wu (Wu17117); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead fruit of Camellia sp., 17 October 2020, W.P. Wu (Wu17511); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of palm, 2 January 1997, W.P. Wu (WU1311i); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of unidentified plant, 2 January 1997, W.P. Wu; (Wu1319c); Guangxi Province, Damingshan, on dead leaves of ?Magnolia sp., 19 December 1997, W.P. Wu. (Wu1420b);

Guangxi Province, Damingshan, on dead branches of unidentified plant, 19 December 1997, W.P. Wu (Wu1421b); Guangxi Province, Nangning, on dead leaves of Quercus sp., 3 January 1998, W.P. Wu (Wu1613I); Guangxi Province, Nangning, on dead leaves of unidentified Pinus sp., on dead leaves of longyan, 3 January 1998, W.P. Wu (Wu1615b); Guangxi Province, Nangning, 3 January 1998, W.P. Wu (Wu1617a); Hainan Province, Sanya, Yalongwan Park, on dead fruit of unidentified tree, 28 December 2020, W.P. Wu (Wu17677); Sichuan Province, Chengdu, Qingchengshan, on dead leaf of unidentified tree, 9 November 2019, W.P. Wu (Wu17206); Yunnan Province, Pu Er, on dead leaves of unidentified tree, 12 June 2018, Yu Zhang (15,208); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (Wu 16,255); Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead bark of Platanus occidentalis, 16 October 2019, W.P. Wu (Wu17013); Japan, Mie Prefecture, Tsu, Mie Center for the Arts, on dead leaf of unidentified tree, 4 October 2019, W.P. Wu (Wu16910). Living strains: 42891 (from 1311i), 44,502 (from 1615b), 42898 (from 1319c), 43775 (from 1420b), 43855 (from 1421b), 44,410 (from Wu1613i), 44,410 (Wu1617a), 54,222 (from Wu12090), 54,215 (from 12,095), 54,223 (from 12,101), 54,202 (from Wu12146), 54,217 (from 12,197), 54,206 (from 12,201), 54,254 (from Wu12202), 54,325 (from Wu12202b), 54,200 (from 12,238), 54,224 (from 12,120), 54,385 (from Wu12296), 54,389 (from Wu12331), 55,324 (from 12,461), 54,355 (from 12,362), 54,388 (from 12,362), 55,341 (from Wu12479), 55,326 (from 12,465), 55,342 (from 12,481), 57,583 (from 12,603), 76,042 (from Wu15208), Wu12316, 76,585 (from Wu16255), 77,270 (from Wu16910), 77,336 (from Wu17013), 77,527 (from Wu17117), 77,576 (from Wu17206), 78,266 (from Wu17511), 78,400 (from Wu17576) and 78,499 (from Wu17677).

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: China.

Notes: The morphological and phylogenetic analysis show that *Codinaeella kuthubutheenii* is closely related to *C. minuta* and *C. yunnanensis*, but differs from them by the unique combination of morphological characters such as onelayered, 2–8-septate and longer conidiophores(50–110 µm long), mono- or polyphialidic cells with 2–6 lateral openings and extending sympodially, and aseptate, falcate and curved conidia in larger size (15–20×2–2.7 µm) and with one setula at each end, 6–8 µm long (Kuthubutheen and Nawawi 1991a; Whitton et al. 2000; Crous et al. 2014, 2018a, b; Réblová et al. 2021e). In the phylogenetic tree (Fig. 65), many studied strains of *C. kuthubutheenii* are clustered together as a distinct clade with strong support.

Codinaeella latispora W.P. Wu & Y.Z. Diao, sp. nov., Fig. 73, MycoBank MB841581.



Fig. 73 *Codinaeella latispora* (Wu6015, holotype). \mathbf{a} - \mathbf{i} Conidiophores and conidiogenous cells. \mathbf{j} - \mathbf{z} Conidia. Scale bar: \mathbf{a} - \mathbf{d} , ×10 µm, \mathbf{e} - \mathbf{v} , \mathbf{y} , \mathbf{z} 5 µm

Etymology: Refers to its wide conidia.

Diagnosis: Setae absent. Conidiophores formed in one layer, 2–4-septate, $50-85 \times 3-4 \mu m$; conidiogenous cells cylindrical or slightly clavate, $25-35 \times 3-4 \mu m$, monophialidic, bearing one terminal, funnel-shaped or subcylindrical collarette. Conidia fusiform, allantoidal, slightly curved, aseptate, $13.5-16.5 \times 3.3-3.6 \mu m$, setulae 5–5.5 µm.

Typification: **China**, Hunan Province, Mangshan, on dead leaves of unidentified tree, 12 April 2002, W.P. Wu, Holotype HMAS 351995 (= Wu6015), ex-type strain CGMCC 3.20789 (= NN47478).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2–5 µm wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, mononematous, formed in one layer, simple, crowded, erect, straight, or slightly flexuous, cylindrical, dark brown and thick-walled in lower part, becoming paler and thin walled towards the apex, 2–4-septate, smooth, $50-85 \times 3-4 \mu m$, terminating with a conidiogenous cell. Conidiogenous cells integrated, terminal, monophialidic, cylindrical or slightly clavate, $25-35 \times 3-4 \mu m$, pale brown to brown, thin-walled; collarette conspicuous, funnel-shaped, subcylindrical, 2-2.3 µm wide, 1.5-2 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, fusiform, allantoidal, slightly curved, aseptate, hyaline, smooth, $13.5-16.5 \times 3.3-3.6 \,\mu\text{m}$, bearing one setula at each end, 5-5.5 µm long,

Culture characteristics: Colonies on PDA effuse, colonies 0.5 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, yellow brown, reverse yellow brown (Fig. 670, p).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Morphologically *Codinaeella latispora* differs from other species in the genus by its shorter conidiophores, monophialidic conidiogenous cells, and fusiform, allantoid and wider conidia $(13.5-16.5 \times 3.3-3.6 \ \mu\text{m})$ with a shorter setula $(5-5.5 \ \mu\text{m} \ \text{long})$ at each end (Réblová et al. 2021e). In the phylogentic tree (Fig. 69), *C. latispora* is clustered among the many studied strains of *C. yunnanensis*. Compared with *C. latispora*, *C. yunnanensis* (original description), the conidiophores are longer $(83-127 \ \mu\text{m})$ and the conidia $(15-17 \times 2.5-3.5 \ \mu\text{m})$ are slightly narrower in average and with one slightly longer $(6-8 \ \mu\text{m})$ setula at each end (Luo et al. 2019).

Codinaeella lutea Réblová & Hern.-Restr., J. Fungi 7 (12, no 1097): 51, 2021. Figure 74

Description on the natural substrate: Colonies effuse, mycelium consisting of hyaline, smooth, septate, branched,

1.5–3 µm diam hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or in small group, arising from creeping hyphae, in two layers, erect, straight, or flexuous, $60-150 \times 3-3.5$ µm, 6-13-septate, thick–walled, smooth, becoming pale to medium brown in fertile region, extending percurrently and sympodially. Conidiogenous cells integrated, apical, subcylindrical, medium brown, smooth, thinwalled, $15-30 \times 2.3-3.5$ µm, mono- and polyphialidic with 1–3 openings; collarettes funnel-shaped, 1.5-2 µm wide and 1–1.5 µm deep. Conidia solitary, aggregating in slimy mass, hyaline, smooth, aseptate, curved, falcate, fusiform, slightly curved, apex subacutely rounded, base slightly truncated, $13-14 \times 1.5-2$ µm, with single appendage at each end, flexuous, unbranched, 5–6.5 µm long.

Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown.

Material examined: **UK**, Scotland, Ayrs, Ballantrae, Glenapp Castle garden, on dead leaves of *Rhododendron* sp., 6 July 2019, W.P. Wu (HMAS 351997 (=Wu16511). Living strain: 76,781 (from Wu16511).

Ecology/Substrate/Host: Saprobe on dead plant material.

Geographical distribution: Australasia, Europe, and Southeast Asia: China, Czech Republic, New Zealand, The Netherlands and UK (Réblová et al. 2021e).

Notes: This fungus from the British collection Wu16511 on dead leaves of *Rhododendron* sp. has very variable morphology of conidiophores (septation, size), and falcate, fusiform, only slightly curved conidia in smaller size. Morphologically it fits well to the concept of *Codinaeella lutea*, but has smaller conidia and shorter setulae than those in the original description (Réblová et al. 2021e).

Codinaeella minuta (Tubaki) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 56, 2021. Figure 75

 \equiv *Menispora minuta* Tubaki, J. Hattori Bot. Lab. 20: 166. 1958.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3–4.5 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, formed in two layers, scattered or aggregated, simple, erect, straight or slightly flexuous, 1–3-septate, pale brown to medium brown, thin- and smooth-walled, 40–80×3–4.5 μ m, base with a swollen and lobbed cell up to 10 μ m wide, percurrently proliferating 2–3 times and with a sympodial appearance. Conidiogenous cells integrated, terminal, mono- and polyphialidic with 1–5 lateral openings, extending percurrently and sympodially, cylindrical to subcylindrical, 18–37×3–4.5 μ m, pale brown, thin- and smooth-walled; collarettes funnel-shaped, persistent, 2–3 μ m wide, 1–2 μ m



Fig.74 *Codinaeella lutea* (Wu16511). **a** Conidiophores. **b** Superficial mycelium. **c–j** Conidiophores and conidiogenous cells. **k–r** Conidia. Scale bar: **a** 20 μm, **b–r** 5 μm



Fig. 75 Codinaeella minuta (Wu12743). a-i Conidiophores and conidiogenous cells. j-s Conidia. Scale bar: a-c, o-p 10 µm, d-n, q-s 5 µm

deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, curved, obtuse at the base, $14-16.2 \times 2-2.5 \mu m$, aseptate, hyaline, smooth, with a setula of 5.5–7.5 μm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse dark yellow brown to dark brown (Fig. 66p).

Materials examined: China, Guangdong Province, on dead leaves of ?Smilax sp., 9 October 1998, W.P. Wu (Wu2083f); Guangdong Province, Zhaoqing, Dinghushan, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu (Wu12162); Guangdong Province, Zhaoqing, Dinghushan, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu (Wu12186); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of Nageia nagi, 4 March 2012, W.P. Wu (Wu12286b); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of Acacia sp., 2 January 1997, W.P. Wu (Wu1249e); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of Smilax sp., 2 January 1997, W.P. Wu (Wu1284e); Guangxi Province, Shiwandashan, on dead leaves of ?Rhododendron sp., 30 December 1997, W.P. Wu (Wu1546d); Guangxi Province, Damingshan, on dead leaves of Cinnamomum sp., 20 December 1997, W.P. Wu (Wu1474b); Yunnan Province, Gaoligongshan, on dead leaves of unidentified plant, 19 September 2003, W.P. Wu (Wu7292); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of unidentified tree, 12 June 2015, W.P. Wu (Wu13321); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of unidentified tree, 12 June 2015, W.P. Wu (Wu13348); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of *Gingko biloba*, 12 June 2015, W.P. Wu (Wu13320, Wu13283a); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of unidentified tree, 12 June 2015, W.P. Wu (Wu13323); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of unidentified tree, 12 June 2015, W.P. Wu (Wu13331); Zhejiang Province, Huaian County, Qiandaohu, on dead leaves of unidentified tree, 18 October 2018, W.P. Wu (Wu16053, 16,056, 16,185 with slightly difference in ITS); Yunnan Province, Jinghong, Xishuangbanna, on dead leaves of unidentified tree, 6 December 2018, W.P. Wu (Wu15206); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of unidentified tree, 6 December 2015, W.P. Wu (Holotype WFH Wu13331). Living strains: 47771 (from Wu7292), 54,248 (from Wu12162), 54,258 (from Wu12286b), 54,225 (from Wu12186), 54,258 (from Wu12286b), 59001 (from Wu13323), 59004 (from Wu13320), 59022 (from Wu13348a), 59033 (from Wu13323), 59058 (from Wu13283a),

59077 (from Wu13348), 58997 (from Wu13331), 76,224 (from Wu16053), 76,225 (from Wu16056), 76,384 (from Wu16185) and 58997 (from Wu13331).

Ecology/Substrate/Host: On dead material of plants including *Cinnamomum* sp., *Fagus* sp., *Gingko biloba*, *Lithocarpus edulis*, *Nageia nagi*, *Quercus* spp., ?*Smilax* sp., ?*Rhododendron* sp.

Geographical distribution: China, Czech Republic, France, Italy, Japan, The Netherland, Slovak Republic and USA (Réblová et al. 2021e).

Description and illustration: Tubaki (1958); Réblová et al. (2021e).

Notes: *Codinaeella minuta* is characterized by dark brown and multiseptate conidiophores, mono- and polyphialidic conidiogenous cells with both sympodial and percurrent proliferations, and falcate and setulate conidia (Réblová et al. 2021e). It was compared with *Codinaeella lutea* and *Tainosphaeria simplex*, two morphologically similar species, but differs from them by shorter setae, slightly wider conidia and producing yellow pigment in vitro. A total of 16 strains were studied by us and the ITS sequences from them are almost identical (with 5–6 bp difference) to the one from the ex-type strain. It has broad distribution in central and southern part of China.

Codinaeella multisporuloca W.P. Wu & Y.Z. Diao, sp. nov., Fig. 76, MycoBank MB841583.

Etymology: Refers to its polyphialidic conidiogenous cells with multisporulating loci.

Diagnosis: Conidiophores formed in two layers, 4–9-septate, $120-185 \times 2.5-4 \mu m$. Conidiogenous cells (15–) $18-26 \times 2.8-3.2 \mu m$, polyphialidic, with 1–5 lateral openings, extending sympodially. Conidia falcate, fusiform, slightly curved, aseptate, $10-13 \times 1.8-2 \mu m$, with one setulae et each end, 5–7 μm .

Typification: **China**, Hebei Province, Zhangjiakou, Chicheng, Haituoshan, on dead fruits of *Quercus dentata*, 25 September 2020, W.P. Wu, Holotype HMAS 351996 (= Wu17413), ex-type strain CGMCC 3.20754 (= NN78175).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2–4.5 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, formed in two layers, scattered or 2–3 aggregated, simple, erect, straight or slightly flexuous, 4–9-septate, brown to dark brown, becoming paler in the upper part, thin- and smooth-walled, (80–)120–185×2.5–4 μ m, base with a swollen cell up to 10 μ m wide. Conidiogenous cells integrated, terminal, polyphialidic with 1–5 lateral openings, extending sympodially, cylindrical to subcylindrical, (15–)18–26×2.8–3.2 μ m, pale brown, thin- and



Fig.76 *Codinaeella multisporuloca* (Wu17413, holotype). **a** Solitary or aggregated conidiophores on natural substrate. **b–d**, **f–h** Conidiophores and conidiogenous cells. **i** Basal part of conidiophores. **e**, **j–l** Conidia. Scale bar: **a** 40 μm, **e** 10 μm, **b–d**, **f–l** 5 μm



Fig. 77 Codinaeella sinensis (a-c Wu17204, d-t Wu16915). a Abundant setiform conidiophores on natural substrate. b, c Setiform conidiophores with main stipe and lateral phialide. d, g-k Part of setiform conidiophores with lateral phialides. e, f Sterile apex of setiform conidiophores. l-u Conidia. Scale bar: a 20 μm, b, c 10 μm, d-u 5 μm

smooth-walled; collarettes funnel-shaped, subcylindrical, pale brown to brown, $1.5-2.5 \ \mu m$ wide, $1-2 \ \mu m$ deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, fusiform, slightly curved, obtuse at the base, aseptate, hyaline, smooth, $10-13 \times 1.8-2 \ \mu m$, with a setula of 5–7 μm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies up to 1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to greybrown, with pale colored margin, reverse brown to dark brown (Fig. 66s, t).

Other materials examined: China, Beijing, Huairou, Hongluosi, on dead leaves of Quercus sp., 11 June 2020, W.P. Wu (WuBJ212, WuBJ213); Beijing, Huairou, Hongluosi, on dead leaves of Quercus sp., 29 July 2020, W.P. Wu (Wu17314); Beijing, Huairou, Hongluosi, on dead leaves of Quercus sp., 11 June 2020, W.P. Wu (WuBJ211); Beijing, Huairou, Hongluosi, on dead leaves of Quercus sp., 29 July 2020, W.P. Wu (Wu17317, Wu17345, Wu17363, Wu17364, Wu17365, Wu17366, Wu17368, Wu17376, Wu17379); Hebei Province, Zhangjiakou, Chicheng, Haituoshan, on dead fruits of Quercus dentata, 25 Sept 2020, W.P. Wu (Wu17407, Wu17410, Wu17417, Wu17421); Sichuan, Chengdu, Qingchengshan, on dead fruit of Picea sp., 9 November 2019, W.P. Wu (Wu17242); Sichuan, Chengdu, Qingchengshan, on dead leaves of unidentified tree, 9 November 2019, W.P. Wu (Wu17158); Zhejiang, Huaian County, Qiandaohu, on dead bark of Platanus occidentalis, 16 October 2019, W.P. Wu (Wu16014, Wu17015, Wu17021, Wu16017); Zhejiang, Huaian County, Qiandaohu, on dead leaves of unidentified tree, 18 October 2018, W.P. Wu (Wu16100, Wu16104); Japan, Mie Prefecture, Tsu, Mie Center for the Arts, on dead leaves of unidentified tree, 3 October 2019, W.P. Wu (Wu16909). Living strains: 76,201 (from Wu16017), 76,200, 76,299, 76,300, 76,301 and 76,302 (from Wu16014), 76,230 (from Wu16100), 76,359 (from Wu16104), 77,269 (from Wu16909), 77,302 and 77,303 (from Wu17015), 77,306 and 77,378 (from 17,021), 77,588 (from Wu17158), 77,661 and 77,698 (from Wu17242a,b), 77,283 (from WuBJ213), 77,250 (from WuBJ212), 77,429 (from WuBJ211), 77,979 (from Wu17314), 78,001 and 78,002 (from Wu17317), 77,988 and 77,989 (from Wu17345), 78,028, 78,029, 78,030 and 78,034 (from Wu17363), 78,035, 78,036 and 78,037 (from Wu17364), 78,032 and 78,033 (from Wu17365), 77,940 and 77,941 (from Wu17366), 77,938 and 77,939 (from Wu17368), 78,044 (from Wu17376), 77,995 (from Wu17379), 78,133 and 78,134 (from Wu17307), 78,135, 78,160 and 78,170 (from Wu17410), 78,142 and 78,143 (from Wu17417), 78,176 and 78,178 (from Wu17413), 78,287, 78,186 and 78,188 (from Wu17421a,b,c).

Ecology/Substrate/Host: Saprobes on dead fruit of *Quercus* sp.

Geographical distribution: China, Japan.

Notes: The morphological and phylogenetic studies show that *Codinaeella multisporuloca* is closely related to *C. minuta*, but differs in the smaller conidia in the former species (Réblová et al. 2021e). Their ITS sequenes have 11-13 bp differences. Based on both morphology and ITS sequences, many collections from China were identified as *C. multisporuloca*. Some variations were observed among these specimens, including presence of short conidiophores clustered with the long ones, and length and septation of conidiophores.

Codinaeella sinensis (D.W. Li, W.B. Kendr. & Jingyuan Chen) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 77, Myco-Bank MB841715.

 \equiv *Codinaea sinensis* D.W. Li, W.B. Kendr. & Jingyuan Chen, Mycol. Prog. 11: 900, 2011.

Description on the natural substrate: Mycelium partly superficial and partly immersed, composed of pale brown to brown, branches, smooth, thick-walled hyphae. Teleomorph: Unknown. Anamorph: Setae cylindrical, erect, straight or flexuous, simple or branched, brown to dark brown, thick-walled, becoming paler and thin-walled at the apical part, 6–12-septate, $200-280 \times 3.5-4.2 \mu m$, basal cell swollen and up to 13 µm wide; terminal cell sterile and obtuse, or fertile and with a monophialidic conidiogenous cell bearing a funnel-shaped collarette; fertile in the lower part of the main stipe and with several lateral branches. Lateral branches 2–5 in the lower part of the setiform conidiophores, lageniform, originally right below the septa, 0-2 septate, often with an enlarged base, developed through pores at septa, arranged in one or both sides of the main stipe of the setiform conidiophores, $15-30 \times 2.5-3 \mu m$, pale brown, thin-walled, with a terminal phialide. Conidiogenous cells integrated, monophialidic, lateral, lageniform, obclavate, smooth, light brown, straight or slightly curved, $12-20 \times 2.5-3 \mu m$; collarettes funnel-shaped, up to 1.5 μm wide and 1.5 µm deep. Conidia in slimy masses, enteroblastic, aseptate, falcate, slightly curved, hyaline smooth- and thin-walled, $12.5-15.5 \times 2-2.5 \mu m$, with a single setula at each end, 5-6 µm long.

Typification: **China**, Hubei Province, Wudang, Tianhufeng, on leaf litter of *Quercus phillyraeoides*, 6 July 2010, Dewei Li, Bryce Kendrick, Jingyuan Chen (BPI882562, holotype).



Fig.78 Codinaeella yunnanensis (Wu17204). **a–m** Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. **n–w** Conidia. Scale bar: **a–f** 10 μm, **g–w** 5 μm

Materials examined: **China**, Zhejiang Province, Huaan County, Qiandaohu, on dead leaves of unidentified tree, 18 Oct 2019, W.P. Wu (Wu16115Zhejiang Province, Huaan County, Qiandaohu, on dead leaves of unidentified tree, 18 Oct 2019, W.P. Wu (Wu16116, 16,183, 16,184); **Japan**, Mie Prefecture, Tsu, Tsukairaku Park, on dead fruit of *Cyclobalanopsis* sp., 2 October 2019, W.P. Wu (Wu16960); Mie Prefecture, Tsu, Mie Center for the Arts, on dead leaves of unidentified tree, 2 October 2019, W.P. Wu (Wu16960); Living strains: 76,235 and 76,364 (from Wu16915). Living strains: 76,235 (from Wu16183), 76,383 (from Wu16184), 77,317 (from 16,915) and 77,288 (from Wu16960).

Ecology/Substrate/Host: Saprobe on dead material of plants, including *Cyclobalanopsis* sp.

Geographical distribution: China and Japan (Li et al. 2011).

Description and illustration: Li et al. (2011).

Notes: Codinaeella sinensis, originally described from leaf litter from China, is similar to several closely related species such as Codinaeella filamentosa (conidia $14-16 \times 2-2.5 \ \mu m$), Codinaea intermedia (conidia 16-18×3.5-4.5 µm), Codinaea menisporoides (conidia $13-19 \times 1.8-2.5$ µm) and D. pahangensis (conidia $18-23 \times 2-3 \mu m$) in having branched setiform conidiophores, lateral branches and phialides, and aseptate and falcate conidia with a single setula at each end. However, Codinaeella sinensis differs from most of them by its smaller conidia (9.5–11×2–2.5 μ m), differs from C. filamentosa by longer branches (29.5-31 µm long) and phialides (13-35 µm long) (Holubová-Jechová 1984; Kuthubutheen and Nawawi 1990; Li et al. 2011; Réblová et al. 2021e). Based on the setiform conidiophores, lateral phialides, and hyaline, aseptate, falcate to fusiform conidia with one setula at each end, several specimens collected in China can be easily identified to C. sinensis. A large variation was observed among different collections, for example in the specimen Wu16915, the setiform conidiophores are branched, with sterile or fertile apex, and the conidia are in broad range from $13-15.5 \,\mu m$ long; while in the specimen Wu16960, the setiform conidiophores are uniformly sterile and with fertile region limited to the lower part of the setae, and the conidia are smaller (12–13.5 µm long). The ITS sequences were also obtained from several specimens and they showed close phylogenetic relationship with Tainosphaeria simplex and related species without setae and producing aseptate and setulate conidia.

Apart from *Codinaeella filamentosa*, *C. sinensis* represents the second species under the morphotype CA2 in the genus recognized by Réblová et al. (2021e). It is characterized by single, branched setiform conidiophores with a sterile setiform extension and lower fertile part, and they are accompanied by shorter, unbranched conidiophores. Conidiogenous cells are monophialidic, discrete, lateral and also integrated, terminal on stalks or short phialide-bearing branches and shorter conidiophores.

Codinaeella yunnanensis (Z.L. Luo, K.D. Hyde & H.Y. Su) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 66, 2021. Figure 78

 \equiv *Codinaea yunnanensis* Z.L. Luo, K.D. Hyde & H.Y. Su, Fungal Divers. 99:590, 2019.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2–3 µm wide. Setae absent. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, single or loosely aggregated, simple, erect, straight or slightly flexuous, 7-9-septate, dark brown but becoming paler towards the apex, thick- and smooth-walled, $80-150 \times 3.5-4.2 \,\mu\text{m}$; basal cell dark brown, swollen, up to 12 µm wide; apex terminating with a polyblastic conidiogenous cell. Conidiogenous cells integrated, terminal, polyphialidic with up to 10 lateral openings, extending percurrently and sympodially, cylindrical, $20-25 \times 3-3.5 \mu m$, pale brown, smooth- and thin-walled; collarettes funnel-shaped,, persistent, 1.5-2 µm wide, 1.5-2 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, slightly curved, attenuated towards both ends, $14-17.5 \times 2.3-2.5 \,\mu\text{m}$, aseptate, hyaline, smooth, guttulate, with setulae at each end of the conidium, 4.5-6.5 µm.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.7 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, brown to dark brown, reverse of the same color (Fig. 66r).

Materials examined: China, Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of Manglietia pachyphylla, 28 February 2016, W.P. Wu (Wu12743); Guangdong Province, Lufushan, on dead branches of unidentified plant, 15 October 1998, W.P. Wu (WU2014a); Guangdong Province, Lufushan, on dead branches of unidentified plant, 15 October 1998, W.P. Wu (Wu2028a); Guangdong Province, Guangzhou, Zhaoqing, Dinghushan, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu (Wu12082, Wu12085; Wu12093); Guangdong Province, Guangzhou, Zhaoqing, Dinghushan, on dead leaves of Camelia japonica, 3 March 2012, W.P. Wu (Wu12346); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of Manglietia pachyphylla, 28 February 2016, W.P. Wu (Wu12742,12744,12746); Guangxi Province, Shangsi, Shiwandashan, Wangle, on wood of unidentified plant, 2 January 1997, W.P. Wu (WU1253); Guangxi Province, Nanning, on dead leaves of Quercus sp., 3 Jan 1998, W.P. Wu (Wu1613i); Guangxi Province, Nangning, on dead leaves of longyan, 3 Jan 1998,

W.P. Wu (Wu1617b); Guangxi Province, Nangning, on dead culm of Arundo donax, 3 Jan 1998, W.P. Wu (WU1667a); Guangxi Province, Nanning, Nanning Subtropical Botanical Garden, on dead leaves of unidentified tree, 15 November 2013, W.P. Wu (Wu13076,13142); Guangxi Province, Nanning, Nanning Subtropical Botanical Garden, on dead leaves of Acacia sp.,15 November 2013, W.P. Wu (Wu13146); Guangxi, on dead branches of unidentified plant, 23 December 1997, W.P. Wu (Wu2084a); Guangxi, on dead branches of tree, 23 December 1997, W.P. Wu (Wu2101b); Hubei Province, Shengnongjia, on dead leaves of unidentified tree, 20 September 2004, W.P. Wu (Wu8182, Wu8282, Wu8284, Wu8289); Hubei Province, Yichang, on dead leaves of unidentified tree, 12 August 2017, W.P. Wu (Wu13466); Hunan Province, Zhangijajie, on dead leaves of unidentified tree, Oct 15 2010, W.P. Wu (Wu11024); Jiangsu Province, Wuxi, Wuxi Forest Park, on decaying fruit of Liquidambar formosana, 25 August 2019, W.P. (Wu16797); Jiangsu Province, Wuxi, Wuxi Forest Park, on dead leaves of Cyclobalanopsis sp., 25 August 2019, W.P. (Wu16797, 16,845, 16,852, 16,872); Sichuan Province, Chengdu, Qingchengshan, on dead leaves of palm, 9 November 2019, W.P. Wu (Wu17128, Wu17129, Wu17159, Wu17202, Wu17204, Wu17205); China: Yunnan Province, Pu Er, on dead leaves of unidentified tree, 12 June, 2018, Yu Zhang (Wu15206, YN004); Yunnan Province, Kunming, on dead leaves of unidentified plant, 12 September 1995, W.P. Wu (Wu961a); Yunnan Province, Xishuangbanna, on dead bark, 6 October 1999, W.P. Wu & Yan Huang (Wu2840); Yunnan Province, Xishuangbanna, on rotten wood, 16 October 1999, W.P. Wu & Yan Huang (Wu2973b, Wu2947q, Wu2880b); China: Yunnan Province, Xishuangbanna, on rotten leaves, 16 October 1999, W.P. Wu & Yan Huang (Wu2887b, Wu2888b); Yunnan Province, Baoshan, Lujiang, Bawan, Gaoligongshan, on dead fruit of Quercus sp., 15 October 2003, W.P. Wu (Wu7246b); Zhejiang Province, Deqing, Moganshan, on dead leaf of Ficus sp., 16 October 2019, W.P. Wu (Wu16996); Zhejiang Province, Hangzhou, Longjing, on dead leaves of Cinnamomum sp., 30 September 2013, W.P. Wu (Wu13012); Zhejiang Province, Hangzhou, Longjing, on dead leaves of Quercus sp., 30 September 2013, W.P. Wu (Wu13013); Sichuan Province, Ya An, Yu Cheng, Bifengxia, on dead leaves of Cinnamomum sp., 15 December 2013, W.P. Wu (Wu13201, Wu13202); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of Cyclobalanopsis glauca, 12 June 2015, W.P. Wu (Wu13272a); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of Cinnamomum sp., 12 June 2015, W.P. Wu (Wu13318); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of unidentified tree, 12 June 2015, W.P. Wu (Wu13334); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of Castanopsis sp., 12 June 2015, W.P. Wu (Wu13272, Wu13347); Zhejiang Province, Huaian County, Qiandaohu, on dead leaves and fruit of unidentified tree, 18 October 2018, W.P. Wu (Wu16088, Wu16118, Wu16155, Wu16171, Wu16174, Wu16179; Wu16180, Wu16193); Japan, Mie Prefecture, Tsu, Mie Center of the Arts, on decaying fruit of unidentified tree, 3 October 2019, W.P. Wu (Wu16915); UK, Scotland, Ayrshire, Ballantrae, Glenappa Castle, on dead leaves of Rhododendron sp., 6 July 2019, W.P. Wu (Wu16504). Living strains: 12346, 44,495 (from Wu1613i) 47754 (from Wu7246b), 48,056 (from Wu8182), 50644 (from Wu8284), 50650 (from Wu8289), 53,372 (from Wu11024), 54,204 (from Wu12085), 54,207 (from Wu12093), 54,204 (from Wu12085), 54,249 (from Wu12082), 57,323 (from Wu13012), 57,324 (from Wu13013), 54,325 (from Wu12202a), 57,422 (from Wu13076), 57,452 (from Wu13142), 57,468 (from Wu13146), 57,549 (from Wu13202), 57,550 (Wu13201), 58993 (from Wu13334), 59006 (from Wu13318), 59020 and 59023 (from Wu13347), 59060 (from Wu13272a), 72,568 (from Wu12742), 72,569 (from Wu12743), 72,570 (from Wu12744), 75,822 and 75,823 (from YN004), 75,844 and 75,845 (from Wu13466), 76,040 and 76,041 (from Wu15206ab), 76,228 (from Wu16088), 76,344 and 76,345 (from Wu16155), 76,378 (from Wu16171), 76,379 (from Wu16174), 76,380 (from Wu16180), 76,381 (from Wu16118), 76,387 (from Wu16193), 76,414 (from Wu16179), 76,778 and 76,779 (from Wu16504), 77,115 (from Wu16797), 77,128 (from Wu16852), 77,142 (from Wu16839), 77,145 (from Wu16845) 77,207 (from Wu16872), 77,317 (from Wu16915), 77,462 (from Wu16996), 77,531 and 77,532 (from Wu17128), 77,533 and 77,534 (from Wu17129), 77,562 (from Wu17202), 77,564 (from Wu17204), 77,589 (from Wu17159) and 77,605 (from Wu17205).

Ecology/Substrate/Host: Saprobes on dead leaves, branches, rotten wood and found on many different plant species.

Geographical distribution: China and Iran (Luo et al. 2019; Réblová et al. 2021e).

Description and illustration: Luo et al. (2019).

Notes: The morphological and phylogenetic studies show that *Codinaeella yunnanensis* is closely related to *C. coryli*, *C. lutea*, *C. minuta*, *C. parvilobata* and *C. yunnanensis* (Crous et al. 2014; Luo et al. 2019; Réblová et al. 2021e). Based on both morphology and ITS sequences, many specimens collected from different parts of China are identified as *C. yunnanensis*, in which some morphological variations were observed, especially on length, septation and proliferation of conidiophores, and also size of conidia. However, they all share the similar characters such as the well-developed conidiophores with up to 10 septa, polyphialidic conidiogenous cells with up to 10 lateral openings, and falcate, aseptate conidia with shorter setulae.

Other related Codinaea/Dictyochaeta species

The following species known under *Codinaea* s. lat. and *Dictyochaeta* s. lat. were not examined in this study, but morphologically fits to the generic concept of *Codinaeella* in terminal mono- or poly-phialidic conidiogenous cells with funnel-shaped collarettes, and hyaline aseptate conidia with one or several setulae at each end. Several of these species are phylogenetically confirmed with available DNA sequences, and thus transferred to the new genus.

Codinaea delicata R.F. Castañeda, Granados & O. Castro, Mycotaxon 127: 116, 2014.

Typification: **Costa Rica**, Cartago Province, Orosi, Rio Macho, 9°45 N 83°51′W, on decaying leaves of unidentified plant, 12 July 2012, coll. M. Granados, V. Vargas, G. Arroyo & I. Castro (Holotype: USJ 83,283).

Geographical distribution: Costa Rica (Granados et al. 2014).

Description and illustration: Granados et al. (2014).

Codinaea longispora S. Hughes & W.B. Kendr., N. Z. J. Bot. 6: 349, 1968.

≡ *Dictyochaeta longispora* (S. Hughes & W.B. Kendr.) Aramb. & Cabello, Mycotaxon 34: 682, 1989.

≡ *Dictyochaeta longispora* (S. Hughes & W.B. Kendr.) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 140, 2000.

Geographical distribution: Malaysia and New Zealand (Hughes and Kendrick 1968).

Description and illustration: Hughes and Kendrick (1968).

Notes: *Codinaea longispora* fits well to the generic concept of *Codinaeella* and differs from other species by longer and narrower conidia $(23-28 \times 2.5-3 \mu m; \text{ setulae } 8-10 \mu m \text{ long})$.

Codinaea obesispora S. Hughes & W.B. Kendr., N. Z. J. Bot. 6: 351 1968.

 \equiv Dictyochaeta obesispora (S. Hughes & W.B. Kendr.) Aramb. & Cabello, Mycotaxon 34 (2): 682 (1989.

≡ *Dictyochaeta obesispora* (S. Hughes & W.B. Kendr.) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 145, 2000.

Typification: **New Zealand**, Auckland Prov., Whangapoua Saddle, Coromandel Peninsula, on *Muehlenbeckia australis*, 5 September. 1963, I.M.D., POD 21,494 (DAOM J14734a, holotype).

Geographical distribution: Brazil (Cruz et al. 2008) and New Zealand (Hughes and Kendrick 1968).

Description and illustration: Hughes and Kendrick (1968); Cruz et al. (2008).

Codinaea pindobacuensis D.A.C. Almeida & Gusmão, Nova Hedwigia 98: 435, 2014.

Typification: **Brazil**, Bahia, Pindobaçu, Serra da Fumaça, on submerged decaying leaf of an unidentified dicotyledonous plant, 16 Dec 2008, leg. D.A.C. Almeida (HUEFS 155,077, holotype).

Geographical distribution: Cuba (Almeida et al. 2014). Description and illustration: Almeida et al. (2014).

Codinaea unisetula Morgan-Jones & E.G. Ingram, Mycotaxon 4: 507, 1976.

≡ Dictyochaeta unisetula (Morgan-Jones & E.G. Ingram) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 150, 2000.

Geographical distribution: USA (Morgan-Jones and Ingram 1976).

Description and illustration: Morgan-Jones and Ingram (1976).

Notes: *Codinaea unisetula* is unique is producing conidia with only apical appendages (Morgan-Jones & Ingram, 1976).

Dictyochaeta ciliata (Onofri & Rambelli) Bhat & W.B. Kendr., Mycotaxon 49: 43, 1993.

≡ Xenokylindria ciliata Onofri & Rambelli, Trans. Br. Mycol. Soc. 88: 397, 1987.

Geographical distribution: India (Bhat and Kendrick 1993; Bhat 2010).

Description and illustration: Rambelli and Onofri (1987); Bhat and Kendrick (1993); Bhat (2010).

Notes: *Dictyochaeta ciliata* differs from other species in producing monophialidic conidiogenous cells with cylindrical collarettes, and ellipsoid broad conidia $(6-11 \times 6-8 \ \mu m)$ with one setula 5–8 μm long at each end.

Dictyochaeta dendroidea Kuthub., Trans. Br. Mycol. Soc. 89: 411, 1987.

 \equiv *Codinaea dendroidea* (Kuthub.) R.F. Castañeda, W.B. Kendr. & Minter, Mycotaxon 127: 119, 2014.

Typification: **Negeri Sembilan**, Pasuh Forest Reserve, on dead leaves, October 1986, A. J. Kuthubutheen (IMI 312,358 holotypus).

Geographical distribution: Malaysia (Kuthubutheen 1987a, b, c, d).

Description and illustration: Kuthubutheen (1987a, b, c, d).

Dictyochaeta fimbriaspora Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 138, 2000.

Setae absent. Conidiophores cylindrical, 7–15-septate, $310-550 \times 6-8 \mu m$, percurrently proliferating. Conidiogenous cells terminal, ampulliform, with flared collarette. Conidia broadly ellipsoid, aseptate, hyaline, Geographical distribution: Philippines (Whitton et al. 2000).

Description and illustration: Whitton et al. (2000).

Notes: *Dictyochaeta fimbriaspora* differs from other species by long conidiophores with percurrent proliferation, terminal and monophialidic conidiogenous cells with funnelshaped collarette, and hyaline, ellipsoid conidia with one apical setula and several basal setulae.

Dictyochaeta multisetula Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 143, 2000.

Geographical distribution: Australia (Whitton et al. 2000).

Description and illustration: Whitton et al. (2000).

Notes: *Dictyochaeta multisetula* differs from other species by long conidiophores, terminal and monophialidic conidiogenous cells with funnel-shaped collarettes, and ellipsoid, aseptate conidia with more than 1 setulae $6-12 \mu m$ long at each end. It also resembles members of *Nimesporella* but differs from them by monophialidic conidiogenous cells and conidia with more than one setulae.

Dictyochaeta renispora Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 146, 2000.

Geographical distribution: Australia (Whitton et al. 2000).

Description and illustration: Whitton et al. (2000).

Notes: *Dictyochaeta renispora* differs from other relevant species by terminal monophialidic conidiogenous cells with percurrent proliferation, and reniform-shaped conidia in smaller size $(6-8.5 \times 3-4.5 \ \mu\text{m})$ and with relatively longer setulae $(6-12 \ \mu\text{m})$.

Dictyochaeta taiwanensis Matsush., Matsush. Mycol. Mem. 5: 12, 1987.

Colony on CMA effuse, brown. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, aggregated or solitary, simple, brown, cylindrical, septate, 90–300 μ m long, 4.5–6 μ m wide, terminated in a conidiogenous cells. Conidiogenous cells terminal, intercalary, polyphialidic with sympodial proliferation, pale brown to brown, with funnel-shaped collarettes. Conidia hyaline, aseptate, falcate, (23–) 30–45 × (2–)2.5–4 (–5) μ m, produced in wet spore mass; setulae simple, one at each end, 5–12 μ m (Matsushima 1987).

Typification: China, Taiwan, Chi Tou, Isolated from rotten leave of *Bambusa multiplicis*, 4 April 1986 (MFC6T776).

Ecology/Substrate/Host: Saprobe on dead material of plants, including *Bambusa multiplicis*.

Geographical distribution: China (Matsushima 1987). Description and illustration: Matsushima (1987). Fungal Diversity (2022) 116:1–546

Notes: *Dictyochaeta taiwanensis* is characterized by absence of setae, simple conidiophores with terminal or intercalary conidiogenous cells, monophialidic conidiogenous cells with funnel-shaped collarettes and sympodial proliferations, and longer conidia (Matsushima (1987). No specimen was examined by us and the above description is based on the original description.

Dictyochaeta tropicalis Bhat & W.B. Kendr., Mycotaxon 49: 45, 1993.

Colony effuse. Conidiophores solitary, cylindrical, straight to slightly flexuous, simple, 5–6-septate, 90–130×5–6 µm, terminating in a polyphialide. Conidiogenous cells terminal, monophialidic, $15-25\times6-8$ µm, the monophialidic bears one persistent remain of the collarettes. Collarettes funnel shaped. Conidia hyaline, smooth, aseptate, ellipsoidal, to drop-shaped, 7–10×3–5 µm, with a single, simple setulae 2–3 µm long at each end.

Geographical distribution: India (Bhat and Kendrick 1993).

Description and illustration: Bhat and Kendrick (1993); Bhat (2010).

Notes: *Dictyochaeta tropicalis* Bhat & W.B. Kendr. fits well to the concept of *Codinaeella* on absence of setae, terminal phialidic conidiogenous cell with funnel-shaped collarettes, and ellipsoidal conidia with 1 setula at each end. It differs from other relevant species by smaller conidia with very short setulae (Kuthubutheen and Nawawi 1991a, b, c, d, e; Bhat and Kendrick 1993; Oliveira et al. 2015; Barbosa1 et al. 2016).

Menispora Link ex Pers., Mycol. Europ. 1: 32, 1822.

Colonies spreading, inconspicuous to conspicuous, irregular in outline, light green to greyish. Teleomorph: Ascomata perithecia, solitary or gregarious, dark brown to black, superficial, globose to subglobose, papillate. Ostiole periphysate. Perithecial wall fragile, two-layered; outer wall textura angularis, composed of brown, thin-walled, polyhedral cells with opaque walls; and inner layer of thinnerwalled, subhyaline to hyaline elongated and compressed cells. Paraphyses persistent, septate, copious, not constricted at the septa, branched, anastomosing, longer than the asci. Asci unitunicate, 8-spored, cylindrical-fusiform, rounded to obtuse at the apex, shortly stipitate, apical annulus distinct, shallow, non-amyloid. Ascospores fusiform, hyaline, septate, smooth, 2-seriate in the ascus. Anamorph: Setae independent and sterile, or fertile as setiform conidiophores, dark brown, sepate, cylindrical, branched or unbranched, septate. Conidiophores simple or loosely branched, sometimes anastomosing, crowded, setiform, erect, straight, or slightly flexuous, septate, brown, the upper part often sterile and setiform. Conidiogenous cells occasionally integrated, terminal, monophialidic, cylindrical, lageniform, in most species



Fig. 79 Maximum likelihood (ML) tree based on ITS sequence data for the genus *Menispora*. Bootstrap support values $\geq 60\%$, Bayesian posterior probability values ≥ 0.95 are shown at the nodes. *Podospora*

didyma AY999127 was chosen as the outgroup. Ex-type strains are indicated with "T" in the end of the taxa labels. The newly generated sequences are in bold

recurved at the tip with rather inconspicuous collarettes, pale brown, thin walled. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, cylindrical with rounded ends, falcate, fusiform, aseptate or septate, hyaline, smooth, with or without setulae.

Type species: Menispora glauca Link ex Pers.

Ecology/Substrate/Host: Saprobe on decaying plant material, especially common on rotten wood.

Geographical distribution: Broadly distributed.

Description and illustration: Hughes and Kendrick (1963, 1968); Ellis (1971, 1976); Holubová-Jechová (1973a, b); Seifert et al. (2011).

Notes: The genus *Menispora*, typified by *M. glauca*, is a dematiaceous, phialidic hyphomycete genus forming conspicuous hairy colonies on decayed wood, the inner side of bark or on decayed leaves and fruit (Tubaki 1958; Hughes and Kendrick 1963, 1968; Ellis 1971, 1976; Holubová-Jechová 1973a, b; Matsushima 1975; Sutton and Hodges 1978; Kirk 1985; Arambarri and Godeas 1994; Arambarri and Cabello 1995; Taylor and Hyde 2003; Réblová 2000, 2004; Réblová et al. 2006; Réblová & Seifert 2008; Seifert et al. 2011). A historical review to the genus and species were provided by Hughes and Kendrick (1963, 1968), Holubová-Jechová (1973a, b) and Réblová et al. (2006) and Réblová and Seifert (2008). Eleven morphological species

are accepted including *M. apicalis*, *M. britannica*, *M. caesia*, *M. ciliata*, *M. convoluta*, *M. fuegiana*, *M. gamsii*, *M. gamundiae*, *M. glauca*, *M. manitobaensis* and *M. uncinata*. These species are distinguished by morphology of setae, setiform conidiophores, conidiogenous cells and conidia, and the identification key was provided by Réblová et al. (2006).

Morphologically the genus is characterized by the dark brown sterile setae or fertile setiform conidiophores formed in densely aggregated colony, terminal or rarely lateral phialidic conidiogenous cells with a tapering, strongly recurved apex, inconspicuous sporulating aperture with indistinct shallow collarette, and hyaline, 0-3-septate, falcate or fusiform conidia with or without polar setulae. Réblová and Seifert (2008) recognized two morphological patterns of conidiophores and setae among the 11 known species: a) lacking setae that grow independently of conidiophores; the conidiophores terminate in sterile, whip-like extensions that branch laterally in their lower part; phialides borne on short setulae along the main axis of the conidiophore or its branches; phialides arise singly or in groups, terminally or laterally, including M. caesia, M. ciliata, M. convoluta, M. gamsii, M. glauca, M. manitobaensis, M. tortuosa; or b) with setae occurring independently of conidiophores; the conidiophores terminating in a mono- or polyphialide; phialides are rarely lateral; including M. britannica, M. fuegiana, M.

gamundiae and M. uncinata. A Phialophora-like synanamorph (produced in vitro) was experimentally proven for Menispora glauca (= Chaetosphaeria ovoidea (anamorph: and Ch. pulviscula (anamorph: Menispora caesia) (Réblová 1998b). In the present phylogeny, Réblová et al. (2021e) reported four morphotypes (M1–M4) hitherto associated with the genus and distinguished based on the arrangement of setae and conidiophores and the conidiophore structure.

The anamorph and teleomorph connections were found for a few species where all belong to the Chaetosphaeriaceae: *M. caesia* is the anamorph of *Chaetosphaeria pulviscula* (=*Zignoëlla pulviscula*); *M. ciliata* is the anamorph of *C. ciliata* Réblová & Siefert, *M. glauca* is the anamorph of *C. ovoidea* (Fr.) Constant., K. Holm & L. Holm (=*Zignoëlla ovoidea*, = *Chaetosphaeria glauca*), *M. tortuosa* is the anamorph of *C. tortuosa* (Booth 1957; Holubová-Jechová 1973a, b; Constantinescu et al. 1995; Réblová 2000, 2004; Réblová et al. 2006; Réblová and Seifert 2008; Seifert et al. 2011).

Recent phylogenetic analysis using the LSU and ITS showed all sampled species including *Menispora britannica*, *M. caesia*, *M. ciliata*, *M. glauca*, *M. manitobaensis*, *M. tortuosa* and *C. uncinata* formed a well–supported monophyletic clade which is distinct from *Chaetosphaeria* based on *C. innumera* (Fernández et al. 2006; Réblová et al. 2006, 2021e; Réblová and Seifert 2008). Our phylogenetic analyses with inclusion of additional species further supports the monophyly (Figs. 3, 79). Under the "One fungus One name" and supported by the molecular phylogenetic evidence, the generic name *Menispora* Pers. was recommended for use against the sexual name *Zignoëlla* Sacc. (Réblová et al. 2016, 2021e).

Key to accepted species in *Menispora* (Revised after Réblová et al. 2006)

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3. 4. Phialides arising singly, terminal on 1-3-septate metulae; phialide apex strongly curved downwards away from the main stipe; conidia $16-26 \times 3-4.5 \,\mu m$M. glauca Phialide arising singly or in clusters, apex straight or 4. curved very gently......5 Phialides arising singly, terminal on 0-2-septate metu-5. lae; conidia 15–25×4–5 µm.....M. paratortuosa 5. Phialides arising in groups of 2–9 with a digitate appearance, terminal or lateral on short, branched, or unbranc-hed metulae; conidia $18-25 \times 3.5-4$ mm...M. tortuosa 6. Apex of the phialide strongly curved downwards towards the main stalk.....7 Apex of the phialide straight or slightly curved down-6. 7. Setiform conidiophores branched in the upper part; 7. Setiform conidiophores unbranched in the upper part; conidia 11.5–21×2.5–3.5 µm......M. ciliata Conidia 14–16 × 3–3.5 µm......M. gamsii 8. 8. Conidia 17–23×3.5–4 µm.....M. convoluta 9. Conidia 3-septate, 17–21.5×4–4.5 µm.....M. manitobaensis 9. Conidia aseptate, $15.5-21.5 \times 3-3.5 \mu m$; Phialophoralike synanamorph; ascospores fusiform, 1-septate later 3-septate, $19-23(-25) \times 3-3.5(-4)$ µm; asci 90–115×7–8.5 μm.....*M. caesia* 10. Conidia aseptate, with subterminally inserted setulum at each end cell.....11 10. 11. Setae sinuous, sometimes coiled apically, rounded at the apex; conidia $18.5-23.5 \times 4-5 \mu m$, setulae 2-3 mmlong.....M. uncinata 11. Setae straight, not coiled, acute at the apex; conidia 15–18×2–2.5 μm......M. britannica 12. Setae straight to sinuous; conidia $22-27 \times$ 2–2.5 µm.....*M. fuegiana* 12. Setae sinuous and coiled above; conidia $23-26 \times$ 2.5–3 µm.....*M. gamundiae*

Menispora ciliata Corda, Icon. Fun. 1: 16, 1837.

Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae. Teleomorph: Not observed. Anamorph: Conidiophores macronematous, mononematous, branched in the lower part, crowded, setiform, erect, straight or slightly flexuous, up to 20-septate, brown, up to 550 μ m long, 3–4.5 μ m wide, smooth, the upper part often sterile and setiform, twisted or loosely coiled; branches pale brown, smooth-walled. Conidiogenous cells occasionally integrated,



Fig. 80 Colony of *Menispora* species on PDA after 20 days at 25 °C. **a**, **b** *Menispora* gamsii (77,475). **c**, **d** *Menispora* paraciliata (ex-type strain 77478). **e**, **f** *M. paratortuosa* (ex-type strain 77,625)

terminal, monophialidic, cylindrical, lageniform, slightly recurved at the tip with rather inconspicuous collarettes, pale brown, thin-walled, $15-20 \times 4-5 \mu m$. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, cylindrical with rounded ends, fusiform, aseptate, $16-18 \times 3.5-4 \mu m$, hyaline, smooth, with or without setulae of $5-8 \mu m \log$.

Material examined: **China**, Hunan Province, Muang Mountain, on dead branches, April 2002, W.P. Wu (Wu4644a). Living strain: 46,591 (from Wu4644a).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Canada, China, Japan, Czechoslovakia, New Zealand, UK and USA (Réblová and Seifert 2008).

Description and illustration: Tubaki (1958); Hughes and Kendrick (1963, 1968); Ellis (1971); Holubová-Jechová (1973a, b); Réblová and Seifert (2008).

Notes: *Menispora ciliata* resembles *Menispora* state of *Chaetosphaeria pulviscula* in having aseptate conidia, but can be distinguished by asetulate conidia in *C. pulviscula*

(Hughes and Kendrick 1963, 1968; Ellis 1971, 1976; Holubová-Jechová 1973a, b; Sutton 1973). Réblová and Seifert (2008) established its teleomorph connection to *Chaetosphaeria ciliata* Réblová & Seifert.

Menispora gamsii Hol.-Jech., Proc. K. Ned Akad. Wet C 76: 298, 1973, Fig. 81

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae. Teleomorph: Not observed. Anamorph: Setae distinct from conidiophores, straight below, sinuous and sometimes more or less coiled above, unbranched, scattered or in groups, arising from repent hyphae, pale to dark brown at the base, paler toward the apex, thickwalled in the lower part, thin–walled in the upper part, smooth, multiseptate, up to 250 μ m long, 3–3.5 μ m wide at the base, 2.3–3 μ m wide in the middle, tapering toward the rounded apex and up to 2 μ m wide. Conidiophores macronematous, mononematous, branched, crowded, erect, straight, or slightly flexuous, septate, brown, 110–130 μ m long, 3–3.5 μ m wide, smooth; branches pale brown,



Fig. 81 Menispora gamsii (Wu17009). a, b Setae and conidiophores; c, e-g Conidiogenous cells with curved collarettes; d Basal part conidiophores and setae. h–l Conidia. Scale bar: a, b 20 μm, c–l 5 μm

smooth-walled, 2–3-septate, clavate, cylindrical, 40–60 μ m long, 2.5–4.5 μ m wide. Conidiogenous cells terminal, monophialidic, cylindrical, lageniform, strongly recurved at the tip with rather inconspicuous collarettes, pale brown, thin-walled, 27–32×3.5–4.5 μ m. Conidia acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, 11.5–15×2.5–3 μ m, hyaline, aseptate, asymmetrical, slightly tapered and pointed at the basal end and obtuse at the other, each end with a single straight or slightly curved setulum, 6–8 μ m long, subterminally or terminally inserted on the concave side.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, central part slightly grey, reverse pale brown (Fig. 80a, b).

Material examined: **China**, Zhejiang Province, Deqing, Moganshan, Luhuadang, on rotten seed pod of unidentified Leguminosae, 16 Oct 2019, W.P. Wu (Wu17009). Living strain: 77,463 (from Wu17009), 77,475 (from Wu17009a) and 77,635 (from Wu17009b).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Netherland (Holubová-Jechová 1973a, b).

Description and illustration: Holubová-Jechová (1973a, b).

Notes: *Menispora gamsii* belongs to the morphotypes M4 as defined by Réblová et al. (2021e), and is characterized by presence of independent unbranched setae with coiled apex, branched conidiophores, and aseptate, falcate and asymmetrical conidia with 1 setulum at each end. It resembles *M. ciliata*, *M. convoluta* (conidia 17–23×3.5–4.2 µm), and *M. uncinata* (conidia 18.7–23.4×3.9–5.0 µm) (Hughes and Kendrick 1968; Ellis 1971, 1976; Holubová-Jechová 1973a, b; Sutton 1973; Lunghini 1994; Réblová et al. 2006; Réblová and Seifert, 2008). *Menispora gamsii* differs from all these species by smaller conidia. In addition, *M. ciliata* does not produce independent sterile setae from conidiophores; *M. uncinata* produces unbranched conidiophores and the larger conidia with shorter setulae (2.1–2.9 µm).

The ITS sequences were obtained from several strains from the fresh specimen. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 77,463 include *Menispora ciliata* (GenBank EU488736, 95% identity).

Menispora glauca Link ex Pers., Mycol. Europ. 1: 32, 1822.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly

superficial, composed of brown, branched and septate hyphae. Teleomorph: Not observed. Anamorph: Conidiophores macronematous, mononematous, branched in the lower part, crowded, setiform, erect, straight or slightly flexuous, up to 20-septate, brown, up to 450 μ m long, 3–5 μ m wide, smooth, the upper part often sterile and setiform, twisted or loosely coiled; branches pale brown, smoothwalled. Conidiogenous cells occasionally integrated, terminal, monophialidic, cylindrical, lageniform, slightly recurved at the tip with rather inconspicuous collarettes, pale brown, thin–walled, 15–20×3.5–4.5 μ m. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, cylindrical with rounded ends, fusiform, 3-septate, 18–30×3.5–4 μ m, hyaline, smooth, with or without setulae of 5–8 μ m long.

Material examined: **China**, Jilin Province, Dunhua, on dead branches, 14 August 2000, W.P. Wu & Yang Huang (Wu4563).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Belgium, Canada, China, Czechoslovakia, England, Germany, Italy, Poland, Scotland, Sweden and USA (Hughes and Kendrick 1963; Ellis 1971; Holubová-Jechová 1973a, b; Xia et al. 2016).

Description and illustration: Hughes and Kendrick (1963); Ellis (1971); Holubová-Jechová (1973a, b); Xia et al. (2016).

Notes: *Menispora glauca* belongs to the morphotypes M2 as defined by Réblová et al. (2021e), and is characterized by the absence of independent setae, setiform conidiophores terminating in sterile, whip–like extension with lateral branches in their lower part, clustered phialides borne on short metulae along the main axis of the conidiophores or its branches, 3-septate conidia with 1 setulum at each end (Réblová et al. 2006). *Menispora glauca* resembles the morphological features of *M. tortuosa* and *M. manitobaensis* by having 3-septate conidia, but can be distinguished by strongly incurved collarette in *M. glauca* and asetulate conidia in *M. manitobaensis* (Hughes and Kendrick 1963, 1968; Ellis, 1971, 1976; Holubová-Jechová 1973a, b; Sutton 1973; Xia et al. 2016).

Menispora manitobaensis B. Sutton, Mycol. Papers 132: 75, 1973. Figure 82

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae. Teleomorph: Unknown. Anamorph: Independent setae absent. Setiform conidiophores macronematous, multiseptate, brown, paler towards the apex, thick-walled, smooth, 330–450 µm long, 3.5–4.5 µm wide at the base, unbranched and straight in the lower part, upper part unbranched and sterile, strongly flexuous or irregularly coiled, terminating



Fig. 82 *Menispora manitobaensis* (Wu17408). **a, b** Setae with branches and sterile apex. **c–h** Part of main stipe of setae and branches bearing conidiogenous cells with narrow collarettes. **i–n** Conidia. Scale bar: **a** 20 μm, **b** 10 μm, **c–n** 5 μm

in a sterile subhyaline rounded cell ca. 2.8–3.2 µm wide; fertile region only in the lower part of the main stipes, with a 1-3-septate and 1-3 times branched stalks and up to 10 terminal phialides aggregated in dense groups that often appear digitate, arising from short, septate, pale brown metulae below the septa, the branches with phialides are directed upwards, $22-30 \times 3.5-4.5$ µm. Phialides develop in the lower part of the main axis of the conidiophore or its lateral branches, cylindrical with a narrowing straight apex, $13-16.5 \times 4-4.5 \mu m$, subhyaline becoming hyaline towards the conidiogenous aperture; conidiogenous aperture 1-1.2 µm wide; collarette shallow, indistinct. Conidia falcate, rounded at each end, 19-21×3.5-4.5 µm, 3-septate, hyaline, each polar cell with a single straight or slightly curved setulum, 15-17 µm long, subterminally inserted on the concave side.

Materials examined: **China**, Hebei Province, Zhangjiakou, Chicheng, Haituoshan, on dead fruit of *Quercus* sp., 25 September 2020, W.P. Wu (Wu17408, Wu17409). Living strains: 76,164 and 76,165 (from Wu17408), 78,166, 78,167 and 78,168 (from Wu17409).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Canada and China (Sutton 1973).

Description and illustration: Sutton (1973); Holubová-Jechová (1973b); Ellis (1976); Réblová et al. (2005).

Notes: Menispora manitobaensis belongs to the morphotypes M3 as defined by Réblová et al. (2021e) and is characterized by the absence of independent setae, setiform conidiophores with strongly flexuous or irregularly coiled upper part terminating in a sterile and obtuse apex, fertile regional with lateral branches in lower part of the main stipes, monophialidic borne laterally along the main stipe of the main stipe, and 3-septate, falcate to fusiform conidia with one setulum at each end. In the original description of M. manitobaensis (conidia 17-21.5×4-4.5 µm, without setulae), no setulae was reported (Sutton 1973). Morphologically it resembles *M. glauca* (conidia $16-26 \times 3-4.5 \,\mu\text{m}$, setulae 6-11 µm) in absence of independent sterile setae, fertile region with lateral branches in the lower part of the main stipes, and 3-septate falcate conidia without or with one setulum at each end (Hughes and Kendrick 1968; Ellis 1971, 1976; Holubová-Jechová 1973a, b; Sutton 1973; Lunghini 1994; Réblová et al. 2006; Réblová and Seifert 2008). M. glauca produces unbranched lateral branches terminating in a conidiogenous cell with a strongly recurved apex toward the main stipe.

Menispora paraciliata W.P. Wu & Y.Z. Diao, sp. nov., Fig. 83, MycoBank MB841613

Etymology: Refers to its morphological similarity with *Menispora ciliata*.

Diagnosis: Similar to *M. uncinata*, *M. ciliata*, *M. convoluta* and *C. gamsii*, but differs in multiple branching in the upper part of the main stipes of setiform conidiophores.

Typification: **China**, Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead cone of *Pinus* sp., 16 Oct 2019, W.P. Wu, Holotype HMAS 352,017 (=Wu17033b), ex-type strains CGMCC 3.20742 (=NN77478).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae. Teleomorph: Unknown. Anamorph: Independent sterile setae absent. Setiform conidiophores macronematous, frequently branched in the upper part with sterile branches, and branched in the lower part as fertile region, crowded, setiform, erect, straight or flexuous, up to 20-septate, brown, up to 600 µm long, basal cell swollen and 7-10 µm wide, 3-4 µm wide in the middle part, smooth, the upper part sterile and setiform, straight or flexuous; branches pale brown, smooth-walled, tapering gradually towards the rounded apex, 1.5-2 µm wide. Fertile region only in the lower part of the main stipes of the setiform conidiophores, with lateral branches, branches 0-2-septate, often in one side of the setiform conidiophores, unbranched with one terminal conidiogenous cell or occasionally branched with 2 terminal conidiogenous cells, strongly curved towards the main stipes, pale brown, thin-walled, smooth, 38-45 × 2.8-3.5 µm. Conidiogenous cells terminal, monophialidic, cylindrical, lageniform, recurved at the tip with rather inconspicuous collarettes, pale brown, thin-walled, $25-35 \times 2.5-3.5 \mu m$, tapering gradually towards the apex. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, $15.5-17.5 \times 2.8-3 \mu m$, hyaline, aseptate, asymmetrical, slightly tapered and pointed at the basal end and obtuse at the other, each end with a single straight or slightly curved setulum, 5–10 µm long, subterminally or terminally inserted on the concave side.

Culture characteristics: Colonies on PDA effuse, colonies 0.8–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, central part grey, reverse pale brown (Figs. 80c, d).

Other studied living strains: 77,466 (from Wu17033d), 77,477 (from Wu17033a) and 77,478 (from Wu17033c).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Menispora paraciliata* belongs to the morphotypes M2 as defined by Réblová et al. (2021e), and is characterized by absence of independent sterile setae, setiform conidiophores with several branches in the upper part and fertile region only at the lower part of the main stipes as whip-like extension with lateral branches, single or occasionally 2 terminal phialides borne on short branches, aseptate conidia with one setulum at each end. It resembles *M*.



Fig.83 Menispora paraciliata (Wu17033, holotype). a, b Setiform conidiophores with secondary branches and lateral branches of conidiophores and conidiogenous cells. c Lateral branch with terminal conidiogenous cell. d Part of setiform conidiophores with branches, showing the base of branches. h Fertile regions of the setiform conidiophores, showing the lateral branches and curved collarette. e-g Conidia. Scale bar: a 40 μm, b, d, h 20 μm, g 10 μm, c, e, f 10 μm

uncinata, M. ciliata, M. convoluta and C. gamsii (Hughes and Kendrick 1968; Ellis 1971, 1976; Holubová-Jechová 1973a, b; Sutton 1973; Lunghini 1994; Réblová et al. 2006; Réblová and Seifert 2008). Menispora paraciliata differs from all these species by frequently branching in the upper part of the main stipes of setiform conidiophores. In addition, M. gamsii and M. uncinata produce independent sterile setae and conidiophores; M. convoluta has larger conidia $(17-23 \times 3.5-4.2 \mu m)$, thus they can be easily distinguished from M. paraciliata. Menispora ciliata is very similar to M. paraciliata in setiform conidiophores, strongly recurved conidiogenous cells towards the main stipes, and shape and size of the conidia, but they differ in unbranched setiform conidiophores in the latter species.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,465 include *Menispora ciliata* (GenBankMH860017, 97% identity), *M. glauca* (MH859920, 93% identities) and *M. tortuosa* (GenBank AF178558, 93% identities).

Menispora paratortuosa W.P. Wu & Y.Z. Diao, sp. nov., Fig. 84, MycoBank MB841614.

Etymology: Refers to its morphological and phylogenetic similarity with *Menispora tortuosa*.

Diagnosis: Similar to *Menispora tortuosa* but differs in the shorter setiform conidiophores with sterile and strongly twisted or coiled upper part, lateral branch with one shorter conidiogenous cell and never with digitate appearance, and 8 bp difference in ITS sequence.

Typification: **China**, Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead fruit of *Platanus occidentalis*, 16 October 2019, W.P. Wu, Holotype HMAS 352,018 (= Wu17005), ex-type strains CGMCC 3.20748 (= NN77625).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, crowded, setiform, cylindrical, straight in the lower part with fertile branches, strongly twisted or coiled and sterile in the upper part, up to 15-septate, thick-walled, smooth, brown to dark brown, up to 450 μ m long, 3.5–4.5 μ m wide, slightly swollen at the basal cell, only slightly tapering toward the apex and terminating in a sterile pale brown apex and 3–3.5 μ m wide; Fertile region only in the lower part of the main stipes of the setiform conidiophores, with lateral branches, branches 1-3-septate, in both sides of the setiform conidiophores, unbranched with one terminal conidiogenous cell, cylindrical, straight, smooth, thick-walled and brown at the lower part and becoming pale brown and thin-walled in the upper part, $15-25 \times 4-5$ µm. Conidiogenous cells terminal, monophialidic, cylindrical, lageniform, slightly recurved at the tip and with rather inconspicuous collarettes, pale brown, thin-walled, $11-15 \times 4-5 \mu m$, tapering gradually towards the apex. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, $18.5-24.5 \times 3.5-4 \mu m$, hyaline, 3-septate, symmetrical, obtuse at both ends, each polar cell with a single straight or slightly curved setulum, 8-9 µm long, subterminally or terminally inserted on the concave side.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, reverse pale brown to soil brown (Figs. 80e, f).

Other studied living strains: 77,473 and 77,474 (from Wu17005).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Menispora paratortuosa belongs to the morphotypes M2 as defined by Réblová et al. (2021e). Morphologically it resembles M. glauca (conidia $16-26 \times 3-4.5 \mu m$, setulae 6-11 µm), M. manitobaensis (conidia $17-21.5 \times 4-4.5 \mu m$, without setulae) and *M. tortuosa* (conidia $18-25 \times 3.5-4.5 \mu m$, setulae $8-12 \mu m$) in absence of independent sterile setae, fertile region with lateral branches in the lower part of the main stipes, and 3-septate falcate conidia with one setulum at each end (Hughes and Kendrick 1968; Ellis 1971, 1976; Holubová-Jechová 1973a, b; Sutton 1973; Lunghini 1994; Réblová et al. 2006; Réblová and Seifert 2008). Menispora paratortuosa differs from these species by the shorter setiform conidiophores with strongly twisted or coiled and sterile upper part, unbranched lateral branches bearing only one phialides with slightly incurved conidiogenous cells. In addition, Menispora glauca and M. tortuosa produces longer lateral branches; M. manitobaensis produces asetulate conidia, thus they can easily be distinguished from M. paratortuosa. In M. tortuosa, the lateral branch is heavily branched with 2-9 conidiogenous cells with a digitate appearance.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,625 include *Menispora ciliata* (GenBank MH863180, 91% identity), *M. glauca* (MH859920, 97% identity), *Menispora manitobaensis* (GenBank EU488738, 98% identity), and *M. tortuosa* (GenBank AF178558, 98% identity).



Fig. 84 *Menispora paratortuosa* (Wu17005). **a**, **b** Setae and setiform conidiophores. **c** Upper part of setiform conidiophores. **d**, **e** Setiform conidiophores bearing lateral conidiogenous cells or conidiogenous

cells. **f–h** Lateral branches bearing conidiogenous cells. **i**, **j** Conidia. Scale bar: **a** 40 μm, **b** 20 μm, **c**, **d–j** 5 μm

Multiguttulispora C.G. Lin & J.K. Liu, Mycosphere 10: 681, 2019.

Saprobic on decaying plant. Asexual morph: Colonies on plant substrate effuse, scattered, white to pale brown. Mycelium partly immersed, composed of brown hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, erect, straight, or flexuous, unbranched, septate, smooth, dark brown at the base becoming light brown towards the apex, cylindrical. Conidiogenous cells polyphialidic, integrated, terminal, pale brown, cylindrical; collarettes funnel-shaped. Conidia aggregated in slimy mass at the apex of the conidiophores, acrogenous, smooth, hyaline, septate, with guttulates, cylindrical, oblong, with an appendage at each end (Adaptred from Lin et al. 2019).

Type species: *Multiguttulispora dimorpha* (Toyaz & Udagawa) Réblová & Hern.-Restr. (=*Multiguttulispora sympodialis* C.G. Lin & J.K. Liu).

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: China, Japan, Malaysia, Peru and Thailand (Réblová et al. 2021b). Description and illustration: Lin et al. (2019).

Notes: In the phylogenetic study of hyaline-spored chaetosphaeriaceous fungi, Lin et al. (2019) found that *Multiguttulispora sympodialis* C.G. Lin & J.K. Liu phylogenetically formed a separate linkage within the family Chaetosphaeriaceae on the tree generated based on the combined LSU and ITS sequence data. Therefore, the new genus *Multiguttulispora* was introduced to accommodate this distinct fungus. Morphologically this genus is characterized by absence of setae, macronematous conidiophores terminated in a polyphialidic conidiogenous cells with sympodial extension, and ellipsoidal to oblong to ellipsoidal-fusiform, hyaline, 3-septate and multiguttulate conidia with a basal hilum and a gently curved setula at each end.

More recently Réblová et al. (2021b) showed that in the phylogeny, the genus forms a monophyletic lineage containing two species, *Codinaea dimorpha* and *C. triseptata*. Furthermore, the comparison of morphological characters and DNA sequences revealed *M. sympodialis* conspecific with *Codinaea dimorpha*. Therefore, *Codinaea dimorpha* and *C. triseptata* were transferred to *Multiguttulispora*, and *M. sympodialis* was reduced to a synonymy of *M. dimorpha*.

In our phylogenetic analysis (Fig. 3), the three *Multiguttulispora* species, *M. dimorpha*, *M. triseptata* and an undescribed species are grouped together and form a well–supported distinct clade. This analysis further supports the generic delimitation of *Multiguttulispora*. In our study including several *Multiguttulispora* specimens from China, we observed the breaking-off of the collarettes from conidiogenous cells and carried away by the conidia, and this make the conidiogenous cells with a sympodial appearance without collarettes. This was also shown in their illustration of *D. triseptata* by Crous et al. (2015).

Key to species of *Multiguttulispora*.

Multiguttulispora dimorpha (Toyaz & Udagawa) Réblová & Hern.-Restr., J. Fungi 7(6, no. 438): 20, 2021. Figure 85

≡ Codinaea dimorpha Toyaz & Udagawa, Mycotaxon 13: 451, 1981.

≡ Dictyochaeta dimorpha (Toyaz & Udagawa) Aramb. & Cabello, Mycotaxon 34: 681, 1989.

≡ *Dictyochaeta dimorpha* (Toyaz & Udagawa) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 137, 2000.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3–4.5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, scattered or aggregated, setiform, simple, erect, straight, or slightly flexuous, 6-13-septate, dark brown to blackish brown and thick-walled in the lower part, becoming paler towards the apex, smooth, $200-300 \times 6.5-7.5 \,\mu$ m, with a sympodial appearance. Conidiogenous cells integrated, terminal, polyphialidic, extending sympodially, cylindrical, $20-35 \times 4-7 \mu m$, pale brown, thinand smooth-walled, with up to ten funnel-shaped collarettes, or with a sympodial appearance without conspicuously collarettes attached. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, cylindrical, straight or slightly curved, obtuse at both ends, $17-22 \times 6.5-8 \mu m$, 3-septate, hyaline, smooth, both apex and base with a setula 5–9 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 10–14 mm diameter in 14 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, pale brown, reverse of the same color.

Material examined: China, Guangdong Province, Zhaoqing, Dinghushan, on dead material of palm, 3 March 2012, W.P. Wu (Wu12160); Guangdong Province, Guangzhou, Yuexiu Park, on dead material of palm, 2 March 2012, W.P. Wu (Wu12209); Guangdong Province, Guangzhou, Yuexiu Park, on dead leaves of unidentified tree, 2 March 2012, W.P. Wu (Wu12243, with a few bases difference from other strains); Guangxi Province, Nanning, on dead leaves of *Podocarpus* sp., 3 January 1998, W.P. Wu (Wu1666e); Guangxi Province, Shiwandashan, on dead leaves of ?Rhododendron sp., 30 December 1997, W.P. Wu (Wu1554e); Guangxi Province, Shiwandashan, on dead branches of unidentified plant, 28 December 1997, W.P. Wu (Wu1497); Guangxi Province, Damingshan, on dead leaves of unidentified plant, 20 December 1997, W.P. Wu (Wu1453a); China: Sichuan Province, Dujiangyan, Qingcheng Shan, on dead leaves of unidentified tree, 9 November 2019, W.P. Wu (Wu17233); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead petiole of palm, 12 June 2015, W.P. Wu (Wu13351; Wu13356); Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of Gingko biloba, 12 June 2015, W.P. Wu (Wu13283). Living strains: 54,255 (from Wu12160), 54,203 (from Wu12243), 54,226 (from Wu12204), 59026 (from Wu13356a), 59027 (from Wu13351b), 59037 (from Wu13351a), 59042 (from Wu13356b) and 59057 (from Wu13283).



Fig. 85 *Multiguttulispora dimorpha* (Wu13349b). **a–d, i** Upper part of conidiophores and conidiogenous cells extending by sympodial proliferation. **f–h** Solitary or aggregated conidiophores. **j–n** Conidia. Scale bar: **f–h** 20 μm, **a–d, i–n** 10 μm



Fig. 86 *Multiguttulispora paratriseptata* (Wu2812a, holotype). **a** Conidiophores. **b** Upper part of conidiophores with polyphialidic conidiogenous cells. **c** Conidia. Scale bar: **a** 40 µm, **b**, **c** 20 µm

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China, Japan, Malaysia, Peru and Thailand (Réblová et al. 2021b).

Description and illustration: Toyaz and Udagawa (1981); Réblová et al. (2021b).

Notes: *Multiguttulispora dimorpha* and *M. triseptata* are very similar on clustered conidiophores, terminal polyphialidic conidiogenous cells with funnel-shaped collarettes with sympodial proliferations, and allantoid, ellipsoid to oblong, 3-septate conidia in similar size (*M. dimorpha*: conidia $22-28 \times 7-8$ µm, setulae 5–6 µm; *M. triseptata*: conidia $21-30 \times 6-7.5$ µm, setulae 3–6 µm). The only difference seems to be production of both 3-septate macroconidia and also aseptate and cylindrical microconidia ($10-18 \times 1-2$ µm) from the monophialidic conidiogenous cells in *M. dimorpha*. However, the aseptate and falcate-fusiform to navicular microconidia ($7-12 \times 2$ µm) was also reported from pure culture of *M. triseptata* (Crous et al. 2015). Réblová et al. (2021e) accepted both as different species.

Multiguttulispora dimorpha has broad variation on morphology of conidiophores, conidiogenous cells and conidia. The conidia from the Chinese collections are slightly smaller than those in original description $(21-30 \times 6-7.5 \ \mu\text{m})$. Phylogenetically the ITS sequences from these Chinese collections are identical to those reported from Malaysia (Crous et al. 2015) and Thailand. This species seems to be a subtropical and tropical species, and has been collected from several different locations in subtropical and tropical areas in China.

Multiguttulispora paratriseptata W.P. Wu & Y.Z. Diao, sp. nov., Fig. 86. MycoBank MB841571.

Etymology: Refers to its 3-septate conidia and also morphological similarity to *Multiguttulispora triseptata*.

Diagnosis: Similar to *Mutliguttulispora triseptata* and *M. dimorpha*, but differs in slightly smaller conidia (than those from the original description) and 7 bp difference in ITS sequences.

Typification: **China**, Guangdong, Shaoguan, Danxiashan, on dead branches of unidentified tree, 25 December 2012, W.P. Wu, Holotype HMAS 352,027 (=Wu12457), ex-type strain CGMCC 3.20796 (=NN55338).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3–4.5 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, scattered or aggregated, setiform, simple, erect, straight, or slightly flexuous, 6–13-septate, dark brown to blackish brown and thick–walled in the lower part, becoming paler towards the apex, smooth, 200–350×6–8 μ m, with a sympodial appearance. Conidiogenous cells integrated, terminal, polyphialidic, cylindrical, 35–45×5–6 μ m, pale brown, thin- and smooth-walled, with up to 5 funnel-shaped collarettes, or with a sympodial appearance without conspicuously collarettes attached. Conidia holoblastic, acrogenous, solitary,



Fig. 87 Neotainosphaeria microsperma (Wu1928a, holotype). a Conidiophores. b Upper part of conidiophores with percurrent proliferation. c Conidia. Scale bar: a 40 μ m, b, c 20 μ m
formed in droplet surrounding the tips of conidiogenous cells, cylindrical, straight or curved, obtuse at both ends, $20-22 \times 5.5-7 \mu m$, 3-septate, hyaline, smooth, both apex and base with a setula up to 6 μm long.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire or regular, aerial mycelium well-developed, grey to greybrown, reverse pale brown to brown (Fig. 66w).

Other materials examined: China, Guangdong Province, Zhaoqing, Dinghushan, on dead material of palm, 3 March 2012, W.P. Wu (Wu12099); Guangdong Province, Zhaoqing, Dinghushan, on dead material of palm, 3 March 2012, W.P. Wu (Wu12118); Guangdong Province, Zhaoging, Dinghushan, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu (Wu12169); Guangdong Province, Zhaoqing, Dinghushan, on dead material of palm, 3 March 2012, W.P. Wu (Wu12194); Guangdong Province, Guangzhou, Yuexiu Park, on dead material of palm, 2 March 2012, W.P. Wu (Wu12211); Yunnan Province, Simao, on dead branches of unidentified plant, 13 October 1999, W.P. Wu & Yan Huang (Wu2812a); Guangdong, Shaoguan, Danxiashan, on dead branches of unidentified tree, 25 December 2012, W.P. Wu (Holotype WFH Wu12457). Living strains: 54,209 (from Wu12118), 54,199 (from Wu12099), 54,253 (from Wu12169), 54,205 (from Wu12194) and 54,201 (from Wu12211).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Multiguttulispora paratriseptata* is morphologically very close to *M. dimorpha* (Matsushima 1981; Toyaz and Udagawa 1981; Réblová et al. 2021b). Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 55338 include *M. dimorpha* (GenBank MW984582, 98.7% identify), *M. sympodialis* (GenBank NR_166292, 98% identify) and *M. triseptata* (GenBank KR611880, 98% identity). This species seems to be also a subtropical and tropical species and has been collected from several locations in subtropical and tropical areas in China.

Neotainosphaeria W.P. Wu & Y.Z. Diao, gen. nov., Myco-Bank MB841527.

Etymology: Refers to its phylogenetic relationship with the genus *Tainosphaeria*.

Diagnosis: Setae absent. Conidiophores simple, cylindrical, extended percurrently; Conidiogenous cells terminal, monophialidic, verruculose, collarettes inconspicuous. Conidia globose to subglobose, thick9 and rough-walled, hyaline, aseptate, bearing 2–3 setulae. Similar to *Codinaeella* and *Tainosphaeria*, but differs in producing roughwalled monophialidic conidiogenous cell with inconspicuous collarette, and globose to subglobose, rough- and thick-walled conidia bearing 2–3 setulae. Type species: *Neotainosphaeria microsperma* W.P. Wu & Y.Z. Diao.

Colonies effuse, hairy, dark brown. Mycelium partly superficial and partly immersed, composed of pale brown to brown, branched and septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, simple, erect, straight or slightly flexuous, dark brown to reddish brown, 4-6-septate, smooth-walled in the lower part, becoming strongly verruculose in the upper part and with irregularly arranged striate, thick-walled, with a swollen basal cell, extending percurrently through collarette, terminated in a conidiogenous cell,. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, thick- and rough-walled, dark brown, apex pale brown, with a narrow sporulating locus, collarette indistinct. Conidia holoblastic, acrogenous, solitary, globose to subglobose, hyaline, roughand thick-walled, with 2-3 slender appendages, accumulating in a head at the tips of the conidiogenous cells.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Morphologically *Neotainosphaeria* is similar to some species of *Codinaeella* and *Tainosphaeria* with globose to ellipsoidal conidia, but differs in producing the rough-walled, monophialidic conidiogenous cell with inconspicuous collarette, and globose to subglobose, rough- and thick-walled conidia bearing 2–3 setulae. It also resembles *Calceispora* and *Bahusutrabeeja* s. lat, but can be distinguished from them by monophialidic conidiogenous cells bearing narrower sporulating loci with inconspicuous collarette, rough- and thick-walled conidia with both lateral setulae (Matsushima 1975; Subramanian and Bhat 1977; Seifert et al. 2011).

Neotainosphaeria microsperma W.P. Wu & Y.Z. Diao, sp. nov., Fig. 87, MycoBank MB841572.

Etymology: Refers to its small-sized conidia.

Diagnosis: Setae absent. Conidiophore $200-500 \times 7-8 \mu m$. Conidiogenous cells terminal monophialidic, thick- and rough-walled, collarette inconspicuous. Conidia globose to subglobose, thick- and rough-walled, 11–13 μm diam, with 2–3 setulae up to 5 μm long.

Typification: **China**, Guangdong Province, Dinghushan, on dead branches of unidentified plant, 9 October 1998, W.P. Wu, Holotype HMAS 352,030 (= Wu1928a), ex-type strain CGMCC 3.20788 (= NN44779).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly superficial and partly immersed, composed of pale brown to brown, branched and septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, solitary, or aggregated in small groups, simple, erect, straight or slightly flexuous, dark brown to reddish brown, 4–6-septate, smooth-walled in the lower part, becoming strongly verruculose in the upper part and with irregularly arranged striate, thick-walled, $200-500 \times 7-8 \mu m$, with a swollen basal cell up to 15 μm wide, terminated in a conidiogenous cell, extending percurrently through collarettes. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, dark brown, apex pale brown, $25-32 \times 6-8 \mu m$, thick- and rough-walled, with a narrow sporulating locus of up to 2 μm wide, collarette indistinct. Conidia holoblastic, acrogenous, solitary, globose to subglobose, hyaline, rough- and thick-walled, 11–13 μm diam, with 2–3 slender appendages, up to 5 μm long, accumulating in a head at the tips of the conidiogenous cells.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Known distribution: China.

Notes: *Neotainosphaeria microsperma* morphologically resembles *Bahusutrabeeja dwaya*, *B. globosa* and *B. bunyensis*, but can be distinguished by smooth-walled conidiogenous cell with a broad sporulating loci and multiappendaged conidia in *B. dwaya* and *B. globosa*; by smaller conidia (7–10 µm diam) in *B. bunyensis* (Subramanian and Bhat 1977; Rao and de Hoog 1986; Bhat and Kendrick 1993; Bhat 1994; McKenzie 1997).

Both LSU and ITS sequences were obtained from the single spore isolate of the type specimen and its affinity to other members of Chaetosphaeriaceae was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 44779 include *Tainosphaeria crassiparies* (GenBank MW984578, 92% identity), T. siamensis (GenBank NR_154524, 90% identity) and *T. jonesii* (GenBank MN121311, 90% identity).

Nimesporella Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 66, 2021.

Colonies effuse, brown, composed of conidiophores, mycelium immersed. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, single or in groups, erect, straight or flexuous to geniculate in the upper part, unbranched, septate, smooth, brown, paler toward the apex. Conidiogenous cells integrated, terminal, polyphialidic, extending sympodially, paler than the conidiophore, often with persistent remnants of the collarettes; collarettes flared, soon evanescent. Conidia ellipsoidal, fusiform, subglobose, rounded at the apical end, papillate at the basal end, aseptate, hyaline, with a straight or gently curved setula at each end, basal setulae positioned ventrally, conidia accumulate in slimy whitish fascicles (Adapted from Réblová et al. 2021e).

Type species: Nimesporella capillacea Réblová & Hern.-Restr.

Ecology/Substrate/Host: Saprobe on decaying plant material.

Geographical distribution: Asia, South American, including China and New Zealand (Réblová et al. 2021b).

Description and illustration: Réblová et al. (2021e).

Notes: The genus *Nimesporella*, typified by *N. capillacea*, is characterized by absence of setae, septate conidiophores bearing terminal polyphialidic conidiogenous cells with sympodially extending and flared collarettes, and hyaline, aseptate, ellipsoidal to fusiform, papillate conidia with one setula at both ends (Réblová et al. 2021e). Our phylogenetic analysis with 3 additional species showed that members of this genus formed a distinct clade (Fig. 3) from other known *Codinaea* and *Dictyochaeta* species.

Apart from the three species presented in this study, several published species with similar morphology as *N. capillacea* are also assigned to the genus, including *Dictyochaeta aliformis, Codinaea aquatica, Codinaea leomaiae, D. tumidospora* and *Hyphodiscosia queenslandica* (Hughes and Kendrick 1968; Holubová-Jechová 1984; Kuthubutheen and Nawawi 1991b, e; Bhat and Kendrick 1993; Whitton et al. 2000; Seifert et al. 2011; Oliveira et al. 2015; Barbosa et al. 2016; Arias et al. 2018).

Key to all accepted species in Nimesporella:

1.	Conidia 8–11.5 × 4.5–5 μ m; setulae 2–3.5 μ m long
	N. capillacea
1.	Conidia more than 10 µm long2
2.	Conidia less than 5 µm wide
2.	Conidia>5 µm wide4
3.	Conidia 10–15.5 \times 3.5–5 µm, setulae 3–5 µm long
	N. daphnioides
3.	Conidia $13-15 \times 4.5-5 \mu m$, setulae $6-9 \mu m \log \dots$
	N. aunstrupii
4.	Conidia more than 20 µm in average
4.	Conidia less than 20 µm long in average6
5.	Conidia 20–28.5 \times 7–9.5 $\mu m,$ setulae 8–10.5 μm
	longN. tumidospora
5.	Conidia $25-28 \times 10-12 \mu m$, setulae $4.5-8 \mu m \log \dots$
	N. aquatica
6.	Conidia $16-22 \times 4-5 \mu m$, setulae $18-22 \mu m \log \dots$
	N. aliformis
6.	Conidial setulae less than 15 µm long7
7.	Conidia 17–20×6.5–7.5 μm, setulae 7–10 μm long
	N. riisgaardii
7.	Conidia 10–18×8.5–9.5 μ m, setulae < 6 μ m long
	N. leomaiae

Nimesporella aliformis (Kuthub. & Nawawi) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841704.

≡ Dictyochaeta aliformis Kuthub. & Nawawi, Mycol. Res. 95: 104, 1991.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores solitary, cylindrical,



Fig. 88 Nimesporella aunstrupii (Wu12202, holotype). a, e Conidia. b–d, f–g Conidiophores and conidiogenous cells. Scale bar: b 10 μm, a, c–g 5 μm

septate, up to 960 µm long, 4.5–6 µm wide at the base, tapering to 3.5–4 µm wide at the apex, terminating in a polyphialide. Conidiogenous cells polyphialidic, up to 80 µm long, with up to 9 successive proliferations and persistent remains of the collarettes. Collarettes tubular to somewhat cylindrical, 1–1.5 µm wide, 1–1.5 µm deep. Conidia hyaline, smooth, aseptate, ellipsoidal, papillate, guttulate, $16-22 \times 4-5$ µm, with a single, simple setulae 18–22 µm long at each end (Kuthubutheen and Nawawi 1991b).

Typification: **Malaysia**, Kedah, Gunong Jerai, on decaying plant, February 1989, A.J. Kuthubutheen, IMI335262.

Ecology/Substrate/Host: Saprobe on decaying plant.

Geographical distribution: Malaysia (Kuthubutheen and Nawawi 1991b).

Description and illustration: Kuthubutheen and Nawawi (1991b).

Notes: *Dictyochaeta aliformis* was described from Malaysia. Although no DNA sequence data is available for phylogenetic analysis, morphologically it fits well to the concept of *Nimesporella* in absence of setae, terminal polyphialidic conidiogenous cell with sympodial extensions, and ellipsoidal, papillate conidia with one setula at each end (Kuthubutheen and Nawawi 1991b). It differs from other accepted species by longer setulae (18–22 µm).

Nimesporella aquatica (R.F. Castañeda, M.S. Oliveira & Malosso) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841705.

 \equiv *Codinaea aquatica* R.F. Castañeda, M.S. Oliveira & Malosso, Mycotaxon 130: 1046, 2015.

Teleomorph: Unknown. Anamorph: Conidiophores solitary, cylindrical, septate, $200-350 \times 4-6 \mu m$, terminating in a polyphialide. Conidiogenous cells polyphialidic, $40-60 \times 6-7 \mu m$, bearing 1–2 persistent remains of the collarettes; collarettes funnel-shaped, 2.5–4 µm deep. Conidia hyaline, smooth, aseptate, ellipsoidal, papillate, guttulate, $25-28 \times 10-12 \mu m$, with a single, simple setulae 4.5–8 µm long at each end (Oliveira et al. (2015).

Typification: **Brazil**, Pernambuco, Cabo de Santo Agostinho, Refúgio de Vida Silvestre, Matas do Sistema Gurjaú, on submerged decaying branches of unidentified plant in a river, 12.V.2015, coll. M.S. Oliveira (Holotype, URM 87,707).

Ecology/Substrate/Host: Saprobe on submerged decaying branches.

Geographical distribution: Brazil (Oliveira et al. (2015). Description and illustration: Oliveira et al. (2015).

Notes: *Codinaea aquatica* is a recently described species from Brazil and it fits well to the concept of *Nimesporella* in absence of setae, terminal polyphialidic conidiogenous cell with sympodial proliferation, and ellipsoidal, papillate conidia with 1 setula at each end. It differs from other relevant species by larger conidia with relatively short setulae (Kuthubutheen and Nawawi 1991a, b, c, d, e; Oliveira et al. 2015; Barbosa et al. 2016).

Nimesporella aunstrupii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 88, MycoBank MB841569.

Etymology: Named after the former President of Novozymes in China, Knud Aunstrup, from whom one of the authors received strong support and encouragement.

Diagnosis: Setae absent. Conidiophores $60-85 \times 3-4.5 \mu m$, 3-4-septate. Conidiogenous cells terminal, polyphialidic, bearing 3-8 funnel-shaped collarettes, or denticulate with a sympodial appearance. Conidia hyaline, aseptate, fusiform, ellipsoid, guttulate, $13-15 \times 4.5-5.5 \mu m$, setulae $6-9 \mu m$ long.

Typification: **China**, Guangdong Province, Zhaoqing, Dinghushan, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu, Holotype HMAS 352,032 (=Wu12202a), ex-type strain CGMCC 3.20648 (=NN54329).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3–5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, simple, separated or aggregated in cluster, erect, straight or slightly flexuous, brown to dark brown in the basal part, becoming paler towards the apex, cylindrical, 3-4-septate, wall thick and slightly verruculose, $60-85 \times 3-4.5 \mu m$, with a swollen basal cell of 10-13 µm wide. Conidiogenous cells integrated, terminal, polyphialidic, cylindrical, $30-38 \times 3.5-4 \mu m$, pale brown to brown, thin-walled, bearing funnel-shaped collarettes, or denticulate, very often the collarettes easily breaking off from the conidiogenous and attached to the conidial bases; collarettes 2-2.5 µm wide, 1.5-2 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, broad fusiform, ellipsoidal, straight or slightly curved, $13-15 \times 4.5-5.5 \mu m$, aseptate, hyaline to pale brown, smooth, apex acute to obtuse, with one setula at each end, 6-9 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, reverse brown to dark brown (Fig. 66u).

Other materials examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of unidentified plant, 2 January 1997, W.P. Wu (Wu1327b); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of unidentified plant, 2 January 1997, W.P. Wu (Wu1319a). Living strains: 43124 (from Wu1319a) and 43202 (from Wu1327b).

Ecology/Substrate/Host: Saprobe on dead leave of plant. Geographical distribution: China.

Notes: Nimesporella aunstrupii resembles D. aliformis, D. daphnioides, D. tropicalis, D. tumidospora and Nimesporella riisgaardii, in absence of fertile or sterile setae, ellipsoïdal and papillate conidia bearing one setula in each end (Kuthubutheen and Nawawi 1991b; Whitton et al. 2000). Among them, D. aliformis (conidia fusiform, papillate at both ends, 16-22×4-5 µm, setulae 18-22 µm long), N. riisgaardii (conidia $17-20 \times 6.5-7.5$, setulae 6.5-8 µm long) and D. tumidospora (conidia $20-28.5 \times 7-9.5 \mu m$, setulae 8–10.5 µm long) have significantly larger conidia than those in D. aunstrupii; furthermore D. aliformis has more or less fusiform conidia which are papillate at both ends, narrower and with much longer setulae than those in N. aunstrupii. Dictyochaeta tropicalis (conidia $7.5-9.5 \times 3-5 \mu m$, setulae 2.5-3.5 µm long) has much smaller conidia with shorter setulae than those in N. aunstrupii. Dictyochaeta daph*nioides* (conidia 10–15.5 \times 3.5–5.5 µm, setulae 2.7–5 µm long) and D. aunstrupii have similar sized conidia, however in the latter species, the conidial setulae are much longer and the conidiophores (up to 85 µm long) are much shorter



Fig. 89 Nimesporella daphnioides (Wu12150). **a-d** Conidiophores and conidiogenous cells. **e-i** Upper part of conidiophores with terminal conidiogenous cells. **j-z** Conidia. Scale bar: **a-d** 10 µm, **e-z** 5 µm



Fig. 90 Nimesporella riisgaardii (Wu13349, holotype). a, b Conidiophores with terminal polyphialidic conidiogenous cells. c, d Apical part of conidiogenous cells. k, l Basal part of conidiophore. m–o Upper part of conidiophores with terminal conidiogenous cells bearing sympodial proliferations. e–j Conidia. Scale bar: a–c 10 μm, d–o 5 μm

than those in *D. daphnioides* (conidiophores up to 250 μ m long). The recently described species *N. capillacea* (conidia 8–11.5×4.5–5 μ m, setulae 2–3.5 μ m long) is also similar to *N. aunstrupii*, but differs by smaller conidia and shorter setulae (Réblová et al. 2021e).

The identical ITS sequences were obtained from three strains. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 54329 include *Nimesporella capillacea* (GenBank NR_175768, 98% identity) and *N. riisgaardii* (GenBank OL654114, 94% identity).

Nimesporella daphnioides (Kuthub. & Nawawi) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 89. MycoBank MB841706.

≡ Dictyochaeta daphnioides Kuthub. & Nawawi, Mycol. Res. 95: 105, 1991.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2-4.5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, scattered or aggregated, simple, erect, straight, or slightly flexuous, 4–7-septate, medium brown to dark brown at the lower part, becoming paler towards the apex, smooth, $120-160 \times 3-4.5 \mu m$, base with a swollen and lobbed cell up to 10 µm wide. Conidiogenous cells integrated, terminal, polyphialidic with up to 6 collarettes, cylindrical, up to 60 µm long, 3.5-4.5 µm wide, pale brown, thin- and smooth-walled, denticulate, extending sympodially; Collarette tubular to somewhat cylindrical, 1–1.5 µm wide, 1–1.5 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, ellipsoidal, papillate at the basal end, straight or slightly curved, obtuse at the apex, $12-13.5 \times 4.5-6 \mu m$, aseptate, hyaline, smooth, with a setula of 4–6 µm long at each end.

Materials examined: **China**, Guangxi Province, Shangsi County, on dead leaves of unidentified plant, 31 December 1997, W.P. Wu (Wu1686b); Guangdong Province, Shaoguan, Danxiashan, on dead leaves of *Smilax* sp., 3 March 2012, W.P. Wu (Wu12150). Living strain: 54,326 (from Wu12150).

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: China and Malaysia (Kuthubutheen and Nawawi 1991b).

Description and illustration: Kuthubutheen and Nawawi (1991b); Zucconi et al. (1994).

Notes: *Nimesporella daphnioides* differs from other related species by its conidiogenous cells with tubular to somewhat cylindrical collarette, and smaller size of conidia and shorter setulae (Kuthubutheen and Nawawi 1991b; Whitton et al. 2000). It resembles *Nimesporella capillacea* (conidia 8–11.5×4.5–5 µm; setulae 2–3.5 µm long) in small sized ellipsoidal–shaped conidia, but differs from it by slightly longer setulae(Réblová et al. 2021e).

Nimesporella leomaiae (M.A. Barbosa, Malosso & R.F. Castañeda) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841707.

 \equiv *Codinaea leomaiae* M.A. Barbosa, Malosso & R.F. Castañeda, Mycotaxon 131: 424, 2016.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores solitary, cylindrical, 10-14-septate, $260-300 \times 7-9 \mu m$. Conidiogenous cells terminal, polyphialidic, $40-50 \times 4-5 \mu m$, with a few sympodial extensions and the polyphialide bears 3-6 persistent remains of the collarettes. Collarettes tubular to somewhat cylindrical, $3.5-5 \mu m$ wide, $2-5 \mu m$ deep. Conidia aseptate, broadly fusiform to eye-shaped, slightly papillate, guttulate, $10-18 \times 8.5-9.5 \mu m$, with a single, simple setulae $3.5-6 \mu m$ long at each end (Barbosa et al. 2016).

Typification: **Brazil**, Pernambuco, Tamandare, REBIO Saltinho, 8°43'S 35°11'W, alt. 85 m., on decaying leaf of an unidentified plant, 9 September 2015, coll. M.A. Barbosa (Holotype URM 88,249).

Ecology/Substrate/Host: Saprobe on decaying leaves. Geographical distribution: Brazil (Barbosa et al. 2016). Description and illustration: Barbosa et al. (2016).

Notes: *Nimesporella leomaiae* is very characteristic in producing broadly fusiform or eye-shaped, guttulate conidia with one setulae at each end (Barbosa et al. 2016).

Nimesporella queenslandica (Matsush.) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841708.

 \equiv Hyphodiscosia queenslandica Matsush., Matsush. Mycol. Mem. 6: 24, 1989.

Geographical distribution: Australia (Matsushima 1989). Description and illustration: Matsushima (1989).

Notes: *Hyphodiscosia queenslandica* Matsush. fits well to the generic concept of *Nimesporella* on both conidiogenous cells and conidia.

Nimesporella riisgaardii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 90, MycoBank MB841570.

Etymology: Named after the former CEO of Novozymes, Mr. Steen Risgaard, who made significant contribution to sustainability and also gave strong support to this work.

Diagnosis: Setae absent. Conidiophore $25-53 \times 4.5-5.5 \mu m$, 8-12-septate. Conidiogenous cells polyphialidic bearing denticulate sporulating loci, extending

sympodially, collarette inconspicuous. Conidia ellipsoidal, slightly papillate at the base, $17-20 \times 6.5-7.5 \mu m$, setulae 7–10 μm .

Typification: **China**, Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead petiole of palm, 12 June 2015, W.P. Wu, Holotype HMAS352032 (=Wu13349), ex-type strain CGMCC3.20797 (=NN59201).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2-4.5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, scattered or aggregated, simple, erect, straight, or slightly flexuous, 8-12-septate, medium brown to dark brown at the lower part, becoming paler towards the apex, smooth, $150-230 \times 5-7 \mu m$, base with a swollen and lobbed cell up to 18 µm wide. Conidiogenous cells integrated, terminal, polyphialidic with up to 6 inconspicuous collarettes, cylindrical, extending sympodially, denticulate, $25-53 \times 4.5-5.5 \mu m$, pale brown, thin- and smooth-walled, collarette inconspicuous. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, ellipsoidal, slightly papillate at the basal end, straight or slightly curved, obtuse at the apex, $17-20 \times 6.5-7.5$ µm, aseptate, hyaline, smooth to slightly verruculose, with a setula of 7-10 µm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies up to 25 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, white, grey in the central part, reverse pale brown to brown (Fig. 66v).

Other materials examined: **China**, Guangdong Province, on dead leaves of *?Smilax* sp., 9 October 1998, W.P. Wu (Wu2083j); Guangdong Province, Dinghushan, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (Wu1931); Guangdong Province, Lufushan, on dead branches of unidentified plant, 15 October 1998, W.P. Wu (Wu2017); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead culms of unidentified plant, 2 January 1997, W.P. Wu (Wu1271g). Living strains: 44,781 (from Wu1931), 45,186 (from Wu2017), 42864 (from Wu1271g), 59062, 59003 and 59081 (from Wu13349).

Ecology/Substrate/Host: Saprobe on dead leaves and branches of plants including ?*Smilax* sp.

Geographical distribution: China.

Notes: Nimesporella riisgaardii resembles Dictyochaeta tropicalis, N. aliformis, N. daphnioides, and N. tumidospora, in absence of setae and producing ellipsoidal and papillate conidia bearing one setula in each end (Kuthubutheen and Nawawi 1991b; Whitton et al. 2000). Among them, Nimesporella daphnioides (conidia 10–15.5 × 3.5–5.5 µm, setulae 2.7–5 µm long) and D. tropicalis (conidia 7.5–9.5 × 3–5 µm, setulae 2.5–3.5 µm long) have smaller conidia with shorter setulae than those in N. riisgaardii; Nimesporella tumidospora (conidia $20-28.5 \times 7-9.5 \mu m$, setulae 8–10.5 µm long) has significantly larger conidia than those in *N. riisgaardii*; while *N. aliformis* has more or less fusiform conidia which are papillate at both ends, narrower $(16-22 \times 4-5 \mu m)$ in size and with much longer $(18-22 \mu m)$ setulae than those in *N. riisgaardii*.

The ITS sequences were obtained from the seven studied strains. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 59021 include *Nimesporella aunstrupii* (GenBank OL654114, 94% identity) and *N. capillacea* (GenBank NR_175768, 95% identity).

Nimesporella tumidospora (Kuthub. & Nawawi) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841709.

≡ Dictyochaeta tumidospora Kuthub. & Nawawi, Mycol. Res. 95: 106, 1991.

Teleomorph: Unknown. Anamorph: Conidiophores solitary, cylindrical, septate, up to 400 μ m long. Conidiogenous cells terminal, polyphialidic, up to 40 μ m long, with up to 4 successive proliferations and bears the persistent remains of the lateral collarettes; collarettes funnel-shaped, 3–5 μ m wide, 3–5 μ m deep. Conidia hyaline, smooth, aseptate, ellipsoidal, papillate, guttulate, 20–28.6×7–9.5 μ m, with a single, simple setulae 8–10.5 μ m long at each end (Kuthubutheen and Nawawi 1991b).

Typification: **Malaysia**, Pahand, Bukit Rengit Forest Reserve, on decaying plant, October 1989, A.J. Kuthubutheen, IMI335263.

Ecology/Substrate/Host: Saprobe on decaying plant.

Geographical distribution: Malaysia (Kuthubutheen and Nawawi 1991b).

Description and illustration: Kuthubutheen and Nawawi (1991b).

Notes: *Dictyochaeta tumidospora* was also described from Malaysia and fits well to the concept of *Nimesporella* (Kuthubutheen and Nawawi 1991b).

Oxenbollia W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB841528.

Etymology: Named after the former mycologist Karen Oxenboll from Novozymes A/S, who gave strong support to this work.

Diagnosis: Similar to *Codinaeella* and *Tainosphaeria* in morphology of conidiophores, conidiogenous cells and conidia, but differs phylogenetically.

Type species: *Oxenbollia lunatospora* W.P. Wu & Y.Z. Diao.

Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, mononematous, simple, scattered or rarely aggregated, erect, straight, or slightly flexuous, cylindrical, dark brown and



Fig. 91 Oxenbollia lunatospora (Wu6065, holotype). a-i Conidiophores and conidiogenous cells with funnel-shaped collarettes. j-t Conidia. Scale bar: a 10 μ m, b-t 5 μ m

thick- and smooth-walled in lower part, becoming paler and thin-walled towards the apex, septate, terminating with a conidiogenous cell. Conidiogenous cells integrated, terminal, monophialidic, occasionally with 1–2 sympodial proliferation, cylindrical, pale brown to brown, thin-walled, ending in a flared collarette which is funnel-shaped. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, lunate, fusiform, curved, aseptate, hyaline, smooth, guttulate, both apex and base bear a setula.

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: China.

Notes: Phylogenetic analysis indicates that *Tainosphaeria* is a polyphyletic genus and the monophyletic generic concept was proposed with 5 lineages that correspond to particular morphologies (Réblová et al. 2021b). One strain obtained from China is grouped together with *Tainosphaeria* and related genera, but forms a distinct linkage and the new genus *Oxenbollia* is introduced for it. The absence of setae, unbranched conidiophores, terminal mono phialidic conidiogenous cells with funnel-shaped collarette, and lunate, aseptate conidia with simple setulae are the main diagnostic characters of this newly established genus. Morphologically it is very similar to member of *Codinaeella* and *Tainosphaeria* s. str.

Oxenbollia lunatospora W.P. Wu & Y.Z. Diao, sp. nov., Fig. 91, MycoBank MB841573.

Etymology: Refers to its lunate conidia.

Diagnosis: Setae absent. Conidiophores $35-60 \times 3-5 \mu m$, 1-2-septate. Conidiogenous cells $30-40 \times 3-3.5 \mu m$, monophialidic, occasionally with 1-2 sympodial proliferations, collarettes funnel-shaped. Conidia lunate, guttulate, $15-17 \times 2.5-3 \mu m$, with one setulae at each end, $6-7 \mu m$ long. Similar to *Tainosphaeria sivanesanii* but differs in longer conidiogenous cells and wider conidia.

Typification: **China**, Hubei Province, Shengnongjia, on rotten wood of unidentified plant, 14 September 2004, W.P. Wu, Holotype HMAS 352,033 (= Wu6065), ex-type strain CGMCC 3.20641 (= NN47501).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2–4 μ m wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, mononematous, scattered or rarely aggregated, simple, cylindrical, erect, straight or slightly flexuous, 1–2-septate then up to 8 septate due to percurrent proliferation and extension, medium brown to dark brown, becoming paler toward apex, wall thick, verrucose at the base, 35–60 (–115)×3–5 μ m, base with a swollen and lobbed cell up to 12 μ m wide. Conidiogenous cells integrated, terminal, monophialidic, occasionally with 1–2 sympodial and geniculate, cylindrical, subcylindrical, $30-40 \times 3-3.5 \mu m$, pale brown, thin- and smooth-walled, terminating in a funnel-shaped collarette; collarettes 2–2.5 μm wide, 1–1.5 μm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, lunate, curved, obtuse at both ends, 15–17×2.5–3 μm , aseptate, hyaline, smooth, with a setula of 6–7 μm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, brown to dark brown, with pale colored margin, reverse of the same color or slightly darker (Fig. 38m).

Ecology/Substrate/Host: Saprobe on rotten wood. Geographical distribution: China.

Notes: Among the known species in Dictyochaeta s. lat., Codinaea s. lat. and Tainosphaeria s. lat., several species resemble O. lunatospora in a similar combination of morphological characters and they are Codinaea acaciae, Codinaeella pini, C. taiwanensis, Dictyochaeta australiensis, D. coffee, D. longispora,, Tainosphaeria parva and T. vulgaris (Hughes and Kendrick 1968; Matsushima 1981; Holubová-Jechová 1984, 1988a, b; Arambarri et al. 1987a, b; Arambarri and Cabello 1990; Kuthubutheen and Nawawi 1991a; Whitton et al. 2000; Crous et al. 2014, 2015; Liu et al. 2016). Among them, D. australiensis, D. longispora, Codinaeella taiwanensis and T. vulgaris produce significant longer conidia (> 17 µm long in average); T. parva and T. vulgaris produce conidia with shorter setulae (<5 µm long); D. coffee produces wider conidia (3.4-5 µm wide); Codinaeella *pini* produces slightly shorter conidia $(13-15 \times 2-3 \ \mu m)$; Codinaea acaciae produces similar sized conidia but with much longer setulae (conidia 16–19 (–23) \times 3–4 µm; setulae 10-13 µm long), thus all these species can be distinguished from O. lunatospora.

The ITS sequences were obtained from the ex-type strains. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 47501 include *Tainosphaeria aquatica* (GenBank NR_173239, 92% identity), *T. obclavata* (GenBank NR_168797, 94% identity), *T. lunata* (GenBank NR_168796, 95% identity), *Tainosphaeriella thailandensis* (GenBank NR_173240, 90% identity), *Phialoturbella aseptata* (GenBank NR_166295, 92% identity) and *P. calva* (GenBank NR_173238, 92% identity).

Parabahusutrabeeja W.P. Wu & Y.Z. Diao, gen. nov. Myco-Bank MB841529.

Etymology: Refers to its similarity on morphology to the genus *Bahusutrabeeja*.

Diagnosis: Similar to *Codinaeella* and *Bahusutrabeeja*, but differs in conidiogenous cells with inconspicuous collarettes, and globose conidia with only one short setulae.

Type species: *Parabahusutrabeeja minima* W.P. Wu & Y.Z. Diao sp. nov.



Fig. 92 *Parabahusutrabeeja minima* (**a**-**n** Wu12460, **o**-**t** Wu12456). **a**-**g** Conidiophores with percurrent proliferations and terminal phialidic conidiogenous cells. **h**-**t** Conidia. Scale bar: **a**-**c** 10 μm, **d**-**t** 5 μm

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly superficial and partly immersed, composed of pale brown to brown, branched and septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, solitary, simple, erect, straight, or slightly flexuous, dark brown, septate, smooth-walled in the lower part, becoming strongly verruculose in the upper part, thick-walled, with a swollen basal cell, terminating in a conidiogenous cell. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, dark brown, apex medium brown, proliferating percurrently, with narrow sporulating loci, collarette indistinct. Conidia acrogenous, solitary, globose to subglobose, hyaline, smooth, with one slender apical setulae, produced in chains or accumulating in a head at the tips of the conidiogenous cells. Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Morphologically *Parabahusutrabeeja* resembles *Codinaeella* and *Bahusutrabeeja*, but differs by monophialidic conidiogenous with inconspicuous collarette and globose to subglobose conidia with only one apical setulae (Seifert et al. 2011). In addition, the conidia in *Parabahusutrabeeja* are usually formed in chain or loosely aggregated around the tips of the conidiogenous cells, but not in wet spore mass. Phylogenetic analysis based on the LSU and ITS sequences also supports the establishment of the new genus (Fig. 3, SFig. 1).

Parabahusutrabeeja minima W.P. Wu & Y.Z. Diao, sp. nov., Fig. 92, MycoBank MB841574.

Etymology: Refers to its small conidia.

Diagnosis: Setae absent. Conidiophores $100-150 \times 5-7 \mu m$, 4–5-septate, proliferating percurrently. Conidiogenous cells monophialidic, $35-40 \times 5-6 \mu m$, with a narrow sporulating loci of 1–1.5 μm wide, collarettes inconspicuous; Conidia globose to subglobose, hyaline, aseptate, in chain or accumulated in a dry spore ahead, 7–8 μm diam, bearing one short apical setulae up to 3 μm long.

Typification: **China**, Guangxi Province, Shiwandashan, on dead leaves of *Cinnamomum* sp., 30 December 1997, W.P. Wu, Holotype HMAS 352,034 (= Wu1559a), ex-type strain CGMCC 3.20654 (= NN55337).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly superficial and partly immersed, composed of pale brown to brown, branched and septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, solitary, simple, erect, straight or slightly flexuous, dark brown, 4-5-septate, smooth-walled in the lower part, becoming strongly vertuculose in the upper part, thick-walled, $100-150 \times 5-7 \mu m$, with a swollen basal cell up to 20 µm wide, terminating in a conidiogenous cell. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, dark brown, apex medium brown, $35-40 \times 5-6 \mu m$, with a narrow sporulating loci of 1–1.5 μm wide, collarette indistinct. Conidia acrogenous, solitary, globose to subglobose, hyaline, smooth, 7-8 µm diam, with one slender apical setulae up to 3 µm long, produced in chains or accumulating in a head at the tips of the conidiogenous cells.

Culture characteristics: Colonies on PDA effuse, colonies 1.5–2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, brown, with pale colored margin, reverse of the same color or slightly darker (Fig. 381).

Other materials examined: **China**, Guangdong Province, Shaoguan, Danxiashan, on dead branches of unidentified tree, 25 Dec 2012, W.P. Wu (Wu12260); Guangdong Province, Shaoguan, Danxiashan, on dead branches of unidentified tree, 25 December 2012, W.P. Wu (Wu12456, Wu12460, Wu12466); Guangxi Province, on dead leaves, 23 December 1997, W.P. Wu (Wu2095). Living strains: 55,337 (from 12,456), 55,339 (from 12,460) and 55,327 (from Wu12466).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Among the known relevant fungal species, *Bahusutrabeeja bunyensis* (conidia 7–10 µm diam, with 2–3 appendages in 5–9 µm long) is the only species with similar morphology in conidiophores, conidiogenous cells and conidia, but differs from *Parabahusutrabeeja minima* by slightly larger conidia with 2–3 setulae which are much longer than those in the latter species (McKenzie 1997).

Both LSU and ITS sequences were obtained from the single spore isolate of the type specimen and several other

specimens, and its affinity to other members of Chaetosphaeriaceae was confirmed. Based on ITS blast in NCBI's Gen-Bank, the closest matches to the ex-type strain 43967 include *Stanjehughesia kaohsiungensis* (GenBank NR_172187, 89% identity), *Tainoshphaeria crassiparies* (GenBank MW984587, 89% identity), *Calvolachnella guaviyunis* (GenBank NR_153892, 86% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the ex-type strain 43967 include *Tainoshphaeria crassiparies* (GenBank AF466089, 97% identity) and *Phialloarthrobotryum triseptatum* (GenBank MH873417, 96% identity).

Paracodinaea W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB841530.

Etymology: Refers to its similarity to Codinaea.

Diagnosis: Similar to *Codinaea* and *Codinaeella*, but differs in allantoid-shaped conidia.

Type species: *Paracodinaea japonica* W.P. Wu & Y.Z. Diao.

Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae. Setae absent. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, solitary or aggregated, simple, erect, straight, or slightly flexuous, cylindrical, dark brown and thick-walled in lower part, becoming paler and thin-walled towards the apex, septate, smooth, terminating with a conidiogenous cell. Conidiogenous cells integrated, terminal, monophialidic, extending sympodially, cylindrical, pale brown to brown, thin-walled; collarettes funnel-shaped. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, allantoidal, curved, aseptate, hyaline, smooth, both apex and base bear an unbranched setula.

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: China and Japan.

Notes: Phylogenetic analysis indicates that *Tainosphaeria* is a polyphyletic genus and the monophyletic generic concepts was proposed with 5 lineages that correspond to particular morphologies (Réblová et al. 2021b). Our phylogenetic analysis shows that several strains obtained from China and Japan are grouped together with *Tainosphaeria* and related genera, but forms a distinct linkage, and the new genus *Paracodinaea* is introduced here. Morphologically it can hardly be distinguished from *Codinaeella* and *Tainosphaeria* s. str.

Paracodinaea japonica W.P. Wu & Y.Z. Diao, sp. nov., Fig. 93, MycoBank MB841575.

Etymology: Refers to one of the localities where this fungus was originally discovered.

Diagnosis: Setae absent. Conidiophores $45-80 \times 3-4 \mu m$, 3–7-septate, extending sympodially. Conidiogenous cells terminal monophialidic, occasionally extending percurrently,



Fig.93 *Paracodinaea japonica* (Wu16901, holotype). **a–c** Conidiophores and conidiogenous cells with funnel-shaped collarettes. **d–k** Conidia. Scale bar: 5 μm

cylindrical, $16-20 \times 3-4$ µm; collarettes funnel-shaped. Conidia allantoidal, aseptate, $13-16 \times 2.2-2.6$ µm, setulae 6.5-8 µm.

Typification: **Japan**, Mie Prefecture, Tsu, Mie Center for the Arts, on dead fruit of unidentified tree, 3 October 2019, W.P. Wu, Holotype HMAS 352,035 (=Wu16913), ex-type strain CGMCC 3.20663 (=NN76395).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2-5 µm wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, solitary or aggregated, simple, erect, straight, or slightly flexuous, cylindrical, dark brown and thick-walled in lower part, becoming paler and thin-walled towards the apex, 3-7-septate, smooth, $45-80 \times 3-4 \mu m$, terminating with a conidiogenous cell. Conidiogenous cells integrated, terminal, monophialidic, occasionally extending percurrently, cylindrical, $16-20 \times 3-4 \mu m$, pale brown to brown, thin-walled; collarettes funnel-shaped, 3-4 µm wide, 2-2.5 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, allantoidal, curved, aseptate, hyaline, smooth, $13-16 \times 2.2-2.6 \,\mu\text{m}$, both apex and base bear a setula of 6.5-8 µm long,

Culture characteristics: Colonies on PDA effuse, colonies 1.5–2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium poorly developed, white, then grey to greybrown, with pale colored margin, reverse of the same color or slightly darker (Fig. 38e).

Other material examined: China, Guangdong Province, Shenzhen, Lianhuashan Park, on dead seed pods of Acacia sp., 11 November 2019, W.P. Wu (Wu17141); Guangdong Province, Shenzhen, Yangtaishan Forestry Park, on dead seed pods of Acacia sp., 17 Oct 2020, W.P. Wu (Wu17581); Guangdong Province, Shenzhen, Lianhuashan Park, on dead leaves of unidentified tree, 11 November 2019, W.P. Wu (Wu17259); Jiangsu, Wuxi, Wuxi Forestry Park, on dead fruit of Cyclobalanopsis sp. 25 August 2019, W.P. Wu (Wu16794, Wu16804, Wu16815, Wu16859, Wu16861); Zhejiang, Huaian County, Qiandaohu, on dead leaves of unidentified tree, 18 October 2018, W.P. Wu (Wu16118). Living strains: 76,395 and 76,396 (from Wu16118), 77,137 (from Wu16794), 77,156 (from Wu16804), 77,170 (from Wu16808), 77,172 (from Wu16815), 77,205 (from Wu16859), 77,185 (from Wu16861), 77,537 (rom Wu17141), 77,750 (rom Wu17259) and 78,401 (from Wu17581).

Ecology/Substrate/Host: Saprobe on dead material of plant, including *Acacia* sp. and *Cyclobalanopsis* sp.

Geographical distribution: China, Japan.

Notes: *Paracodinaea japonica* differs from other related species in *Codinaeella* and *Tainosphaeria s. str.* by its allantoid conidia with obtuse ends. The ITS and LSU sequences

were obtained from many studied strains. Based on ITS blast in NCBI's GenBank, the closest matches to the extype strain 77,392 include *Stanjehughesia kaohsiungensis* (GenBank NR_172187, 89% identity), *Tainoshphaeria crassiparies* (GenBank MW984587, 90% identity), *Stilbochaeta ramulosetula* (GenBank OL654124, 90% identity) and *S. novae-guineensis* (GenBank OL654123, 90% identity). Based on LSU blast in NCBI's GenBank, the closest matches to the strain 77,172 include *T. crassiparies* (Gen-Bank AF466089, 98% identity) and *T. cecropiae* (GenBank MW984586, 97% identity).

Stilbochaeta Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 68, 2021.

Colonies effuse, hairy, brown, composed of setae and conidiophores, occasionally ascomata. Teleomorph: Ascomata perithecial, non-stromatic, superficial, globose to subglobose, papillate, dark brown, setose; setae sterile, rounded at the apex. Ostiole periphysate. Ascomatal wall fragile, carbonaceous, two-layered. Paraphyses disappearing with age, septate, tapering, longer than the asci. Asci unitunicate, cylindrical-clavate, shortly-stipitate, apically rounded, ascal apex with a non-amyloid apical annulus. Ascospores fusiform, hyaline, transversely septate, without gelatinous sheath or appendages. Anamorph: Setae grow singly or in groups, erect, straight or flexuous, septate, brown, unbranched, apex sterile, bluntly rounded, sometimes with a terminal or several lateral phialidic openings. Conidiophores macronematous, mononematous, single or grow in fascicles, erect, straight or flexuous to slightly undulating, unbranched, septate, smooth, brown, paler toward the apex. Conidiogenous cells integrated, terminal, mono- or polyphialidic, extending percurrently and sympodially, paler than the conidiophores; collarettes flared, funnel-shaped, often slightly stipitate or tubular near the base. Conidia falcate, oblong-falcate, ellipsoidal-fusiform, curved, tapering toward both ends, slightly truncate at the base, with an inconspicuous basal scar, 0-1(-3)-septate, hyaline, with a straight or gently curved setula at each end, setulae simple, bifid or trifid, inserted terminally at the apex and subterminally at the base, conidia accumulate in slimy fascicles (Adapted from Réblová et al. 2021e).

Type species: *Stilbochaeta malaysiana* (Kuthub.) Réblová & Hern.-Restr.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Ecological distribution: Africa, Asia, the Caribbean and South America (Réblová et al. 2021b).

Description and illustration: Réblová et al. (2021e).

Notes: *Stilbochaeta* is a recently established genus for eight species of *Codinaea* s. lat. with shorter conidiophores in clusters with longer setae, and septate conidia with simple or branched setulae (Réblová et al. 2021e). The eight Fig. 94 Colony of *Stilbochaeta* species on PDA after 20 days at 25 °C. **a**, **b** *S. ejnerii* (ex-type strain 57536). **c–f** *S. malaysiana* (**c**, **d** 76,748. **e**, **f** 76,617). **g**, **h** *S. sinensis* (78,288). **i**, **j** *S. minteri* (ex-type strain 76,642). **k**, **l** *S. sinensis* (ex-type strain 54257)



accepted species are *Stilbochaeta aquatica*, *S. brevisetula*, *S. cangshanensis*, *S. malaysiana*, *S. novae-guineensis*, *S. ramulosetula*, *S. septata*. and *S. submersa*.

In our phylogenetic analysis (Fig. 3 and Supplementary Fig. 3), a total of 10 species formed the strongly supported *Stilbochaeta* clade, including *Stilbochaeta aquatica*, *S. cangshanensis*, *S. septata* and *S. submersa* and 6 undescribed species. All these species share the morphology similarity with the type species of *Stilbochaeta*, such as presence of fertile or sterile setae (except for one undescribed species), short conidiophores clustered with setae, terminal monophialidic or polyphialidic conidiogenous cell with funnelshaped collarette, and hyaline, septate, falcate to fusiform conidia bearing setulae at each end. None of these species is known with teleomorph. Morphologically it is closely related to some *Codinaea* species with clustered setae and conidiophores, but differs from it by septate conidia. Apart from the eight accepted species, here we add another five new species to the genus and ITS barcodes are provided for all of them.

Several known species with septate conidia bearing setulae might belong to this genus, including *Codinaea jingenglingensis*, *Codinaea matsushimae*, *Dictyochaeta caatingae*, *D. macrospora*, *D. variabiliis*, *Codinaea* state of *Chaetosphaeria dingleyae* (Hughes and Kendrick 1968; Matsushima 1971; Hewings and Crane 1981; Kuthubutheen 1987a, b, c, d; Crous et al. 1990; Kuthubutheen and Nawawi 1991a, b, c, d, e; Kuthubutheen et al., 1992; Whitton et al. 2000; Xia et al. 2015; Cruz et al. 2008; Réblová et al. 2021e).

Living strains of many studied species were also studied on PDA (Fig. 94), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Key to accepted species of *Stilbochaeta* (*S*.) and other known *Codinaea* (*C*.) and *Dictyochaeta* (*D*.) species which might belong to *Stilbochaeta*:

1.	Conidia 1-septate; setulae branched, bild at one end and trifid at the other, up to 18.5 µm long
	S. ramulosetula
1.	Conidia 1–3-septate: setulae simple2
2	Conidial septa variable between 1–3
2	Conidia consistently 1- or 3-septate 5
3	Setula $< 3.0 \text{ µm long: conidia 1 (rarely 2-3) sentate}$
5.	$21-245 \times 3-37$ µm setae sterile S brevisetula
3.	Setula $> 3.0 \text{ µm}$ long.
4	Conidia 1–2-septate $17-23 \times 2$ µm setulae 5 5–
	10 um S sentata
Δ	Conidia 1–3-sentate $31-38 \times 4.4-5.7$ µm; setulae
ч.	17 23 µm D variabilis
5	Conidia consistently 3-sentate
5. 5	Conidia consistently 1 sentate: setae present 10
5. 6	Sterile setae present
0. 6	Sterile setae present
0. 7	Sterile setae absent
7.	Conduce $27 - 55.5 \times 5.5 - 5.5 \mu m$; seturate 1 of 2 at each
7	end, $0.5 - 2.5 \mu\text{m}$ long
1.	Contata $20-27 \times 5.5-5.4 \ \mu\text{m}$; seturae $5.5-7.8 \ \mu\text{m}$
0	longD. matsushimae
8.	Conidia $28-4/\times 5-7$ µm; setulae $22-30$ µm
0	D. macrospora
8.	Conidia 22–32 μ m long; setulae less than 15 μ m
_	long
9.	Conidia fusiform to lunate, $22-30 \times 4-6 \mu m$; setulae
	7.5–11 longS. jianfenglingensis
9.	Conidia fusiform, $30-32 \times 4-4.5 \mu m$; setulae
	5–12.5 μm longS. ejneri
10.	Setae loosely coiled and tortuous towards apices, apex
	sterile; conidiophores up to 6-fasciculate; conidia
	$11.5 \times 1.5 \mu m$; setulae 5–7.5 μm long <i>C. tortuosa</i>
10.	Setae straight, apex sterile or fertile11
11.	Conidia 21.2–24 \times 3–3.5 µm; setulae 10–13 µm long
	S. malaysiana
11.	Conidia less than 20 µm long12
12.	Conidial setulae less than 10 µm long in average13
12.	Conidial setulae more than 10 µm long in aver-
	age0.14
	-

13.	Setae sterile; conidiogenous cell monophialidic; conidia fusiform or subcylindrical, only slightly curred: 145 , 17×18 , 2 um; catulae 7, 10 um long
	curved, $14.3-17 \times 1.8-2 \mu m$, seturae 7–10 μm long
13.	Setae sterile and with swollen apex; conidial
	$13-17 \times 2-2.5 \mu m$; setulae 4–8 $\mu m \log \dots S$. sinensis
14.	Conidia $13-20 \times 2.5-3.5 \mu m$; setulae $9-16 \mu m \log$
	S. novae–guineensis
14.	Conidia and setulae slightly shorter15
15.	Conidia 1-septate, falcate to fusiform, $12-16 \times 2 \mu m$;
	setulae 7–13 µmS. cangshanensis
15.	Conidia 0–1-septate, 2–3.5 µm wide
16.	Conidia 0–1-septate, oblong to allantoid, 14–18×
	2–3 μm; setulae 9–12 μm long <i>S. aquatica</i>

16. Conidia 0–1-septate, fusiform, 13.5–16.5×2.5–3.5 μm; setulae 10–13 μm long.....S. *submersa*

Stilbochaeta aquatica (W. Dong & H. Zhang) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 69, 2021. Figure 95 ≡ Dictyochaeta aquatica W. Dong & H. Zhang, Phytotaxa 362: 193, 2018.

Description on the natural substrate: Colonies on natural substrate, effuse, hairy, brown, with white, glistening conidial mass. Teleomorph: Unknown. Anamorph: Setae cylindrical, erect, slightly curved, septate, unbranched, smooth, 11-15-setpate, sterile, dark brown and robust at the base, fading towards the apex, apical cell with a round end, surrounded by 2-5 short conidiophores, $180-210 \times 5-6 \mu m$. Conidiophores mononematous, macronematous, brown at the base, fading to pale brown towards the apex, 4-5(-10)-septate, unbranched, cylindrical, 30–50 (-100) \times 2.5–3 µm, erect, straight or slightly curved, thin-walled, smooth, arising in groups from the bases of setae. Conidiogenous cells mono- or poly-phialidic integrated, terminal, determinate, clavate, ellipsoidal, $14.5-23 \times 3.5-4 \mu m$, collarette funnel-shaped, up to 3 μm wide, and 1.5 μ m deep. Conidia 12–13 \times 2 μ m, acrogenous, usually aggregated in slimy mass at the apex of setae, hyaline, 1-septate, oblong to allantoid, slightly curved, rounded at ends, smooth, with 8-11 µm long hair-like appendages at both ends.

Material examined: **China**, Guangdong Province, Guangzhou, South China Agriculture University, on dead fruit of *Dimocarpus longan*, 3 December 2018, W.P. Wu (16,337). Living strain: 76,652 and 76,653 (from Wu16337).

Ecology/Substrate/Host: Saprobe on dead material of plants, including *Dimocarpus longan*.

Geographical distribution: China (Wei et al. 2018), Philippine and Thailand (Réblová et al. 2021e).

Description and illustration: Wei et al. (2018); Réblová et al. (2021e).



Fig. 95 *Stilbochaeta aquatica* (Wu16337). **a**, **b** Setae and conidiophores in clusters. **e**–**g** Setae with sterile or fertile apex. **h** Upper part of setae with sterile and rounded apex. **i**, **k**, **l** Conidiophores and con-

idiogenous cells bearing funnel-shaped collarettes. **c**, **d**, **j** Part of conidiogenous cells with funnel-shaped collarettes. **m–s** Conidia. Scale bar: **a**, **b** 40 μm, **e–g** 20 μm, **c**, **d**, **h–s** 5 μm



Fig.96 *Stilbochaeta canshangensis* (Wu17344). **a, b** Setae and conidiophores in clusters. **c** Apical part of setae with sterile and rounded apex. **d–h** Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. **i** Conidia. Scale bar: **a, b** 10 μm, **c–i** 5 μm

Notes: *Stilbochaeta aquatica* was originally introduced by Wei et al. (2018) and redescribed by Réblová et al. (2021e). It is characterized by presence of sterile or fertile setae, 2–4 cylindrical and septate conidiophores clustered together with one setae, terminal mono- or polyphialidic conidiogenous cells, and hyaline, 0–1-septate, falcate to oblong-falcate conidia (14–18×2–3 µm) with one setulae (5–)8–13 µm long at each end. One of our specimens was identified as this species and the identical ITS sequence to the one from the ex-type strain was also obtained. The conidia (12–13×2 µm) from our collection are smaller than those given by Wei et al. (2018) and Réblová et al. (2021e).

Stilbochaeta cangshanensis (Z.L. Luo, K.D. Hyde & H.Y. Su) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 76, 2021. Figure 96

≡ *Dictyochaeta cangshanensis* Z.L. Luo, K.D. Hyde & H.Y. Su, Fungal Divers. 99:592, 2019.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3-4 µm wide. Teleomorph: Unknown. Anamorph: Setae sterile, simple, cylindrical, erect, straight, dark brown at the base, paler towards the apex, 7–10-septate, thick–walled, smooth, $97-168 \times 3-5 \mu m$, basal cell swollen and up to 10 µm wide, apical cell thin-walled, pale brown, with a rounded apex. Conidiophores macronematous, simple, 5-8 in cluster surrounded the base of one setae, erect, straight, or slightly flexuous, dark brown and becoming paler towards the apex, 4-6-septate, smooth- and thick-walled, $50-70 \times 3-3.5 \,\mu\text{m}$. Conidiogenous cells integrated, terminal, polyphialidic with up to 6 collarettes, subcylindrical, $15-18 \times 3.5-4 \mu m$; collarette funnel- or cup-shaped, $2-3 \mu m$ wide, 1–1.5 µm deep, proliferating percurrently through the collarette. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate or fusiform, curvate, 1-septate, hyaline, smooth, $12-16 \times 2-2.5 \,\mu\text{m}$, apex obtuse, with one setula at each end, setulae 7–13 µm long.

Typification: **China**, Yunnan Province, Cangshan Mountain, on submerged decaying wood in a freshwater stream, July 2016, H.Y. Su, S-829 (MFLU 18-1614, holotype), extype living culture MFLUCC 17-2214.

Materials examined: **China**, Beijing, Huairou, Hongluosi, on dead fruit of *Quercus* sp., 16 August 2020, W.P. Wu (Wu17344); Beijing, Huairou, on dead branches of unidentified tree, 12 September 2002, W.P. Wu (Wu01). Living strains: 47608 (from Wu01) and 77,987 (from Wu17344).

Ecology/Substrate/Host: Saprobe on dead material of plants, including *Quercus* sp.

Geographical distribution: China.

Description and illustration: Luo et al. (2019).

Notes: *Stilbochaeta cangshanensis* differs from other similar species by a combination of morphological characters of setae, conidiophores and conidia (Hughes and Kendrick 1968; Kuthubutheen and Nawawi 1990, 1991a; Whitton et al. 2000; Liu et al. 2016; Luo et al. 2019; Réblová et al. 2021e). The two specimens from our collections bear the fungus well aligned with the original description (Setae 125–175 µm long, 4.5–6.5 µm wide, sterile at the apex; Conidiophores 39–53 µm long, 3.5–4.5 µm wide; Conidia 15–18×2.5–3.5 µm wide) (Luo et al. 2019). Although the conidia from the type specimen were described as aseptate by Luo et al. (2019), but at least one septate conidium was showed in their illustration.

Stilbochaeta ejneri W.P. Wu & Y.Z. Diao, sp. nov., Fig. 97, MycoBank MB841585.

Etymology: Named after the senior employee Ejner Bech Jensen, with whom one of the authors (Wu) worked together for long period and from whom Wu also got strong support for this work.

Diagnosis: Setae absent. Conidiophores 10–14 septate, 180–285×4–7 μ m. Conidiogenous cells cylindrical, polyphialidic, 25–35×4–5 μ m, with up to 4 funnel-shaped collarettes. Conidia fusiform, subcylindrical, slightly curved, 3-septate, 30–32×4–4.5 μ m, setulae 5–12.5 μ m long.

Typification: **China**, Sichuan Province, Yaan, Wanguan, Bifengxia, on dead branches of unidentified tree, 15 December 2013, W.P. Wu, Holotype HMAS 352,056 (=Wu13224), ex-type strains CGMCC 3.20716 (=NN57536).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2-4.5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, scattered or rarely aggregated, simple, erect, straight, or slightly flexuous, 10-14-septate, medium brown to dark brown at the lower part, becoming paler towards the apex, smooth, $180-285 \times 4-7 \mu m$, base with a swollen cell up to 15 µm wide. Conidiogenous cells integrated, terminal, polyphialidic with up to 4 collarettes, cylindrical, $25-35 \times 4-5 \mu m$, pale brown, thin- and smoothwalled; collarette funnel-shaped, 3-4 µm wide, 2-3 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, fusiform, subcylindrical, slightly curved, obtuse at both ends, $30-32 \times 4-4.5 \,\mu\text{m}$, 3-septate, hyaline, smooth, with a setula of 5-12.5 µm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 0.5 cm diameter in 20 days, circular, flat, margin entire,



Fig.97 *Stilbochaeta ejnerii* (Wu13244, holotype). **a, b** Conidiophores. **c–h, m** Upper part of conidiophores and conidiogenous cells bearing funnel-shaped collarettes. **i–l, n** Conidia. Scale bar: **a–d** 20 μm, **e–n** 5 μm

aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown (Fig. 94a, b).

Other living strains: 57,537 and 57,538 (from Wu13224). Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China.

Notes: Stilbochaeta ejnerii differs from the other eight accepted species by Réblová et al. (2021e) in absence of setae, solitary and longer conidiopores, and 3-septate conidia in bigger size. All other species in the genus are with 1-septate conidia, the inclusion of S. ejnerii might support to emend the genus to include several known species with 3-septate conidia in Codinaea s. lat. and Dictyocaheta s. lat. Of the many Codinaea s. lat. and Dictyochaeta s. lat. described, only Codinaea jianfenglingensis, Dictyochaeta aciculata, D. caatingae, D. macrospora, D. matsushimae, D. variabilis and Multiguttulispora triseptata produce 3-septate conidia with or without a setula at each end (Hewings and Crane 1981; Castañeda-Ruiz 1986b; Kuthubutheen and Nawawi 1991a, d; Cruz and Gusmão 2009; Silva and Gusmão 2013; Xia et al. 2015). Presence of setae among conidiophores in D. aciculata, D. caatingae, C. jianfenglingensis and D. matsushimae easily distinguish them from Stilbochaeta ejneri. In addition, the conidia in D. aciculata are obclavate and without setulae; in D. caatingae and D. matsushimae (conidia $20-27 \times 3.3-5.4 \mu m$, setulae 5.5-7.8 μm long), the conidia are worm-shaped and with very short setulae. In Stilbochaeta ejneri, Dictyochaeta macrospora, M. triseptata and D. variabilis, the setae are absent. These species can be separated from each other by their conidial morphology (Kuthubutheen and Nawawi, 1991a, d; Whitton et al. 2000). Multiguttulispora triseptata can be easily distinguished from the other three species by its ellipsoidal-shaped conidia. The other three species with falcate to fusiform conidia can be distinguished by size of conidia and setulae: D. macrospora (conidia constantly 3-septate, 38-47×5-7 µm, setulae 22-30 µm long) and D. variabilis (conidia 1-3 septate, $30-40 \times 4.5-5.7$ µm, setulae 17–23 µm long) have significantly longer conidia and setulae than those in S. ejnerii.

The ITS and LSU sequences were obtained from several studied strains. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 57536 include *Stilbochaeta submersa* (GenBank NR_168800, 95% identity), *S. ramulosetula* (GenBank OL654124, 94% identity) and *S. novae-guineensis* (GenBank OL654123, 93% identity).

Stilbochaeta jianfenglingensis (J.W. Xia & X.G. Zhang) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841722.

 \equiv *Codinaea jianfenglingensis* J.W. Xia & X.G. Zhang, Mycotaxon 130: 835, 2015.

Teleomorph: Unknown. Anamorph: Setae solitary, erect, straight or flexuous, 3–5-septate, smooth, brown, $100-130 \times 3.4-4.5 \ \mu$ m. Conidiophores distinct, single,

erect, straight or slightly flexuous, cylindrical, smooth, thick–walled, brown, 4–7-septate, $120-200 \times 4.5-5 \mu m$. Conidiogenous cells monophialidic, integrated, cylindrical, subhyaline to pale brown, $28-50 \times 4.5-5 \mu m$; collarette, $3.5-4.5 \times 2.5-3.5 \mu m$. Conidia fusiform to lunate, 3-septate, smooth, subhyaline, $22-30 \times 4-6 \mu m$, with a filiform setula, $7.5-11.5 \mu m \log$, at each end (Xia et al. 2015).

Materials examined: **China**, Hainan Province, Jianfengling, on dead stems of unidentified broadleaf tree, 22 Apr. 2014, J.W. Xia (Isotype, HMAS 245,589).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Xia et al. 2015). Description and illustration: Xia et al. (2015).

Notes: The isotype material of *Codinaea jianfenglin*gensis in HMAS was examined by us. Morphologically it is similar to *Dictyochaeta caatingae*, *D. macrospora* and *D. matsushimae* in having 3-septate conidia, but differs in conidial size.

Stilbochaeta malaysiana (Kuthub.) Réblová & Hern.-Restr., J. Fungi 7(12, no 1097): 76, 2021. Figure 98

≡ Dictyochaeta malaysiana Kuthub. Trans. Br. Mycol. Soc. 89: 356, 1987.

Description on the natural substrate: Colonies on substrate effuse, gregarious, brown, shining. Mycelium mostly immersed, composed of branched, septate, smooth, thinwalled, brown hyphae. Teleomorph: Unknown. Anamorph: Setae cylindrical, erect, or slightly flexuous, dark brown at the base, paler towards the apex, 6-10-septate, acerose to subacerose, unbranched, smooth, $180-235 \times 4-6 \mu m$, tapering toward the apex, the upper part 3-4 µm wide. Conidiophores macronematous, 3-5 in groups from the mycelial knots and associated with 1-2 setae, brown, straight, or slightly flexuous, 3–4(–8)-septate, unbranched, cylindrical, smooth, 60-100 (-140) µm long, 3-5 µm wide, extending sympodially. Conidiogenous cells integrated, terminal, monophialidic and polyphialidic, with 3-7 collarettes, cylindrical, pale brown, thin-walled, smooth, $20-30 \times 3-3.7 \,\mu\text{m}$; collarettes funnel-shaped, 3.5-4.2 µm wide and 2-2.5 µm deep. Conidia acrogenous, solitary, aggregating in a globose mass at apex of conidiophore, 1-septate, fusiform, falcate, slightly curved, guttulate, $21.2-24 \times 3-3.5 \mu m$, with one setulae at each end, 10–13 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1.2–2.5 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, white to soil brown, with pale colored margin, reverse dark yellow brown, slightly paler towards the margins (Fig. 94c, f).

Material examined: **China**, Guangdong, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (Wu16288); Guangdong, Guangzhou, South China Botanical Garden,



Fig. 98 *Stilbochaeta malaysiana* (Wu16288). **a–d** Setae and conidiophores in cluster. **e, f** Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. **g–k** Conidia. Scale bar: **a–d** 20 μm, **e–k** 10 μm



Fig. 99 *Stilbochaeta minteri* (Wu16270, holotype). **a–e** Setae and conidiophores in clusters. **f**, **i**, **j** Conidiophores and conidiogenous cells. **g**, **h** Setae with sterile and rounded apex. **k–o** Conidia. Scale bar: **a–e** 20 µm, **f–o** 10 µm

on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (HMAS352057 = Wu16279). Living strains: 76,749 (from Wu16288b), CGMCC 3.20665 (= NN76617, from Wu16288a), ex-type strain CGMCC 3.20666 (= NN 76,748) and 76,751 (from Wu16279).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China and Malaysia (Réblová et al. 2021b).

Notes: *Stilbochaeta malaysiana* differs from other known species in the genus by a combination of large conidia $(21.2-24 \times 3-3.5 \ \mu\text{m})$ and longer setulae $(10-13 \ \mu\text{m})$ (Réblová et al. 2021e). *Stilbochaeta brevisetula* (conidia $21-24.5 \times 3-3.3.7 \ \mu\text{m}$, setulae $1.4-2.7 \ \mu\text{m}$) and *S. septata* (conidia $17.5-23 \times 2 \ \mu\text{m}$, setulae $5.5-10 \ \mu\text{m}$) produce uniseptate conidia in similar size as *S. lingnanensis*, but differs from it by shorter setulae (Réblová et al. 2021e). The ITS and LSU sequences obtained in this study are almost identical (>99% identity) to those from the ex-type strain.

Stilbochaeta minteri W.P. Wu & Y.Z. Diao, sp. nov., Fig. 99, MycoBank MB841588.

Etymology: Named after the former IMI mycologist David Minter.

Diagnosis: Setae sterile, $150-175 \times 4-5.5 \mu m$, 7-10-septate, apex rounded. Conidiophores $60-80 \times 3-3.5 \mu m$, 3-7 in group associated with one setae, 3-6-septate. Conidiogenous cells with terminal monophialidic or occasionally polyphialidic, bear 1-3 funnel-shaped collarettes, extending sympodially. Conidia fusiform or subcylindrical, slightly curved, uniseptate, $14.5-17 \times 1.8-2 \mu m$; setulae $7-10 \mu m$ long.

Typification: **China**, Guangdong, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu, Holotype HMAS 352,059 (=Wu16270), ex-type strain CGMCC 3.20732 (=NN76642).

Description on the natural substrate: Colonies on substrate effuse, gregarious, brown. Mycelium mostly immersed, composed of branched, septate, smooth, thinwalled, brown hyphae. Teleomorph: Unknown. Anamorph: Setae 150-175 µm long, 4-5.5 µm wide, erect, dark brown at the base, paler towards the apex, 7–10-septate, acerose to subacerose, unbranched, smooth, basal cell swollen and 10-13 µm wide, tapering toward a rounded sterile apex of 3-3.5 µm wide. Conidiophores macronematous, mononematous, 60-80 µm long, 3-3.5 µm wide, 3-7 in group from the mycelial knots from the bases of setae, short, brown, straight, or slightly flexuous, 3-6-septate, unbranched, cylindrical, smooth, terminating with a monophialidic conidiogenous cell. Conidiogenous cell monophialidic, or occasionally polyphialidic, bear 1-3 funnel-shaped collarettes, terminal, cylindrical, $2228 \times 3-3.5 \mu m$, pale broth, smooth- and thinwalled, extending sympodially; collarette funnel-shaped, up to 1.5 μ m wide and 2–2.5 μ m deep. Conidia acrogenous, solitary, aggregating in a globose mass at apex of conidiophore, cylindrical or fusiform, 1-septate, slightly curved, 14.5–17 × 1.8–2 μ m, with a slightly truncate base and a rounded apex, bearing one unbranched setulae at each end, 7–10 μ m long.

Culture characteristics: Colonies on PDA effuse, colonies 0.8 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, yellow to soil brown, reverse brown to dark brown (Fig. 94i, j).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China.

Notes: Morphologically *Stilbochaeta minteri* resembles *S. aquatica* (conidia 14–18×2–3 µm, setulae 8–13 µm), *S. sinensis* (conidia 13–17×2–2.5 µm, setulae 4–8 µm) and *S. submersa* (conidia 13.5–16.5×2.5–3.5 µm; setulae 8–13 µm), but differs from them by a combination of different characters of conidiophores, conidiogenous cells and conidia (Kuthubutheen and Nawawi 1991a; Whitton et al. 2000; Wei et al. 2018; Luo et al. 2019; Réblová et al. 2021e).

The ITS sequence was obtained from the ex-type strain. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 76,642 include *Stilbochaeta aquatica* (GenBank NR_158452, 96% identity), *S. submersa* (Gen-Bank NR_168800, 96% identity), *S. novae-guineensis* (Gen-Bank OL654123, 97% identity) and *S. ramulosetula* (Gen-Bank OL654124, 96% identity).

Stilbochaeta sinensis W.P. Wu & Y.Z. Diao, sp. nov., Figs. 100–101, MycoBank MB841589.

Etymology: Refers to the locality where this fungus was originally discovered.

Diagnosis: Setae cylindrical, $60-150 \times 4-4.5 \mu m$, 7–10-septate, with a sterile and swollen apex. Conidiophores up to 4 around the base of 1 setae, 2–3-septate, $30-60 \times 3-4 \mu m$. Conidiogenous cells monophialidic or polyphialidic, cylindrical, $20-28 \times 3.5-4.5 \mu m$, extending sympodially; collarette funnel-shaped, 3–3.5 μm wide, 2.5–3.55 μm deep. Conidia falcate, slightly curved, $13-17 \times 2-2.5 \mu m$, uniseptate, setulae 4–8 μm long.

Typification: **China**, Guangdong Province, Zhaoqing, Dinghushan, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu, Holotype HMAS 352,060 (=Wu12195), ex-type strain CGMCC 3.20713 (=NN54257).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of $3-5 \mu m$ wide. Teleomorph: Unknown. Anamorph: Setae straight, arising mostly single, erect, straight, or flexuous, cylindrical, smooth– and thick–walled, 60–150 μm long, 4–4.5 μm wide above the swollen base, 7–10-septate, dark brown in the lower part, becoming paler towards the



Fig. 100 *Stilbochaeta sinensis* (Wu16101). **a**, **b** Setae and conidiophores in clusters. c-e Setae with sterile and swollen apex. f-i Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. j-p Conidia. Scale bar: 5 μ m



Fig. 101 *Stilbochaeta sinensis* (Wu17536). **a–c** Sterile setae clustered with conidiophores, which have terminal phialidic conidiogenous cells with funnel-shaped collarettes. **d** Setae with sterile and swol-

len apex. e, f conidiophores with terminal condiogenous cell. g–l Conidia. Scale bar: a, b 10 $\mu m,$ f, g, c–l 5 μm

apex, apex swollen, rounded and sterile. Conidiophores macronematous, simple, up to 4 around the base of 1 setae, erect, straight, or slightly flexuous, brown in the basal part, becoming paler towards the apex, 2–3-septate, thin- and smooth-walled, $30-60 \times 3-4$ µm. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, cylindrical, $20-28 \times 3.5-4.5$ µm, pale brown, thin-walled, extending sympodially; collarette funnel-shaped, 3–3.5 µm wide, 2.5–3.55 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, slightly curved, $13-17 \times 2-2.5$ µm, uniseptate, hyaline, smooth, apex obtuse, base slightly truncate to obtuse, with one setulae at each end, 4–8 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, dark soil brown, with pale colored margin, reverse yellow brown (Fig. 94g, h).

Other materials examined: China, Guangdong Province, Guangzhou, South China Botanical Garden, on dead fruit of unidentified tree, 28 February 2016, W.P. Wu (Wu16236); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (Wu16263, Wu16267, Wu16272, Wu16278); Guangxi Province, Nanning, Nanning Subtropical Botanical Garden, On dead fruit of palm tree, 15 November 2013, W.P. Wu (Wu13079); Guangxi Province, Nanning, Nanning Subtropical Botanical Garden, on dead leaves of unidentified tree, 15 November 2013, W.P. Wu (Wu13144); Guangdong Province, Shenzhen, Yangtaishan, on dead leaves of unidentified board leaf tree, 17 October 2020, W.P. Wu (Wu17536, Wu17478, Wu17480); Guangdong Province, Guangzhou, Orchard Garden, on dead leaves of Eucalyptus sp., Dec 29 2012, W.P. Wu (Wu12435a, 12435b); Guangxi Province, Shiwandashan, on dead branches of Eucalyptus sp., 31 December 1997, W.P. Wu (Wu1593a, Wu1594g, Wu1602f); Hubei province, Shengnongjia, on dead leaves of unidentified plant, 17 September 2004, W.P. Wu (Wu8286b); Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead fruit of Cyclobalanopsis sp., 25 August 2019, W.P. Wu (Wu16806, Wu16810, Wu16811, Wu16871); Yunnan Province, Xishuangbanna, on dead leaves of unidentified tree, 12 June 2018, Yu Zhang (Wu15172). Zhejiang Province, Huaian County, Qiandaohu, on dead leaves of unidentified tree, 18 October 2018, W.P. Wu (Wu16099, Wu16101, Wu16102); Zhejiang Province, Huaian County, Qiandaohu, on dead pod of Leguminosae, 18 October 2018, W.P. Wu (Wu16162). Living strains: 43750 (from Wu1593a), 55,322 and 55,280 (from Wu12435), 57,391 (from Wu13079), 57,446 (from Wu13144), 76,325 (from Wu16099), 76,326 (from Wu16101), 76,356 (from 16,102), 76,374 (from Wu16162), 76,571 (from Wu16236), 76,590 (from Wu16263), 76,692 (from Wu16267), 76,599 (from Wu16272), 77,230 (from Wu16806), 77,158 (from Wu16810), 77,231 (from Wu16811), 77,238 (from Wu167=871), 76,394 (from Wu16101a), 76,426 (from Wu16102a), 76,462 (from Wu16102a1), 76,375 (from Wu16162a), 76,607 and 76,608 (from Wu16278), 77,230 (from Wu16806), 76,002 and 76,007 (from Wu15172), 78,238 (from Wu17478), 78,240 (from Wu17480) and 78,288 (from Wu17536),

Ecology/Substrate/Host: Saprobe on dead material of plants, including leaves, seed and branches of *Cyclobalanopsis* sp. and *Eucalyptus* sp.

Geographical distribution: China.

Notes: Stilbochaeta sinensis resembles S. brevisetula (conidia $21-24 \times 3-3.7 \mu m$, setulae less than 3 $\mu m \log$) in producing sterile setae with swollen apex, but differs in conidia with longer setulae (Réblová et al. 2021e). Morphologically S. sinensis also resembles Dictyochaeta anamorph of Chaetosphaeria dingleyae, S. malaysiana, and S. novaeguineensis in producing sterile setae and 1-septate conidia bearing one single setulae at each end (Hughes and Kendrick 1968; Kuthubutheen and Nawawi 1991a; Whitton et al. 2000; Réblová et al. 2021e). Among them, S. malaysiana (conidia $24-32 \times 3-4 \mu m$, setulae up to 18 μm long) and S. novae-guineensis (conidia $13-20 \times 2.5-3.5 \mu m$, setulae 5–10 µm long) have significantly larger conidia than those from S. sinensis. Dictyochaeta anamorph of Chaetosphaeria dingleya has similar sized conidia $(14-17 \times 1.8-2.7 \,\mu\text{m}, \text{set-}$ ulae 11–13 µm) as S. sinensis, but the conidia in this species have much longer setulae than those in S. sinensis (Hughes and Kendrick 1968; Matsushima 1971; Kuthubutheen 1987c).

The ITS sequences were obtained from many studied strains and they are almost identical (>99% identity). Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 54257 include *Stilbochaeta submersa* (GenBank NR_168800, 95% identity), *S. aquatica* (GenBank NR_158452, 94% identity), *S. septata* (GenBank MH107889, 94% identity).

Stilbochaeta submersa (Z.L. Luo, K.D. Hyde & H.Y. Su) Réblová & Hern.-Restr., J. Fungi 7(12, no. 1097): 84, 2021. Figure 102

 \equiv Dictyochaeta submersa Z.L. Luo, K.D. Hyde & H.Y. Su, Fungal Divers. 99: 597, 2019.

Description on the natural substrate: Saprobic on submerged decaying wood. Colonies on the substratum superficial, effuse, greyish brown, shining. Mycelium partly immersed, partly superficial, consisting of branched, septate, brown, smooth hyphae. Teleomorph: Unknown. Anamorph: Setae erect, cylindrical, straight, septate, unbranched, pale brown to brown. Conidiophores 62-122(-152) µm long, 3-5 µm wide, macronematous, mononematous, erect, solitary or in small groups, unbranched, cylindrical, 4–6-septate, straight, or slightly flexuous, pale brown, smooth.



Fig. 102 *Stilbochaeta submersa* (Wu8101). **a–d** Setae with sterile and rounded apex. **g** Setae and conidiophores in cluster. **e**, **f**, **h–k** Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. **l–p** Conidia. Scale bar: **a–e**, **g** 10 µm, **f**, **h–p** 5 µm

Conidiogenous cells monophialidic, terminal, determinate, subhyaline, narrowing below the collarette. Conidia 13.5–16.5 μ m long, 2.5–3.5 μ m wide, acrogenous, solitary, aggregating in a globose mass at apex of conidiophore, fusiform, curved, rounded and narrow at both ends, with polar appendages, aseptate, hyaline, smooth-walled; setulae 8–13 μ m long.

Materials examined: **China**, Hubei Province, Shengnongjia, on dead leaves of unidentified tree, September 2004, W.P. Wu (Wu8101); Yunnan Province, Baoshan, Lujiang, Bawan, Gaoligongshan, on dead branches of unidentified tree, 15 Oct 2003, W.P. Wu (Wu7302). Living strains: 47791 (from Wu7302) and 47996 (from Wu8101).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Luo et al. 2018; Réblová et al. 2021b).

Description and illustration: Luo et al. (2019); Réblová et al. (2021e).

Notes: *Stilbochaeta submersa* differs from several morphologically similar species such as *D. malysiana* and *D. novae-guneensis* by its smaller conidia (Hughes and Kendrick 1968; Matsushima 1975; Kuthubutheen 1987c; Kuthubutheen and Nawawi 1991a, b, d, e; Whitton et al. 2000; Liu et al. 2016; Wei et al. 2018).

Apart from the 11 accepted species from Réblová et al. (2021e) and this study, the following *Codinaea/Dictyochaeta* species morphologically fit well to the generic concept of *Stilbochaeta* in producing sterile or fertile setae, clustered conidiophores with setae, terminal mono- or poly-phialidic conidiogenous cells with funnel-shaped collarette, and hyaline, septate conidia with one setulae at each end.

Dictyochaeta caatingae A.C. Cruz & Gusmão, Mycotaxon 106: 16, 2008.

Geographical distribution: Brazil (Cruz et al. 2008).

Description and illustration: Cruz et al. (2008).

Notes: *Dictyochaeta caatingae* differs from other *Codinaea/Dictyochaeta/Stilbochaeta* species by sterile setae with acute apex, monophialidic conidiogenous cells, and fusiform, 3-septate conidia $(27-35.5 \times 3.3-5.5 \ \mu m)$ with very short setulae $(0.5-2.5 \ \mu m \ long)$.

Dictyochaeta macrospora Kuthub. & Nawawi, Mycol. Res. 95: 248, 1991.

Geographical distribution: Malaysia (Kuthubutheen and Nawawi 1991d).

Description and illustration: Kuthubutheen and Nawawi (1991d).

Notes: *Dictyochaeta macrospora* is characterized by polyphialidic conidiogenous cells with funnelshaped collarettes, and hyaline, falcate, 3-septate conidia $(38-47 \times 5-7 \mu m)$ with a setula 22–30 μm at each end. *Codinaea matsushimae* Hewings & J.L. Crane, Mycotaxon 13: 423, 1981.

≡ *Dictyochaeta matsushimae* (Hewings & J.L. Crane) Aramb. & Cabello, Mycotaxon 34: 682, 1989.

≡ *Dictyochaeta matsushimae* (Hewings & J.L. Crane) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 140, 2000.

Setae cylindrical, up to 20-septate, dark brown, pale brown to subhyaline at bluntly rounded apex, up to 340 μ m high. Conidiophores cylindrical, associated with setae, septate. Conidiogenous cells terminal, mono- or poly-phialidic, 14–27×3–6 μ m; collarettes funnel-shaped, extended sympodially. Conidia fusiform, symmetrical, 3-septate, rarely 1- or 2-septate, 20–27×3.3–5.4 μ m; setulae 5.5–7.8 μ m.

Geographical distribution: USA (Hewings and Crane 1981).

Description and illustration: Hewings and Crane (1981).

Codinaea tortuosa B. Sutton, Proc. R. Soc. Qld. 91: 16, 1980.

≡ Dictyochaeta tortuosa (B. Sutton) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 150, 2000.

Geographical distribution: Australia (Sutton 1980a, b). Description and illustration: Sutton (1980a, b).

Notes: The setae of this species are simple and loosely coiled and tortuous towards the sterile apex, the conidiophores are up to 6-fasciculate with one setae, and the conidia are $11.5 \times 1.5 \,\mu\text{m}$ and with a 5–7.5 μm long setula at each end.

Dictyochaeta variabilis Kuthub. & Nawawi, Mycol. Res. 95: 1216, 1991.

Geographical distribution: Malaysia (Kuthubutheen and Nawawi 1991e).

Description and illustration: Kuthubutheen and Nawawi (1991e).

Notes: *Dictyochaeta variabilis* differs from other species by absence of setae, cylindrical and septate conidiophores with percurrent proliferations, and falcate, 3-septate conidia $(30-40 \times 4.5-5.7 \ \mu m)$ with a setula 17–23 μm long at each end.

Tainosphaeria F.A. Fernández & Huhndorf, Fungal Divers. 18: 44, 2005.

Colony effuse, brown to dark brown. Mycelium composed of partly immersed and partly superficial, hyaline to pale brown, septate, erect hyphae with glistening conidial masses at their apices. Teleomorph: Ascomata subglobose to ovoid. Paraphyses simple, septate, hyaline. Asci unitunicate, cylindrical, stipitate, with an apical ring. Ascospores hyaline, septate. Anamorph: Asexual morph Conidiophores superficial, macronematous, mononematous, erect, unbranched, brown to dark brown below half, pale brown towards the apex, septate, smooth-walled. Conidiogenous cells monophialidic, integrated, terminal, determinate. Conidia fusiform or cylindrical, aseptate, gently curved, rarely straight, hair-like appendages at both ends, hyaline, smooth, thin–walled.

Type species: *Tainosphaeria crassiparies* F.A. Fernández & Huhndorf.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Ecological distribution: Broadly distributed (Réblová et al. 2021b).

Description and illustration: Fernández and Huhndorf (2005).

Notes: The genus Tainosphaeria was created to accommodate T. crassiparies found on Hymenia pod and on erumpent stromata of overmatured ascomycetes from Puerto Rico (Fernández and Huhndorf, 2005). It is characterized by subglobose to ovoid ascomata, simple, septate, hyaline paraphyses, unitunicate, cylindrical, pedicellate asci, with an apical ring, and hyaline, septate ascospores. Apart from the teleomorph state, the anamorph state similar to Codinaea/Dictyochaeta was also described for the type species in the original description (Fernández and Huhndorf 2005; Liu et al. 2016; Lin et al. 2019; Luo et al. 2019). Since then 8 more species, have been added into the genus, and they are T. aquatica, T. aseptata, T. jonesii, T. lunata, T monophialidica, T. obclavata, T. siamensis J, and Tainosphaeria thailandensis. All these species were described with only anamorphic states with cylindrical conidiophores, terminal phialidic conidiogenous cells, and hyaline, aseptate, setulate or asetulate conidia in various shapes.

Recent phylogenetic analysis showed that the genus Tainosphaeria is polyphyletic (Lin et al. 2019; Luo et al. 2019; Hyde et al. 2020; Li et al. 2021; Réblová et al. 2021b, e). In a recent paper, Réblová et al. (2021b, e) accepted 6 monophyletic genera in the *Tainosphaeria* clades on the phylogenetic tree generated by using the integrated ITS and LSU data: Anacacumisporium, Flectospora, Tainosphaeria s. str., Phialogeniculata, Phialoturbella, and Tainosphaeriella. Each of these genera is also morphologically distinct from each other. Under this concept, Tainosphaeria was separated into three monophyletic genera: Tainosphaeria s. str. for Tainosphaeria crassiparies (the type species), T. cecropiae, T. jonesii, T. monophialidica, T. parva, T. siamensis, T. simplex and T. vulgaris with macronematous, solitary, simple conidiophores, usually monophialidic conidiogenous cells, and falcate, setulate conidia; Phialoturbella for Tainosphaeria aseptata and T. lunata, characterized by macronematous, solitary or crowded, simple conidiophores with mono- occasionally polyphialidic conidiogenous cells and aseptate, falcate to lunate conidia without setulae; Phialogeniculata for Tainosphaeria obclavata, characterized by conidiogenous cells with sympodial proliferations, and obclavate and septate conidia without setulae; and *Tainosphaeriella* for *Tainosphaeria* aquatica and *T. thailandensis*, characterized by 1–3-septate conidia with one setulae at each end. Our phylogenetic analysis (Fig. 3 and Supplementary Fig. 4) support this treatment. In addition, several genera are added into this clade from our study, including *Calceisporiella*, *Parabuhu-sutrabeeja* and *Paracodinaea*.

Species of *Tainosphaeria* s. str. are reported as saprobic on decaying or submerged wood (Fernández & Huhndorf 2005; Liu et al. 2016). Among the accepted species, only *T. jonesii*, is known from China (Lu et al. 2016; Luo et al. 2019). Five new species are added into the genus from this study. Living strains of many studied species were also studied on PDA (Fig. 103), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species. *

Key to accepted species of Tainosphaeria

1. Conidiophores verruculose; conidiogenous cells monophialidic; conidia falcate, fusiform, straight or slightly curved, $10-14 \times 2-2.5 \,\mu\text{m}$; setula of 2.5–5 μm long.....T. verrucophora 1. Conidiophores smooth.....2 2. Conidia falcate, tapering towards both ends, slightly truncate at the basal hilum; two kinds: conidia without se-tulae $15.5-21 \times 2.5-3.5 \mu m$, conidia with setulae $16-19 \times 2.5-3 \mu m$, setulae straight or gently curved 6.5–8.5 μm long.....*T. cecropiae* 2. Conidia one kind, always with setulae at both ends...3 3. Conidia longer than 15 µm long......4 3. Conidia less than 15 µm long......9 4. Conidiophores 5-6.4 µm wide; conidia naviculate to fusiform or cylindrical, 17.5-20.5 × 3.2-3.4 µm; setulae 7.8–9.1 µm long......*T. jonesii* 4. Conidiophores less than 5 µm wide; conidia slightly shorter.....5 5. Conidial setulae 2–5 µm long......6 5. Conidial setulae longer than 5 µm in average......7 6. Conidia $17-23 \times 2-2.7 \mu m$; setulae $3-5 \mu m \log \ldots$T. vulgaris Conidia $11-17 \times 2.5-3.1 \,\mu\text{m}$; setulae $2-4 \,\mu\text{m}$ 6.*T. parva* 7. Conidia $14-19 \times 2.5-3 \mu m$; setulae $6-8 \mu m \log \dots$T. simplex and T. sivanesanii 7. Conidial setulae up to 10 µm long......8 8. Conidiophores $33-102 \times 2.7-4.8 \mu m$; conidiogenous cells $20-46 \times 2.7-4.3 \ \mu\text{m}$; conidia ellipsoidal, long fusi-form, $14-19 \times 2.3-3.5 \mu m$; setulae 7-10 μm long.....T. monophialidica 8. Conidiophores $40-86 \times 2.5-4$ µm; conidia cylindrical or long fusiform, straight or slightly curved,



Fig. 103 Colony of *Tainosphaeria* species on PDA after 20 days at 25 °C. **a**, **b** *T. cupulata* (ex-type strain 78,378). **c**, **d** *T. microsperma* (ex-type strain 76,340). **e**, **f** *T. phialogeniculata* (ex-type strain

 $13.5-19 \times 2-3.5 \ \mu\text{m}$; setulae 3.6-10 μm long.....

-T. siamensis
- Conidiophores 50–105×2–3 μm, with both sympodial and percurrent proliferations. Conidiogenous cells mon-ophialidic or polyphialidic, cylindrical, 25–30×2.5–3 μm; Conidia fusiform, 9–13.5×2.5– 2.8 μm; setulae 3–4 μm long......*T. microsperma*
- 9. Conidia slightly larger; setulae longer than 5 μm......10
- Conidiophores 87–121×2.7–4.5 μm; conidiogenous cells cylindrical, monophialidic, with percurrent prolifer-ations, 27–35×2.5–3.5 μm; Conidia falcate, 10.5–14.8×2–3; setulae 4–8.5 long.....*T. crassiparies*
- 10. Conidiophore and conidiogenous cell shorter (20– 25×2.5 –2.8 µm), no percurrent proliferation......11

76,036). **g**, **h** *T. verrucophora* (ex-type strain 78,530). **i**, **j** *T. sivanesa-nii* (ex-type strain 78,406). **k–t** *T. jonesii* (**a–l** 44,886, **m, n** 43723, **o**, **p** 44,639, **q**, **r** 44,886, **s**, **t** 44,639)

- 11. Conidiophores 2–3–septate, $30-55 \times 2.5-3.5 \mu m$. Conidiogenous cells cylindrical, with 1–3 sympodial prolife-ration; collarette funnel–shaped, $1.5-2 \mu m$ deep, 2–2.5 μm wide; conidia fusiform, $14-15 \times 1.7-2 \mu m$; setulae 5–6 μm long.....*T. phialogeniculata*

Tainosphaeria cupulata W.P. Wu & Y.Z. Diao, sp. nov., Fig. 104, Mycobank MB841590.

Etymology: refers to its cup-shaped collarettes.



Fig. 104 *Tainosphaeria cupulata* (Wu17579, holotype). a–l Conidiophores and conidiogenous cells with funnel-shaped collarettes. m–o Conidia. n Low part of conidiophores in groups. Scale bar: a-c 10 μ m, d-o 5 μ m

Diagnosis: similar to *Tainosphaeria jonesii*, but differs in monophialidic conidiogenous cell with cup-shaped collarettes and slightly longer conidia and setulae.

Typification: **China**, Guangdong Province, Shenzhen, Yangtaishan Forest Park, on decaying seed pod of *Acacia* sp., 17 October 2020, W.P. Wu, Holotype HMAS 352061 (= Wu17579), ex-type strain CGMCC 3.20761 (= NN78738).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2-4 µm wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, solitary or 2-3 in groups, simple, erect, straight, or flexuous, brown but becoming paler towards the apex, 1-4-septate, smoothand thick-walled, $42-85 \times 2-2.5 \mu m$, basal cell up to 5 μm wide. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, $22-26 \times 2.5-2.8 \mu m$; collarette cup-shaped, 2.8–3.8 µm deep, 3–4.5 µm wide. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, fusiform, lunate, slightly curved, aseptate, hyaline, smooth, $13.9-14 \times 2-2.2 \,\mu\text{m}$, apex obtuse, base slightly truncated or obtuse, with one setula at each end, 5-8 µm long.

Culture characteristics: Colonies on PDA effuse, colonies up to 1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown (Fig. 103a, b).

Other material examined: **China**, Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead seed pod of *Acacia* sp., 17 October 2020, W.P. Wu (Wu17584). Living strains: 53,392 (from Wu11026) and 78,380 (from Wu17584).

Ecology/Substrate/Host: Saprobe on decaying seed pod of *Acacia* sp.

Geographical distribution: China.

Notes: *Tainosphaeria cupulata* is similar to *T. jonesii*, but differs in producing monophialidic conidiogenous cells with deeper and wider cup-shaped collarettes, and slightly longer conidia and setulae (Liu et al. 2016).

Tainosphaeria jonesii Y.Z. Lu, J.K. Liu & K.D. Hyde, Mycosphere 7: 1328, 2016. Figure 105

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2–4 µm wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, simple, erect, straight, or flexuous, dark brown but becoming paler towards the apex, 2–8-septate, smooth- and thick-walled, up to 240 µm long, 2.5–3.5 µm wide, extending sympodially and percurrently. Conidiogenous cells integrated, terminal then becoming intercalary due to proliferation, monophialidic, subcylindrical, up to 40 μ m long, 2.5–3.5 μ m wide; collarette funnel-shaped, 2–2.5 μ m wide, 1–1.5 μ m deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, fusiform, falcate, aseptate, hyaline, smooth, 11.5–13 (–15)×2–2.5 μ m, apex acute or obtuse, with one setulae at each end, setulae 3–4.5 μ m long.

Culture characteristics: Colonies on PDA effuse, colonies 1–3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, grey to grey-brown, reverse brown to dark brown (Fig. 103k–t).

Materials examined: China, Guangdong Province, Guangzhou, Orchard Garden, on dead leaves of Eucalyptus sp., 29 December 2012, W.P. Wu (Wu12454); Guangdong Province, Lufushan, on rotten wood, 14 October 1998, W.P. Wu (Wu1981b); Guangdong Province, Zhaoqing, Dinghushan, on dead fruit of palm, 3 March 2012, W.P. Wu (Wu12141a); Guangdong Province, Dinghushan, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (Wu1872c); Guangdong Province, Shenzhen, Lianhuashan, on dead seed of Acer sp., 15 November 2019, W.P. Wu (Wu17141); Guangdong Province, Shenzhen, Lianhuashan, on dead seed of unidentified tree., 15 November 2019, W.P. Wu (Wu17259); Guangdong Province, Shenzhen, Yangtaishan Park, on dead fruit of mongo, 18 October 2020, W.P. Wu (Wu17422); Guangdong Province, Shenzhen, Yangtaishan Park, on dead fruit of Acacia sp., 17 October 2020, W.P. Wu (Wu17483, Wu17486, Wu17581); Guangxi Province, Nangning, on dead leaves of Eucalyptus sp., 3 Jan 1998, W.P. Wu (Wu1612b); Hainan Province, Sanya, Yalongwan Park, on dead leaves of unidentified tree, 28 December 2020, W.P. Wu (Wu17651); Hunan, Zhangjiajie, on dead leaves of unidentified tree, 15 October 2010, W.P. Wu (Wu11026); Zhejiang Province, Huanan County, Qiandaohu, on dead leaves of unidentified tree, 18 October 2018, W.P. Wu (Wu16140). Living strains: 43723 (from Wu1612b), 44,886 (from Wu1981b), 44,639 (from Wu1872c), 53,373 and 54,367 (from Wu12141), 54,367 (from Wu12141), 55,286 (from Wu12454), 76,369 (from Wu16140), 76,370 (from Wu16140a), 77,537 (from Wu17141), 77,750 (from Wu17259a), 78,328, 78,424 and 78,425 (from Wu17651), 78,242 (from Wu17483), 78,246 (from Wu17486), 78,329 (from Wu17423), 78,189 (from Wu17422) and 78,401 (from Wu17581).

Ecology/Substrate/Host: Saprobe on dead plant material, including *Eucalyptus* sp.

Geographical distribution: China (Luo et al. 2016).

Description and illustration: Lu et al. (2016).

Notes: *Tainosphaeria jonesii*, originally described from decaying wood in freshwater stream from Guangxi, China, is characterized by absence of stroma and setae, macronematous conidiophores, terminated and polyphialidic conidiogenous cells with conspicuous funnel-shaped collarettes



Fig. 105 *Tainosphaeria jonesii* (Wu17259). **a–g** Conidiophores and conidiogenous cells with funnel-shaped collarettes. **h–n** Conidia. Scale bar: **a, b** 10 μm, **c–n** 5 μm



Fig. 106 *Tainosphaeria microsperma* (Wu16152, holotype). **a–f** Conidiophores and conidiogenous cells with funnel-shaped collarettes. **g–y** Conidia. Scale bar: **a, b** 10 μm, **c–y** 5 μm

and percurrent proliferation, and fusiform conidia with one setula at each end (Lu et al. 2016). Tainosphaeria jonesii (conidia $14-19 \times 2-3 \mu m$; setulae $6-8.5 \mu m \log$) was originally described with larger conidia than those in T. crassiparies (conidia $10.5-14.8 \times 2-3 \mu m$; setulae $4-8.5 \mu m$ long), the type species of the genus. However, in this study, a total of 21 specimens collected from different localities in China were studied and they showed some variation. The ITS sequences were obtained from 28 strains are with high identity (>99%). The conidia from these specimens are with broad variation in size and in general smaller than those from the original description. We found tht morphologically T. jonesii can be hardly distinguished from T. siamensis, both have fusiform-shaped conidia with one setula at each end and in very similar sized of conidia and setulae (Liu et al. 2016; Lu et al. 2016). The ITS sequences from both species are also very similar and with only 4-5 bp difference.

Tainosphaeria microsperma W.P. Wu & Y.Z. Diao, sp. nov., Fig. 106, Mycobank MB841591.

Etymology: Refers to its smaller conidia.

Diagnosis: Similar to *Tainosphaeria jonesii* in conidiophores, conidiogenous cells and conidia, but differs in shorter conidia and setulae.

Typification: **China**, Zhejiang Province, Huaian County, Qiandaohu, on decaying cone of Pinus sp., 18 October 2019, W.P. Wu, Holotype HMAS 352,062 (= Wu16152), ex-type strain CGMCC 3.20730 (= NN76340).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2–4 µm wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, solitary or in groups, simple, erect, straight or flexuous, brown but becoming paler towards the apex, 2-6-septate, smoothand thick-walled, $50-105 \times 2-3 \mu m$, basal cell up to 5 μm wide, terminated with a conidiogenous cell, extending sympodially and percurrently, with 1-3 percurrent proliferations and 1–2 sympodial proliferations. Conidiogenous cells integrated, terminal, monophialidic cylindrical, $25-30 \times 2.5-3 \mu m$; collarette funnel-shaped, $1.5-2 \mu m$ wide, 1–1.5 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, fusiform, slightly curved, aseptate, hyaline, smooth, $9-13.5 \times 2.5-2.8 \mu m$, both ends obtuse, with one setula at each end, 3–4 µm long.

Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium welldeveloped, grey to grey-brown, with pale colored margin, reverse brown to dark brown (Fig. 103c, d).

Materials examined: **China**, Guangdong Province, Guangzhou, South China Botanical Garden, on dead fruit of unidentified tree, 3 March 2012, W.P. Wu (Wu12141, Wu12349). Living strains: 76,341 (from Wu16152) and 54,413 (from Wu12349).

Ecology/Substrate/Host: Saprobe on decaying cone of *Pinus* sp.

Geographical distribution: China.

Notes: Among the known species of *Tainosphaeria*, *Tainosphaeria microsperma* is similar to *T. crassiparies*, *T. cupulata*, *T. jonesii* and *T. phialogeniculata* in small-sized conidia, but differs from them by shorter setulae (Fernández and Huhndorf 2005; Liu et al. 2016; Lu et al. 2016).

Tainosphaeria phialogeniculata W.P. Wu & Y.Z. Diao, sp. nov., Fig. 107, Mycobank MB841592.

Etymology: Refers to its geniculate conidiophores due to proliferation.

Diagnosis: Similar to *Tainosphaeria jonesii* in morphology of conidiophores, conidiogenous cells and conidia, but differs in relatively longer conidia.

Typification: **China**, Yunnan Province, Pu Er, on dead leaves of unidentified tree, 8 June 2018, Yu Zhang Holotype HMAS 352,063 (= Wu15202), ex-type strain CGMCC 3.20799 (= NN76036).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2-3.5 µm wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, solitary or 2-3 in groups, simple, erect, straight, or flexuous, brown but becoming paler towards the apex, 2-3-septate, smooth- and thick-walled, $30-55 \times 2.5-3.5 \mu m$, basal cell up to 4.5 μm wide. Conidiogenous cells integrated, terminal, monophialidic and polyphialidic, cylindrical, $20-25 \times 2.5-2.8 \mu m$, extending sympodially, with 1-3 collarettes; collarettes funnel-shaped, 1.5-2 µm deep, 2-2.5 µm wide. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, fusiform, straight or slightly curved, aseptate, hyaline, smooth, $14-15 \times 1.7-2 \mu m$, apex obtuse, base slightly truncated or obtuse, with one setula at each end, setulae 5–6 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 0.6 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown (Fig. 103e, f).

Materials examined: **China**, Yunnan Province, Pu Er, on dead leaves of unidentified tree, 8 June 2018, Yu Zhang (Holotype Wu15202); Yunnan, Kunming, Botanical Garden, on dead culm of bamboo, 22 October 1999, W.P. Wu and Yan Huang (Wu2601b); Yunnan Province, Xishuangbanna, on dead wood, 16 October 1999, W.P. Wu & Yan Huang (Wu2750a). Living strains: ex-type strain 76,036 (from Wu15202), 46,011 (from Wu2750a) and 46,017 (from Wu2601a).

Ecology/Substrate/Host: Saprobe on decaying leave.


Fig. 107 *Tainosphaeria phialogeniculata* (Wu15202, holotype). **a–c** Conidiophores and conidiogenous cells with funnel-shaped collarettes. **d–u** Conidia with setulae. Scale bar: 5 µm

Geographical distribution: China.

Notes: *Tainosphaeria phialogeniculata* is similar to *T. crassiparies, T. cupulata, T. jonesii, T. microsperma* and *T. phialogeniculata* in small-sized conidia, but differs from them by fusiform conidia with slightly longer size in average and its unique ITS sequence (Fernández and Huhndorf 2005; Liu et al. 2016; Lu et al. 2016).

Tainosphaeria parva (S. Hughes & W.B. Kendr.) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 85, 2021.

 \equiv *Codinaea parva* S. Hughes & W.B. Kendr., N.Z. J. Bot. 6: 354, 1968.

≡ *Dictyochaeta pava* (S. Hughes & W.B. Kendr.) Hol.-Jech., Česká Mykol. 42: 204, 1988.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2–4.5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, scattered or aggregated, simple, erect, straight, or slightly flexuous, 3-6-septate, brown to dark brown at the lower part, becoming paler towards the apex, smooth, $40-110 \times 3.5-5 \mu m$, base with a swollen and lobbed cell up to 10 µm wide. Conidiogenous cells integrated, terminal, mono- or poly-phialidic, cylindrical, $10-20 \times 3.5-4.5 \mu m$, pale brown, thin- and smooth-walled, collarette funnelshaped 3-3.5 µm wide, 1.5-2 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, curved, obtuse at the base, $11-17 \times 2.5-3 \mu m$, aseptate, hyaline, smooth, with a setula of 3-5 µm long at each end.

Material examined: **China**, Yunnan Province: Kunming: Kunming Botanical Garden, on dead leaves of undetermined trees, 24 November 1995, W.P. Wu (Wu955g, Wu958a).

Geographical distribution: China, Costa Rica, New Zealand and Seychelles (Réblová et al. 2021b).

Description and illustration: Hughes and Kendrick (1968); Réblová et al. (2021e).

Notes: *Tainosphaeria parva* is very similar to *T. simplex*, but differs from it by conidia with shorter setulae (Hughes and Kendrick 1968). This species is rarely known in the publication (Grandos-Montero et al. 2018; Réblová et al. 2021e). Its occurrence on palm in Hongkong was reported by Taylor and Hyde (2003).

Tainosphaeria sivanesanii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 108, MycoBank MB841594.

Etymology: Named after the former IMI mycologist, A. Sivanesan, with whom one of the authors (Wu) worked in the same office for 3 years in IMI and got strong support from him.

Diagnosis: Setae absent. Conidiophores $30-50 \times 2-3.5 \mu m$. Conidiogenous cells monophialidic, extending

sympodially, cylindrical, $13-20 \times 3-3.5 \mu$ m, bearing funnel-shaped collarettes. Conidia falcate, fusiform, straight or curved, aseptate, $15-17 \times 2.5-2.8 \mu$ m, both apex and base bear short setulae of 6–7 µm long,

Typification: **China**, Guangdong Province, Shenzhen, Yangtaishan Forestry Park, on dead see pod of *Acacia* sp., 17 Oct 2020, W.P. Wu, Holotype HMAS 352,065 (=Wu17575), ex-type strain CGMCC 3.20767 (=NN78406).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3-5 µm wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, solitary or in small groups, simple, erect, straight, or slightly flexuous, cylindrical, dark brown and thick-walled in lower part, becoming paler and thin-walled towards the apex, 2-5-septate, smooth, 30-50×2-3.5 µm. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, with 1-3collarettes, cylindrical, $13-20 \times 3-3.5 \mu m$, pale brown to brown, thin-walled; collarette funnel-shaped, 2.5-3 µm wide, 1-1.5 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate, fusiform, straight or curved, aseptate, hyaline, smooth, $15-17 \times 2.5-2.8 \mu m$, both apex and base bear short setulae of 6–7 µm long,

Culture characteristics: Colonies on PDA effuse, colonies 1–1.3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown (Fig. 103i, j).

Ecology/Substrate/Host: Saprobe on dead plant material of *Acacia* sp.

Geographical distribution: China.

Notes: Morphologically *Tainosphaeria sivanesanii* with aseptate conidia bearing setulae at both ends fits well to the generic concept of Tainosphaeria (Fernández and Huhndorf 2005; Réblová et al. 2021e). However in the phylogenetic tree, *Tainosphaeria sivanesanii* is clustered together with members of *Phialoturbella*, which is characterized by aseptate conidia without setulae. Its placement in *Tainosphaeria* needs to be further confirmed in future phylogenetic analysis with involvement of more marker genes. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 78,406 include *Tainosphaeria* lunata (GenBank NR_168796, 96% identity) and *T. obclavata* (GenBank NR_168797, 93% identity).

Tainosphaeria vulgaris (S. Hughes & W.B. Kendr.) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 88, 2021.

 \equiv *Codinaea vulgaris* S. Hughes and W.B. Kendr., New Zealand Journal of Botany 6: 367, 1968.



Fig. 108 *Tainosphaeria sivanesanii* (Wu17575, holotype). **a–f, j–l** Conidiophores and conidiogenous cells with funnel-shaped conidia. **g–i** Conidia. Scale bar: a 10 μm, **b–l** 5 μm



Fig. 109 *Tainosphaeria verrucophora* (Wu17647b1, holotype). **a–i** Conidiophores and conidiogenous cells with funnel-shaped conidia. **j–s** Conidia. Scale bar: **a, b** 20 μ m **c–l** 5 μ m

≡ *Dictyochaeta vulgaris* (S. Hughes and W.B. Kendr.) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 151, 2000.

Geographical distribution: New Zealand and Seychelles (Réblová et al. 2021b).

Description and illustration: Hughes and Kendrick (1968); Whitton et al. (2000); Réblová et al. (2021a, b, c, d, e).

Notes: Tainosphaeria vulgaris differs from other relevant species by relatively larger conidia $(17-23 \times 2-2.7 \ \mu\text{m})$ with shorter setulae $(3-5 \ \mu\text{m})$. It has been reported on leaf litter and rotten wood of various plants including Nothofagus solandri var. cliffortioides, N. runcata, Pandanus seychellarum, Quintinia serrata, Rubus sp. and Weinmannia racemosa.

Tainosphaeria verrucophora W.P. Wu & Y.Z. Diao, sp. nov., Fig. 109, MycoBank MB841593.

Etymology: Refers to its verruculose conidiophores.

Diagnosis: Setae absent. Conidiophores cylindrical, 1–3-septate, verruculose, $30-80 \times 3-3.5 \mu m$. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, $25-30 \times 3-3.5 \mu m$; collarettes funnel-shaped or very flat with wide opening. Conidia fusiform, subcylindrical, $10-14 \times 2-2.5 \mu m$, setulae 2.5–5 µm long.

Typification: **China**, Hainan Province, Sanya, Yalongwan Park, isolated from dead leaves of unidentified tree, 28 Dec 2020, W.P. Wu, Holotype HMAS 352,064 (=Wu17647b1), ex-type strain CGMCC 3.20765 (=NN78530).

Description on the natural substrate: Colonies on PDA effuse, hairy, dark brown, granulate appearance due to sporulation in old culture. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 1–3 µm wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, solitary or in small groups, simple, erect, straight or slightly flexuous, cylindrical, brown to dark brown, thick-walled in lower part, becoming paler and thin-walled towards the apex, 1–3-septate, vertuculose with dark colored pitch on the wall, $30-80 \times 3-3.5 \mu m$. Conidiogenous cells integrated, terminal, monophialidic, occasionally with percurrent proliferation, cylindrical, $25-30 \times 3-3.5 \mu m$, pale brown to brown, thin-walled; collarette dark brown, funnel-shaped, 2.5-3 µm wide, 1-1.5 µm deep. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, fusiform, subcylindrical, straight or curved, aseptate, hyaline, smooth, $10-14 \times 2-2.5 \mu m$, bear a short setula of 2.5-5 µm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.4 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium less developed, pale brown to brown, reverse of the same color (Fig. 103g, h).

Ecology/Substrate/Host: Saprobe on dead plant material.

Geographical distribution: China.

Notes: *Tainosphaeria verrucophora* is unique in producing rough-walled conidiophores, monophialidic conidiogenous cells, and hyaline, aseptate, fusiform to subcylindrical conidia with 1 setula at each end. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 78,530 include *T. jonesii* (GenBank MN121306, 93% identity), 11 gaps (2%) and *Tainosphaeria siamensis* (GenBank NR_154524, 94% identity).

Xyladelphia Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 90, 2021.

Colonies effuse, hairy, dark brown. Teleomorph: Ascomata subglobose to broadly ovoid, papillate, dark brown, separate, superficial, papillate. Setae sparse, scattered, brown, multiseptate, slender, tapering to an acute apex. Ascomatal wall of textura epidermoidea in surface view in water, and in lactophenol, composed of pseudoparenchymatic cells, with a thin, light-colored outer coating. Paraphyses sparse, unbranched, hyaline, septate. Asci cylindroclavate, short-stalked, unitunicate, thin-walled, broad apical cap, with 8 ascospores irregularly arranged. Ascospores hyaline, broadly fusiform to ellipsoid, rounded ends, aseptate, rarely one-septate. Anamorph: Setae sterile, straight, smooth- and thick-walled, tapering gradually towards the pointed apex, septate, uniformly brown except at the ultimate or penultimate cells which are dark brown. Conidiophores macronematous, mononematous, simple, crowded, erect, straight, or slightly flexuous, pale brown to brown, becoming pale brown towards the apex, septate, dark brown but becoming paler towards the apex, thin- and smoothwalled. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, pale brown, thin-walled, ending in a flared collarette which is funnel-shaped. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, falcate but asymmetrical, slightly curved, narrowing sharply and attenuated towards the basal end, aseptate, hyaline, smooth, multiguttulate, without or with setulae at each end of the conidium (Adapted from Réblová et al. 2021e).

Type species: *Xyladelphia longiseta* (F.A. Fernández & Huhndorf) Réblová & Hern.-Restr.

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: Asia, New Zealand, South America.

Description and illustration: Réblová et al. (2021e).

Notes: *Xyladelphia* is a recently created genus to include *Chaetosphaeria longiseta* with both teleomorph and anamorph known (Fernández and Huhndorf 2005; Réblová et al. 2021e). The anamorph is *Codinaea*-like fungus, which produces sterile setae with darker ultimate and/or penultimate cells, short conidiophores bearing terminal monophialidic conidiogenous cells, and hyaline, aseptate, guttulate and

falcate conidia with one setulae at each end. They are phylogenetically very different from other species assigned to *Codinaea*, *Dictyochaeta* and related genera (Fernández & Huhndorf 2005; Lin et al. 2019; Réblová et al. 2021e). In our phylogenetic analysis, three *Codinaea*-like fungal species are clustered together with *Dictyochaeta brevis* and *Xyladelphia longiseta* as a strongly supported clade. Morphologically, all these species share very similar morphological characters with *Xyladelphia longiseta*, such versicolorous setae, shorter conidiophores associated with setae, terminal and mono- or poly-phialidic conidiogenous cells, and hyaline, aseptate, multiguttulate conidia with or without setulae Apart from the type species, we add another 3 new species to the genus *Xyladelphia*.

Several species among many described *Codinaea/Dictyochaeta* species show morphological similarity with *Xyladelphia* in sterile setae with a darker ultimate or penultimate cell and acute apex, short conidiophores, and falcate and multiguttulate conidia, such as *D. intermedia*, *D. vittata* and *Codinaea* state of *Chaetosphaeria pulchriseta* (Hughes and Kendrick 1968; Hewings & Crane 1981; Kuthubutheen and Nawawi 1991a, b, c, d, e; Kuthubutheen & Nawawi 1991a; Whitton et al. 2000; Fernández & Huhndorf 2005; Cruz et al. 2008). They are transferred to the genus *Xyladelphia* and an identification key is provided.

Key to all accepted species of Xyladelphia

1.	Conidia without or with inconspicuous setulae2
1.	Conidia with setulae
2.	Setae uniformly brown except for the darker apical
	cellX. pluriguttulata
2.	Setae uniformly brown except at the significantly darker
	penultimate cell
3.	Setae up to 360 µm long; conidia more or less symmetri-
	cal, 23–29×2.4–3 μmX. pulchriseta
3.	Setae up to 250 µm long; conidia asymmetrical4
4.	Conidia15–20×2.3–2.5 μm
4.	Setae 156–240 μ m long; conidia 22–25 × 2.3–
	2.5 µmX. parapulchriseta
5.	Conidia $25-32 \times 2.5-3 \mu m$; setulae 10–12 μm long
	X. vittata
5.	Conidia less than 25 μ m long; setulae less than 10 μ m
	long6
6.	Conidia 18-21×1.5-2.5 µm; setulae 3.5-6.5 µm
	longX. intermedia
6.	Conidia 21.3-24.8×2.4-2.9 µm; setulae 5-8.3 µm
	longX. longiseta

Xyladelphia intermedia (Gusmão & S.M. Leão) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841699.

≡ *Dictyochaeta intermedia* Gusmão & S.M. Leão, Mycotaxon 106: 18, 2008. Description on the natural substrate: Teleomorph: Unknown. Anamorph: Setae solitary, 9–15-septate, 150–354×6–9 µm; penultimate cell dark brown, 25–47.5 µm long. Conidiophores arising solitary or in groups of 2–5, associated with base of setae, 2–7-septate, 30–90×3–6 µm. Conidiogenous cells monophialidic, cylindrical. Conidia aseptate, falcate, symmetrical, simple, smooth, pluriguttulate, in slimy mass, hyaline, 18–25×1.5–4 µm. setulae simple at each end, 3.5–6.5 µm long (Adapted from Cruz et al. 2008).

Typification: **Brazil**, Bahia, Senhor do Bonfim, On leaves, 10 October 2006, coll. S.M. Leão-Ferreira (Holotypus: HUEFS 114,791).

Ecology/Substrate/Host: Saprobe on dead leaves. Geographical distribution: Brazil (Cruz et al. 2008). Description and illustration: Cruz et al. (2008).

Notes: Dictyochaeta intermedia was well documented in the original description and morphologically fits well to the concept of Xyladelphia on a combination of characters including setae with one cell darker and pluriguttulate conidia found in all accepted species, including X. longisetata, X. pulchriseta, X. pluriguttulata and X. vittata (Hughes and Kendrick 1968; Kuthubutheen and Nawawi 1991b). The inconspicuous setulae and asymmetrical morphology of conidia in X. pluriguttulata are enough to separate it from X. intermedia. Xyladelphia intermedia is mostly similar to X. pulchriseta and X. vittata in the general morphology, but the size of conidia and setulae are intermediate between the two known species (Cruz et al. 2008). No specimen was examined by us, and the above diagnosis is based on the excellent documentation by Cruz et al. (2008).

Xyladelphia longiseta (F.A. Fernández & Huhndorf) Réblová & Hern.-Restr., J. Fungi 7 (12, no. 1097): 91, 2021. ≡ Chaetosphaeria longiseta F.A. Fernández & Huhndorf,

Fungal Divers. 18: 28, 2005.

Description on the natural substrate: Anamorph: Setae associated with conidiophores, multiseptate, brown, $184-251 \times 3-4.5 \mu m$, sometimes two most apical cells dark brown, tapering to an acute apex. Conidiophores cylindrical, pale brown, $28-104 \times 3-4.8 \mu m$. Conidiogenous cells terminal, monophialidic, cylindrical, pale brown to brown, ending in an apical collarette, $25-37.5 \times 3.5-4.6 \mu m$, Conidia hyaline, fusiform, $21.3-24.8 \times 2.4-2.9 \mu m$, with a single setula at each end, $5-8.3 \mu m \log$ (Adapted from Fernández and Huhndorf, 2005, also with teleomorph described).

Typification: **Puerto Rico**, Caribbean National Forest, El Verde Research Area, 16–ha Grid, Luquillo Mts., 18 January 1997, on 1 cm branch, S.M. Huhndorf, F.A. Fernández, SMH3048 (F; *holotype*).

Ecology/Substrate/Host: Saprobe on dead branches.

Geographical distribution: Costa Rica, Ecuador, Puerto Rico and USA (Réblová et al. 2021b).

Description and illustration: Fernández and Huhndorf (2005); Réblová et al. (2021a, b, c, d, e).

Notes: *Xyladelphia longiseta* is the only species in the genus known with both anamorph and teleomorph. It differs from other two species with falcate and setulate conidia in the genus by size of conidia and setulae (Kuthubutheen and Nawawi 1991a, b, c, d, e; Fernández and Huhndorf 2005; Crut et al. 2008). Another species described from South American (Brazil), X. intermedia (setae $150-354 \times 6-9 \mu m$, with a darker penultimate cell; conidiophores 2-7-septate, $30-90 \times 3-6 \mu m$; conidia aseptate, falcate, pluriguttulate, $18-25 \times 1.5-4 \mu m$, setulae 3.5-6.5 $\mu m \log$) is very similar to X. longiseta, and can only be distinguished by slighter shorter conidia (Crut et al. 2008).

Xyladelphia parapulchriseta W.P. Wu & Y.Z. Diao, sp. nov., Fig. 110, MycoBank MB841567.

Etymology: Refers to its morphological similarity to Xyladelphia pulchriseta.

Diagnosis: Similar to Dictyochaeta sampahia Kuthub. & Nawawi, Xyladelphia pluriguttulata Kuthub. & Nawawi and X. pulchriseta S. Hughes, W.B. Kendr. & Shoemaker in presence of setae, and guttulate and asetulate conidia with pointed ends, but differs in a combination of morphology of setae and conidia.

Typification: China: Guangdong, Shenzhen, Lianhuashan Park, on dead branches of unidentified tree, 11 November 2019, W.P. Wu, Holotype HMAS 352,086 (= Wu17090), extype strains CGMCC 3.20751 (= NN 77,767).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2–5 µm wide. Teleomorph: Unknown. Anamorph: Setae solitary or crowded, straight, cylindrical, smooth- and thickwalled, (156)190-240 µm long, 5-6.5 µm wide above the swollen base, tapering gradually towards the pointed apex, 6–9-septate, uniformly brown except for the penultimate cell which is significantly darker; penultimate cell black, $37-62 \times 3.5-4.5 \ \mu\text{m}$; ultimate cell $14-27.5 \times 2.5-3.5 \ \mu\text{m}$, apex acute. Conidiophores macronematous, mononematous, simple, crowded, erect, straight, or slightly flexuous, pale brown to brown, becoming paler towards the apex, 1-2-septate, thin- and smooth-walled, smooth, $25-30 \times 2.5-4.2 \,\mu\text{m}$. Conidiogenous cells integrated, terminal, mono- or polyphialidic, cylindrical, $20-23 \times 3-4 \mu m$, pale brown, thinwalled, ending in 1-4 cylindrical collarettes, up to 1 µm deep and wide. Conidia holoblastic, acrogenous, solitary, falcate, asymmetrical, slightly curved, narrowing gradually and attenuated towards both ends, 22-24×2.3-2.6 µm, aseptate, hyaline, smooth, multiguttulate, with an inconspicuous setulae less than 2 µm long at each end of the conidium,

accumulated in slimy, compact, colorless fascicles surrounding the tips of conidiogenous cells.

Culture characteristics: Colonies on PDA effuse, colonies up to 1 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium poorly developed, grey to greybrown, reverse brown to dark brown (Fig. 48s, t).

Other material examined: China, Guangdong, Shenzhen, Lianhuashan Park, on dead branches of unidentified tree, 11 November 2019, W.P. Wu (Wu17091). Living strain: 77,768 (from Wu17090).

Ecology/Substrate/Host: Saprobe on dead branches. Geographical distribution: China.

Notes: Xyladelphia parapulchriseta morphologically resembles Dictyochaeta sampahia Kuthub. & Nawawi, Xyladelphia pluriguttulata and X. pulchriseta. In D. sampahia in the setae are fertile and without a darker penultimate cell. In X. plutiguttulata, the sterile setae are with ultimate cell darker than others, and the conidia are smaller (Kuthubutheen and Nawawi 1991a). X. pulchriseta also resembles X. parapulchriseta, but in this species, the setae are significantly longer (up to 360 µm) and the conidia are larger conidia $(23-29 \times 2.4-3.0 \,\mu\text{m})$ (Hughes and Kendrick 1968). Xyladelphia vittata and X. intermedia also produce sterile setae with darker ultimate or penultimate cells, short conidiophores and multiguttulate conidia, but the conidia in both species are with long setulae (Kuthubutheen and Nawawi 1991a; Cruz et al. 2008). The LSU and ITS sequences were also obtained from the single spore isolates of both specimens. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,767 include Dictyochaeta brevis (GenBank NR_166298, 92% identity) and Xyladelphia longiseta (GenBank OL654132, 97% identity).

Xyladelphia pluriguttulata (Kuthub. & Nawawi) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841701.

≡ Dictyochaeta pluriguttulata Kuthub. & Nawawi, Mycol. Res. 95: 1212, 1991.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Setae cylindrical, up to 220 µm long, 5-7 µm wide, up to 8-septate, versicolorous, uniformly brown except at the ultimate cell and rarely the penultimate cell which is dark brown; the ultimate cell 18-28 µm long; the penultimate cell 20-50 µm long. Conidiophores $15-35 \times 3-4$ µm. Conidiogenous cells monophialidic, cylindrical, up to 25 µm long, 3.5-4 µm wide. Conidia falcate, asymmetrical, slightly curved, wide at the apical end, narrowing sharply and attenuated towards the basal end, $20-27 \times 2-2.7 \,\mu m$, aseptate, multiguttulate, with no or very short and inconspicuous setulae at each end of the conidium, (Kuthubutheen and Nawawi 1991e).

Ecology/Substrate/Host: Saprobe on dead branches.



Fig. 110 *Xyladelphia parapulchriseta* (Wu17090, holotype). **a–f** Conidia. **g–i** Setae with darker penultimate cells. **k–p** Conidiophores and conidiogenous cells. Scale bar: **h, i** 20 μm, **g** 10 μm, **a–f**, **k–p** 5 μm

Geographical distribution: Brazil, China, Malaysia and Mexico (Kuthubutheen and Nawawi 1991e; Arias et al. 2015, 2018).

Description and illustration: Kuthubutheen and Nawawi (1991e); Aries et al. (2015, 2018).

Notes: *Xyladelphia pluriguttulata* is characterized by presence of sterile setae with darker ultimate cell and acute apex, short conidiophores in clusters with setae from basal stroma, monoblastic conidiogenous cells with funnel-shaped collarette, and asymmetrical, falcate and multiguttulate conidia $(20-27 \times 2-2.7 \ \mu\text{m})$ with no or with very short setulae at each end (Kuthubutheen and Nawawi, 1991e). *Xyladelphia intermedia, X. vittata, X. pulchriseta* resemble *X. pluriguttulata* in morphology, but the conidia in all these species bear well-developed setulae, thus can easily be distinguished from *D. pluriguttulata* (Kuthubutheen and Nawawi 1991a, e; Hewings and Crane 1981; Whitton et al. 2000).

Xyladelphia pulchriseta (S. Hughes & W.B. Kendr. & Shoemaker) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841702.

 \equiv *Chaetosphaeria pulchriseta* S. Hughes & W.B. Kendr. & Shoemaker, N. Z. J. Bot. 6:356, 1968.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Setae $180-378 \times 7-10.5 \mu m$, up to 13-septate, versicolorous, the penultimate cell dark brown, $30-72 \mu m$ long, the ultimate cell $18-30 \mu m$ long and with acute apex. Conidiophores 1-5-septate, $28-130 \times 4.0-4.4 \mu m \mu m$. Conidiogenous cells polyphialidic, with 1-3 successive proliferations and funnel-shaped collarettes. Conidia aseptate, falcate, more or less symmetrical, $27-33 \times 2.2-3.0 \mu m$, with a short ($1.5-3 \mu m$ long) s setula at each end, they are multiguttulate (Hughes and Kendrick 1968; Whitton et al. 2000).

Specimen: China, Hongkong, Hongkong Island, Mt Austin, On decaying leaves of *Pandanus furcatus*, 7 Jun. 1995, E.H.C. McKenzie (HKU(M) 4933); China: Hongkong, Hongkong Island, Mt Austin, On decaying leaves of *Pandanus furcatus*, 7 Jun. 1995, S.R. Whitton (HKU(M) 4931).

Ecology/Substrate/Host: Saprobes on decaying leaves, including *Pandanus furcatus*.

Geographical distribution: Brazil, Brunei, China, Czechoslovakia, Malaysia, New Zealand and USA (Hughes and Kendrick 1968; Holubová-Jechová 1984; Kuthubutheen and Nawawi 1991e; Whitton et al. 2000; Santa Izabel et al. 2011).

Description and illustration: Hughes and Kendrick (1968); Holubová-Jechová (1984); Kuthubutheen and Nawawi (1991e); Whitton et al. (2000); Santa Izabel et al. (2011).

Notes: *Xyladelphia pulchriseta* differs from other species by versicolorous setae with a longer and darker penultimate cell (30–72 µm long), and falcate, more or less symmetrical, multiguttulate conidia $(27-33 \times 2.2-3.0 \,\mu\text{m})$ with a short setulae $(1.5-3 \,\mu\text{m})$ at each end (Hughes and Kendrick 1968; Whitton et al. 2000). It is mostly similar to *X. parapulchriseta*, but differs in longer setae (up to 360 μm) and larger conidia $(27-33 \times 2.2-3.0 \,\mu\text{m})$ (Hughes and Kendrick 1968) The fungus was reported on decaying leaves of palm in Hongkong. No specimen was examined by us and the above description is based on the origination and also documentation by Whitton et al. (2000).

Xyladelphia sinensis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 111, MycoBank MB841568.

Etymology: Refers to the locality where this fungus was originally discovered.

Diagnosis: Similar to *Dictyochaeta sampahia*, *Xylandephia pluriguttulata* and *X. pulchriseta* but differs in a combination of setae, conidia and setulae.

Typification: **China**, Guangdong Province, Shenzhen, Lianhuashan Park, on dead petiole of unidentified palm, 17 Oct 2020, W.P. Wu, Holotype HMAS 352,087 (=Wu17453), ex-type strain CGMCC 3.20760 (=NN78332).

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 2-4 µm wide. Teleomorph: Unknown. Anamorph: Setae straight, crowded, arising mostly single, smoothand thick-walled, 100-230 µm long, 5-7 µm wide above the swollen base, tapering gradually towards the pointed apex, 3-7-septate, uniformly brown except at the penultimate and sometimes ultimate cells which are dark brown; penultimate cells dark brown, $45-57 \times 4.5-5.5 \mu m$; ultimate cells acute, brown to dark brown, $15-17.5 \times 2-3.5 \,\mu\text{m}$; basal cell swollen, 12-15 µm wide. Conidiophores macronematous, mononematous, simple, crowded, up to 5 around the base of 1–2 setae or spreading among setae, erect, straight or slightly flexuous, pale brown to brown, becoming pale brown towards the apex, extending sympodially or percurrently, 1-8-septate, brown but becoming paler towards the apex, thick- and smooth-walled, $80-105 \times 2.5-4 \mu m$. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, $13-21 \times 2.8-4 \mu m$, pale brown, thin-walled; collarettes funnel-shaped, 2.5-4 µm wide, 2.5-4 µm deep. Conidia holoblastic, acrogenous, solitary, falcate, asymmetrical, slightly curved, wide at the apical end, narrowing sharply and attenuated towards the basal end, $15-20 \times 2-2.5 \mu m$, aseptate, hyaline, smooth, multiguttulate, with no or very short and inconspicuous setulae at each end of the conidium, accumulated in slimy, compact, colorless fascicles surrounding the tips of conidiogenous cells.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium poorly developed, white, grey to grey-brown, reverse brown to dark brown (Fig. 48p).



Fig. 111 *Xyladelphia sinensis* (Wu17453, holotype). **a–e** Setae with dark cell. **f–j** Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. **k–r** Conidia. Scale bar: **a** 20 μm, **b–d** 10 μm, **e–s** 5 μm

Other materials examined: **China**, Guangdong Province, Shenzhen, Lianhuashan Park, on dead petiole of unidentified palm, 17 Oct 2020, W.P. Wu (Wu17556); Guangdong Province, on dead bark of unidentified plant, 9 October 1998, W.P. Wu (Wu2049). Living strains: 78,363 and 78,364 (from Wu17556).

Ecology/Substrate/Host: Saprobe on dead petiole of palm and bark of tree.

Geographical distribution: China.

Notes: *Xyladelphia sinensis* morphologically it resembles *Dictyochaeta sampahia* Kuthub. & Nawawi, *S. pluriguttulata X. parapulchriseta* and *X. pulchriseta* in versicolorous setae, and aseptate, falcate, asymmetrical or symmetrical conidia with or without very short setulae. *Xyladelphia sinensis* differs from *D. sampahia* by the fertile setae without a darker penultimate cell, and asymmetrical falcate conidia in the latter species. In *X. Pluriguttulata*, the versicolorous setae are with only ultimate cells darker than others, and conidia ($20-27 \times 2-2.7 \mu m$) are longer than those in *X. sinensis* (Kuthubutheen and Nawawi 1991a, e). In *X. pulchriseta*, the conidia are more or less symmetrical and significant larger ($23-29 \times 2.4-3.0 \mu m$), and the setae are also significantly longer (up to 360 µm) (Hughes and Kendrick 1968).

Morphological variations were observed among the three examined collections from China. In the specimen Wu2049, the setae are longer (19–230 μ m), the conidiophores are shorter (28–30 μ m) and with only 1–2 septa, and the conidia are slightly longer (18–20×2–2.5 μ m). While in the specimen Wu17453 and Wu175567, the setae vary a lot on size, the conidiophores are up to 8-septate and up to 105 μ m, and the conidia are shorter (15–18×2.3–2.5 μ m).

The LSU and ITS sequences were also obtained from the single spore isolates of two specimens. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 78,332 include *Dictyochaeta brevis* (GenBank NR_166298, 92% identity) and *Xyladelphia longiseta* (GenBank OL654132, 97% identity).

Xyladelphia vittata (Kuthub. & Nawawi) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841703.

≡ Dictyochaeta vittata Kuthub. & Nawawi, Mycol. Res. 95: 1217, 1991.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: *Setae* up to 350 μ m long, 6–8 μ m wide above the base, uniformly brown except at the penultimate cell which is usually dark brown; apical cell 20–25 μ m long, penultimate cell 20–35 μ m long. Conidiophores up to 7-septate, cylindrical, up to 80 μ m long, 4–5 μ m wide. Conidiogenous cells monophialidic, up to 25 μ m long; collarette. Collarette funnel-shaped, 3–4 μ m wide, 2.5–3.5 μ m deep. Conidia aseptate, falcate, somewhat symmetrical but broader towards the base, multiguttulate, $25-32 \mu m$ (mostly $28-30 \mu m$) long, $2.5-3 \mu m$ wide, with a single, simple, setula $10-12 \mu m$ long at each end of the conidium (Adapted from Kuthubutheen and Nawawi 1991a, b, c, d, e).

Geographical distribution: China (Tsui et al. 2001a) and Malaysia (Kuthubutheen and Nawawi 1991a, b, c, d, e).

Description and illustration: Kuthubutheen and Nawawi (1991a, b, c, d, e); Tsui et al. (2001a).

Notes: On morphology, *Xyladelphia vittata* is closely related to *X. intermedia* (conidia 18–21×1.5–2.5 µm; setulae $3.5-6.5 \mu$ m long) and *X. longiseta* (21.3–24.8×2.4–2.9 µm; setulae $5-8.3 \mu$ m long) in versicolorous setae, and falcate, symmetrical, multiguttulate conidia with long setulae, but differs from them by longer conidia and setulae (Hughes and Kendrick 1968; Kuthubutheen and Nawawi 1991a, b, c, d, e; Tsui et al. 2001a). The occurrence of *X. vittata* in Hong Kong, China was recorded by Tsui et al. (2001a). No specimen was examined by us, the above description is based on the excellent documentation from Kuthubutheen and Nawawi (1991a, b, c, d, e) and Tsui et al. (2001a). No living strain and DNA sequence from this fungus are available for phylogenetic analysis, its placement in *Xyladelphia* is based on the characteristics of the genus.

Doubtful species of Xyladelphia:

Dictyochaeta brevis C.G. Lin & K.D. Hyde, Mycosphere 10: 670, 2019.

Description on the natural substrate: Teleomorph: Unknown. Asexual morph: Setae absent. Conidiophores mononematous, cylindrical, 13.5-51(-102) µm long, 2–4 µm wide just above the basal cell, sometimes reduced to conidiogenous cells. Conidiogenous cells monophialidic, with flared collarette, terminal, integrated, cylindrical, $12.7-33.6 \times 2.5-3.9$ µm. Conidia aseptate, fusiform, most curved, with hair-like and 3.5-6.5 µm long appendages at both ends, 0–2 guttulates, smooth, hyaline, 7.5-11.4 µm long, 2.0-2.9 µm wide.

Typification: **China**, Guizhou Province, Qiannan Buyi Miao Autonomous Prefecture, Dushan County, Guizhou Zilinshan National Forest Park (Shengou District), unnamed road, on decaying wood, 6 July 2018, Chuan–Gen Lin, DS 2–39 (MFLU 19–0216, holotype; HKAS 105,173, isotype), ex-type living culture GZCC 18–0096.

Geographical distribution: China (Lin et al. 2019).

Description and illustration: Lin et al. (2019).

Notes: Phylogenetically, *D. brevis* is grouped together with species of *Xyladelphia* but as a distinct linkage. Morphologically *Dictyochaeta brevis* differs from all known species of *Xyladelphia* in absence of setae, and falcate, symmetrical conidia without guttulate (Lin et al. 2019). Its phylogenetic relationship with other *Codinaea/Dictyochaeta* and related genera in the Chaetosphaeriaceae remains to be studied.

Doubtful and excluded species from *Codinaea* and *Dictyochaeta*:

Taxonomic position of the following species under *Codinaea* s. lat. and *Dictyochaeta* s. lat. can not be determined at this stage, mainly due to the morphological difference and lacking living strains for molecular phylogeny. Future study will be needed to elucidate their phylogenetic relationship with other fungi and taxonomic rearrangement. The identification key is provided for them.

Key to doubtful species of *Codinaea* s. lat. and *Dictyochaeta* s. lat.

1. Setae present, fertile; conidiophores in small group associated with setae; conidiogenous cells mono- or poly-phialidic, with funnel-shaped collarette; conidia ovate, initially hyaline to subhyaline, becoming pale brown, 17–22×6–8 µm.....D. subfuscospora 1. Setae absent......2 2. Conidia aseptate......4 Conidia lunate, 1-sepate, 10–16×2.5–3.5 µm..... 3.D. lunata 3. Conidia falcate, 0–2-septate, one rudimentary setula at apex, base acute, $17-23 \times 2.5-3 \mu m....D$. zapatensis 4. Conidia strongly curved......5 4. Conidia straight or only slightly curved......7 5. Conidia botuliform, rounded at ends, with an inconspicuous basal scar, 15–19×3.1–3.5 µm.....D. botulispora 5. 6. Conidia crescent-shaped, falcate or sigmoid, filiform, pointed at the ends, $8.8-12 \times 0.8-1 \mu m$D. lunulospora 6. Conidia always curved, crescent-shaped or falcate, both ends obtuse, $7-8-8.5 \times 0.5-0.6-0.7 \mu m$; conidiophores 50–115 µm long.....curvispora 7. Conidia filiform, $21-30\times0.5-1$ µm....D. lilliputiana Conidia fusiform, guttulate, $24-32 \times 3-4 \mu m$ 8.D. occidentalis 8. Conidia less than 20 µm long......9 9. Conidia $14-19 \times 3.3-4.4 \mu m$; setula rudimentary.....D. illinoensis 9. Conidia less than 14 µm long.....10 10. Conidia ellipsoid to allantoid, guttulate, $9-13 \times$ 3–4 µm.....*D. heteroderae* 10. Conidia allantoid, 8.5–12×2.5–3 μm.....D. curvispora Codinaea botulispora S. Hughes & W.B. Kendr., N. Z. J. Bot. 6: 332, 1968.

≡ Dictyochaeta botulispora (S. Hughes & W.B. Kendr.) Aramb. & Cabello, Mycotaxon 34: 681, 1989.

≡ *Dictyochaeta botulispora* (S. Hughes & W.B. Kendr.) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4:137, 2000.

Geographical distribution: New Zealand (Hughes and Kendrick 1968).

Description and illustration: Hughes and Kendrick (1968).

Notes: Morphologically this species is closely related to several species with fusiform to falcate, and asetulate conidia in *Codinaea/Dictyochaeta*, including *Codinaea heteroderae*. No sequence is available for molecular phylogeny. It might belong to *Tainosphaeria* or similar genus.

Dictyochaeta curvispora L. Cai, McKenzie & K.D. Hyde, Nova Hedwigia 78: 441, 2004.

Geographical distribution: Philippine (Cai et al. 2004).

Description and illustration: Cai et al. (2004).

Notes: Based on the absence of setae and asetulate conidia, *Dictyochaeta curvispora* should be excluded from the redefined *Codinaea* s. str. and *Dictyochaeta* s. str.. However, the ITS sequence (MH862954) generated from the extype strain (CBS114070) showed 99% identity of *Codinaea aquatica*. Its taxonomic position is still in doubtful and needs to be further studied.

Dictyochaeta curvispora (Y.L. Zhang & T.Y. Zhang) Y.L. Zhang & T.Y. Zhang, Flora Fungorum Sinicorum 51: 181, 2019.

≡ *Codinaea curvispora* Y.L. Zhang & T.Y. Zhang, Mycosystema 33: 795, 2014.

Geographical distribution: China (Zhang and Zhang 2014; Zhang and Wu 2019).

Description and illustration: Zhang and Zhang (2014); Zhang and Wu (2019).

Notes: The new combination Dictyochaeta curvispora is an invalid name. Morphologically this species is closely related to several species with fusiform to falcate, and asetulate conidia in *Codinaea/Dictyochaeta*, including *Codinaea heteroderae*. No sequence is available for molecular phylogeny.

Codinaea heteroderae Morgan-Jones, Mycotaxon 14: 175, 1982.

≡ Dictyochaeta heteroderae (Morgan-Jones) Aramb. & Cabello, Mycotaxon 34: 682, 1989 (Invalid).

≡ *Dictyochaeta heteroderae* (Morgan-Jones) Carris & Glawe, Mycotaxon 33: 23, 1988.

Geographical distribution: USA (Morgan-Jones 1982). Description and illustration: Morgan-Jones (1982). Notes: Morphologically this species is closely related to several species with absence of setae, solitary conidiophores with terminal monophialidic conidiogenous cells with conspicuous collarettes, and fusiform to falcate, and asetulate conidia in known *Codinaea/Dictyochaeta* species. No sequence is available for molecular phylogeny. It might belong to *Tainosphaeria* or similar genus.

Codinaea illinoensis Hewing & J.L. Crane, Mycotaxon 13: 419, 1981.

≡ *Dictyochaeta illinoensis* (Hewing & J.L. Crane) Aramb. & Cabello, Mycotaxon 34: 682, 1989 (Invalid).

≡ *Dictyochaeta illinoensis* (Hewing & J.L. Crane) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 140, 2000.

Geographical distribution: USA (Hewing and Crane 1981).

Description and illustration: Hewing and Crane (1981).

Notes: Morphologically this species is closely related to several species with absence of setae, solitary conidiophores with terminal monophialidic conidiogenous cells with conspicuous collarettes, and fusiform to falcate, and asetulate conidia in known *Codinaea/Dictyochaeta* species, including *Codinaea heteroderae*. No sequence is available for molecular phylogeny. It might belong to *Tainosphaeria* or similar genus.

Dictyochaeta incrassate Kuthub. & Nawawi.

It is marked as legitimate name in MycoBank, but no data is available.

Dictyochaeta keniensis P.M. Kirk.

It is marked as legitimate name in MycoBank, but no data is available.

Dictyochaeta lilliputiana R.F. Castañeda, Fungi Cubenses: 8, 1986.

Geographical distribution: Cuba (Castañeda-Ruiz 1986b). Description and illustration: Castañeda-Ruiz (1986b).

Notes: No DNA sequence is available for molecular phylogeny. It might belong to *Tainosphaeria* or similar genus.

Codinaea lunata Matsush., Icon. Microfung Matsush. Lect.: 37, 1975.

≡ *Dictyochaeta lunata* (Matsush.) Aramb. & Cabello, Mycotaxon 34: 682, 1989 (Invalid).

≡ Dictyochaeta lunata (Matsush.) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4:140, 2000.

Geographical distribution: Japan (Matsushima 1975). Description and illustration: Matsushima (1975).

Notes: No sequence is available for molecular phylogeny. It might belong to *Tainosphaeria* or similar genus. *Dictyochaeta lunulospora* (Hewings & J.L. Crane) Hol.-Jech., Česká Mykol. 40: 148, 1986. Figure 42d, e

 \equiv *Codinaea lunulospora* Hewings & J.L. Crane, Mycotaxon 13: 421, 1981.

≡ *Dictyochaeta lunulospora* (Hewings & J.L. Crane) Cabello & Aramb., Mycotaxon 34: 682, 1989.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Mycelium partly immersed and partly superficial, composed of brown, branched and septate hyphae of 3-4.5 µm wide. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores macronematous, mononematous, scattered or aggregated, simple, erect, straight, or slightly flexuous, 3-8-septate, pale brown to medium brown, thick- and smooth-walled, 50-80×2.5-3.5 µm. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, lageniform, subcylindrical, $13-16 \times 3-3.5 \mu m$, pale brown, thin-and smooth-walled, sporulating loci up to 1.5 µm, without conspicuously collarette. Conidia holoblastic, acrogenous, solitary, formed in droplet surrounding the tips of conidiogenous cells, uncinate, curved, filiform, rostrate at the apex, obtuse at the base, $8-12 \times 0.5-0.8 \mu m$, aseptate, hyaline, smooth.

Materials examined: **China**, Sichuan Province, Huanglong Nature Reserve, on dead culm of bamboo, 8 August 2000, W.P. Wu (Wu3524b).

Geographical distribution: China, Cuba and USA (Hewings and Crane 1981; Holubová-Jechová and Mena Portales 1986).

Description and illustration: Hewings and Crane (1981); Holubová-Jechová and Mena Portales (1986).

Notes: Of the accepted species in the genus, only *Dic*tyochaeta lunulospora and *D. uncinata* produce aseptate, uncinate, curved, and falcate conidia. *Dictyochaeta uncinata* has larger conidia ($20-25 \times 1 \mu m$) than *D. lunulospora*, thus they can easily be distinguished (Hewings and Crane 1981; Kuthubutheen and Nawawi 1991a, b, c, d, e; Castañeda-Ruiz et al. 1998; Whitton et al. 2000). No sequence is available for molecular phylogeny. It might belong to *Tainosphaeria* or similar genus.

Dictyochaeta occidentalis R.F. Castañeda & W.B. Kendr., Univ. Waterloo Biol. Ser. 32: 19, 1990.

Typification: **Cuba** Pinar del Rio, Aspiro, on fallen leaves of *Alchornea latifolia*, 2 June 1988, R.F. Castañeda (INIFAT C88/182–1, holotype).

Geographical distribution: Cuba (Castañeda-Ruiz and Kendrick 1990a).

Description and illustration: Castañeda-Ruiz and Kendrick (1990a).

Notes: The conidiophores of this species are short and with terminal monophialidic conidiogenous cells bearing conspicuous collarette, and the conidia are hyaline, fusiform to falcate, aseptate, guttulate, $24-32 \times 3-4 \mu m$. It might belong to *Tainosphaeria* or similar genus.

Dictyochaeta subfuscospora Kuthub & Nawawi, Mycol. Res. 95: 1214, 1991.

Description on the natural substrate: Setae fertile at the apex, aggregated in small clusters together with short conidiophores, smooth, dark brown, cylindrical, septate, $117-210 \times 3.5-6 \mu m$, widening up to 9 μm diam. in the apical part, percurrently proliferating; Conidiophores clustered with setae, light brown, smooth, cylindrical or slightly constricted near the middle, aseptate, $24-48 \times 6-7 \mu m$. Conidiogenous cells of the setiform conidiophores apical, brown, proliferating, with 1-several apical and subapical flaring, $4-6 \mu m$ wide and $2-3 \mu m$ deep collarettes, conidiogenous cells of the short conidiophores with 1 apical and several lateral collarettes similar to those of the setiform conidiophores. Conidia with densely granulated cytoplasm, at first hyaline, becoming brown during maturation, ellipsoid, smooth, apiculate, $17-25 \times 8-10 \mu m$, produced in slimy heads (Kirschner et al. 2001).

Geographical distribution: China, Malaysia and Mexico (Kuthubutheen and Nawawi 1991b; Kirschner et al. 2001; Tsui 2001; Marques and Gusmão 2015).

Description and illustration: Kuthubutheen and Nawawi (1991b); Kirschner et al. 2001); Marques and Gusmão (2015).

Notes: No specimen was examined, and the above description is based on the description by Kirschner et al. (2001). Among the many known species in *Dictyochaeta* Speg. and *Codinaea*, *Dictyochaeta subfuscospora* is the only species with brown conidia (Kuthubutheen and Nawawi 1991a; Whitton et al. 2000). Its occurrence in China was reported by Tsui et al. (2001a, b, c) and Kirschner et al. (2001). No sequence is available for molecular phylogeny. It might belong to *Tainosphaeria* or similar genus.

Dictyochaeta zapatensis R.F. Castañeda & W.B. Kendr., Univ. Waterloo Biol. Ser. 33: 18, 1990.

Typification: **Cuba**, Matanzas, Cienaga de Zapata, Palpite, on fallen leaves of *Bucida palustris*, 9 March 1989, R.F. Castañeda, B. Kendrick & Nag Raj (INIFAT C89/57, holotype).

Geographical distribution: Cuba (Castañeda-Ruiz and Kendrick 1990b).

Description and illustration: Castañeda-Ruiz and Kend-rick (1990b).

Notes: In this species, the conidiophores are short and with terminal monophialidic conidiogenous cells, without conspicuous collarette, and the conidia are hyaline, fusiform to falcate, 1-septate, guttulate, $17-23 \times 2.5-3 \mu m$. No sequence is available for molecular phylogeny. It might belong to *Tainosphaeria* or similar genus.

Chloridium, Catenularia, Chaetosphaeria and related genera

In the phylogenetic tree generated from the integrated ITS and LSU dataset (Fig. 3), all *Chloridium* and related genera are grouped together, phylogenetically they are more closely related to *Chaetosphaeria* s. lat. complex. Morphologically they are characterized by absence or presence of setae, solitary or grouped conidiophores, mono- or polyphialidic conidiogenous cells, and hyaline to brown, aseptate, globose, subglobose, conical conidia bearing no setulae appendage. Among these genera, *Chloridium* and *Chaetosphaeria* are by far the largest genera with many species described with broadly geographical distribution, but they are also polyphyletic.

Key to Chloridium, Chaetosphaeria and related genera

Conidio obnymomidal incida view availarm obevoid to

1.	obtriangular, with 2–5 protuberant corners and irreg-ular
	outline when viewed from above, truncate at the basal
	scar
1.	Conidia not round-tetrahedral to obpyramidal5
2.	Sterile setae present; conidiophores reduced to a few
	supporting calls; conidiogenous cell globose or subglo-
	bose, with broad funnel-shaped collarette
	Paragaeumannomyces
2.	Sterile setae or capitate hyphae present or absent; conidi-
	ophores well-developed; conidiogenous cells cylindric-
	cal, with funnel-shaped collarettes
3.	Capitate hyphae present or absent; conidia brown to dark
	brown, without setulaeCatenularia
3.	Sterile setae or capitate hyphae absent; conidia hya-
	line
4.	Conidia pyramidal, with 2 corners at the
	topsChalarodes
4.	Conidial round, tetrahedral to pyramidal, with 3-5 pro-
	tuberant cornersNawawia
5.	Conidia brown to dark brown6
5.	Conidia hyaline to very pale brown7
6.	Conidia cuneiform to obovoid, broadly rounded apically,
	truncate at baseFuscocatenula
6.	Conidia globose, ellipsoid, or cylindrical, but not cunei-
	formCraspedodidymum
7.	Conidiogenous cell monophialidic, with multisporulat-
	ing loci within collaretteChloridium
7.	Conidiogenous cell polyphialidic, proliferation percur-
	rently, with single sporulating loci within collarette8
8.	Setae fertile, with terminal phialides; conidiophores in
	clusters with setae; conidia fusiform, constricted in the
	middleFusichloridium
8.	Setae absent; conidia ellipsoid, elongate-ellipsoidal to
	cylindrical, not constrictedChaetosphaeria

Chloridium Link ex Fr., Mag. Ges. Naturf. Frende, Berl. 3: 13, 1809.

= *Gonytrichum* C.G. & F. Nees, Nova Acta Acad. Leop.-Carol. Nat. Cur. 9: 244, 1818.

Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth hyphae. Anamorph: Setae present or absent. Conidiophores solitary or in group, cylindrical, unbranched or branched at the upper part, erect, straight, or slightly flexuous, septate, brown, becoming paler towards the apex, smooth. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, pale brown to brown, becoming paler towards the apex, smooth, apex subhyaline; collarette funnel- or cup-shaped, cylindrical, proliferating sympodially and/or percurrently. Conidia produced singly, successively, semi-endogenous, aggregated in a spore masses or in short or long chains, subglobose, oblong–ellipsoidal, cylindrical, fusiform, reniform, straight, aseptate, hyaline to brown.

Type species: *Chloridium virescens* (Pers.) W. Gams & Hol.-Jech. (Hughes 1951; Ellis 1971; Gams and Holubová-Jechová 1976).

Ecology/Substrate/Host: Saprobe on dead material of plants and isolated from ecological samples.

Geographical distribution: Broadly distributed, especially in subtropical and tropical area.

Description and illustration: Hughes (1951); Ellis (1971); Gams and Holubová-Jechová (1976).

Notes: Réblová et al. (2016), based on the widespread use of Chloridium and its priority, recommended to use the generic name Chloridium to accommodate species under Chloridium, Gonytrichum and Melanopsammella which are synonyms (Hughes 1951; Réblová and Winka 2000; Fernández and Huhndorf 2005; Fernández et al. 2006; Crous et al. 2012; Réblová et al. 2016, 2017). Chloridium and Gonytrichum was monographed by Gams and Holubová-Jechová (1976) and three sections with different patterns of conidiogenesis and formation of chlamydospores can easily be distinguished for the accepted species: Chloridium section with multiple conidiogenous loci and pigmented chlamydospores, Gongromeriza section with single conidiogenous loci and percurrent proliferation, and Psilobotrys section with single conidiogenous loci and sympodial proliferation. Most species in this genus occur on dead barks and rotten wood. There are many species names described under the genus Chloridium and these species are morphologically diversified on conidiophores, conidiogenous cells and conidia (Tubaki 1958; 1963; Sinclair and Eicker 1985; Wang and Wilcox 1985; Crous et al. 1995; Datarathne et al. 2020). Some of these species have already been or need to be reclassified based on molecular phylogeny. For example, Chloridium paucisporum was reclassified as a synonym of *Hyaloscypha finlandica* (*= Phialophora finlandica*) (Fehrer et al. 2018).

Under the genus *Gonytrichum*, Gams and Holubová-Jechová (1976) accepted four species and five varieties. Later, another two species were added (Sharma and Munjal 1978; Holubová-Jechová 1982). *Gonytrichum ypsilosporum* produces hyaline and y-shaped conidia, which is very different from any other species in this genus (Holubová-Jechová 1982). *Gonytrichum indicum* is very similar to *G. macrocladum*, but differs on the size of conidiophores and conidia, and the arrangement and shape of phialides (Sharma and Munjal 1978). Among these known species, *Gonytrichum caesium* Nees and *G. chlamydosporium* were transferred into *Chloridium*, as *Chloridium caesium* and *Chloridium chloroconium* respectively. A revision for known species under this genus is needed for redeposition in right genus.

The phylogenetic analysis showed that the genus Chloridium is polyphyletic, and members of the genus are grouped in several different clades, including some outside Chaetosphaeriaceae (Figs. 3, 112) The type species of the genus *Chloridium*, *Chloridium virescens* (= *Chloridium viride*) is grouped together with Chloridium aquaticum, C. chloroconium, C. cylindrosporum, C. salinicola, C. submersum, C. virescens var. chlamydosporum, C. virescens var. caudigerum, all species known as Gonytrichum (including G. caesium (the type species, = Chaetosphaeria inaequalis), G. mirabile, G. chlamydosporium, and G. macrocladum), and several undescribed *Chloridium* species (Hughes 1951; Réblová and Winka 2000; Fernández and Huhndorf 2005; Fernández et al. 2006; Crous et al. 2012; Réblová 2000; Réblová et al. 2016). It is a sister group of Sporoschisma and well supported in the phylogenetic analysis. This supports the proposal by Réblová et al. (2021d) to redefine the genus Chloridium Link in narrow concept and monophyletic genus to only accommodate the species in this clade.

Most of the other studied *Chloridium* species are clustered together in a strongly supported group with the type species of *Chaetosphaeria*, *C. innumera*. These species, including *Chloridium botryoideum* var. *minutum*, *Chloridium lignicola*, *C. pini*, and several undescribed species, can be well accommodated by *Chaetosphaeria* s. lat. Among them, *C. clavaeforme* is the anamorphic state of *Chaetosphaeria myriocarpa*, which has been confirmed by previous molecular analysis (Réblová 2000; Crous et al. 2018a, b; Luo et al. 2019).

Chloridium obclavata, characterized by geniculate conidiogenous cells and hyaline, aseptate and obclavate conidia, is phylogenetically grouped together with *Tainosphaeria*, thus it should be transferred to the latter genus.

Two species of *Chloridium*, *C. phaeosporum* and *C. reniforme* are excluded from the genus *Chloridium* and family Chaetosphaeriaceae. *Chloridium reniforme* is clustered together with *Xylolentia brunneola* (the type species of the



◄ Fig. 112 Maximum likelihood (ML) tree based on ITS sequence data for the *Chloridium* narrow concept. Bootstrap support values ≥ 60%, Bayesian posterior probability values ≥ 0.95 are shown at the nodes. *Striatosphaeria castaneae* CBS145352 and *Striatosphaeria codinaeophora* MR1230 were chosen as the outgroup. Ex-type strains are indicated with "T" in the end of the taxa labels. Latin names and extype strain numbers of the new species described in the current study are shown in font genus), X. reniformis, and several other members of the recently established new family Rhamphoriaceae Reblová in Sordariomycetidae incertae sedis (Réblová 2018; Yuan et al. 2020). Thus, C. reniformis should be transferred to *Xylolentia*. In fact, X. reniformis and C. reniforme probably represent the same fungal species, judged by both morphology and ITS sequences (Gams and Holubová-Jechová 1976; Yuan et al. 2020). Several strains of C. phaeosporum



Fig. 113 Colony of *Chloridium* species on PDA after 20 days at 25 °C. **a, b** *Chloridium crousii* (ex-type strain 42830). **c, d** *C. kirkii* (ex-type strain 43888). **e, f** *C. culmicola* (ex-type strain 45714). **g, h,**

k, **l** *C. proliferatum* (**g**, **h** ex-type strain 78531. **k**, **l** 78518). **i**, **j** *C. cylindrosporellum* (ex-type strain 47981). **m**, **n** *C. jilinense* (ex-type strain 46507). **o**, **p** *C. setosum* (53381)



Fig. 114 Colony of *Chloridium* species on PDA after 20 days at 25 °C. **a**, **b** *Chloridium* shangsiense (ex-type strain 43199). **c**, **d** *C*. *tropicale* (ex-type strain 76009). **e**, **f** *C*. *sinensis* (ex-type strain 77481). **g**, **h** *C*. *xishuangbanaense* (ex-type strain 75978). **i**, **j** *C*.

virescens (i-j 85152, k, l 85145). m C. setosum (53381). n C. virescens var. chlamydosporum (12033). o C. virescens var. caudigerum (12125). p C. chloroconium (12049). q C. gonytrichii (12066)

or similar fungus with terminal conidiogenous cell bearing sympodial proliferation, and ellipsoidal, aseptate, pale brown conidia are obtained, and they are clustered together with members of Plectosphaerellaceae in Glomerellales, including *Gibellulopsis*, *Plectospharella* and *Musicillium*, thus should be excluded from the genus *Chloridium* and family Chaetosphaeriaceae. Based on morphological and phylogenetic study, a new generic name *Phaeochloridium* is created to accommodate *C. phaeosporum* and similar species.

Three species in this genus have been reported from freshwater habitats in China (Luo et al. 2019). *Chloridium chlamydosporium* and *C. laeënse* were also recorded from Taiwan, China (Matsushima 1980; Chen 1990). Here we

reported the genus with some additional species from mainland China. Living strains of many studied species were also studied on PDA (Figs. 113, 114), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Chloridium chloroconium (W. Gams & Hol.-Jech.) Réblová & Seifert, IMA Fungus 7: 134, 2016.

≡ *Chaetosphaeria chloroconia* W. Gams & Hol.-Jech., Stud. Mycol. 13: 86, 1976.

≡ Melanopsammella chloroconia (W. Gams & Hol.-Jech.) Réblová, M.E. Barr & Samuels, Sydowia 51: 65, 1999.

= Gonytrichum chlamydosporium G.L. Barron & G.C. Bhatt, Mycopath. Mycol. Appl. 32: 126, 1967.

Description on the natural substrate: Colonies effuse, dark brown becoming white grey due to production of conidia. Mycelium partly immersed and partly superficial, consisted of hyaline to pale brown, septate, branched, thinor slightly thick-walled hyphae, up to 3 µm wide. Conidiophores crowded, arising singly, consisting of a straight, erect stipe which are dark brown, 10-13-septate, setiform, 180-250 µm long, 3-3.5 µm wide, with a swollen base 7-8.5 µm wide, wall thick and smooth, becoming paler and thin-walled towards the apex, apex sterile and up to 1 µm wide, fertile hyphae formed just below septa in the lower 2/3 part of the conidiophores and bearing several whorls of 2-5 conidiogenous cells each. Collar hyphae regularly present, irregularly curved, darker than the phialides, 2-3 µm wide, hyaline to pale brown, smooth, 0-1-septate, from which 2-5 phialides formed. Conidiogenous cells integrated, terminal, monophialidic, 2–5 growing together on the fertile branches, subcylindrical, lageniform, tapering to a narrower collarette of 1–1.5 μ m wide, hyaline to subhyaline, 12–18×2.5–3 μ m. Conidia holoblastic, solitary, aggregated into spore head on the apex of fertile branches, hyaline, aseptate, subglobose, subellipsoid, guttulate, $2.5-3.5 \times 1.5-2.5 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown (Fig. 114p).

Materials examined: **China**, Guangdong Province, Guangzhou, Baiyunshan, on dead leaves of *Bauhinia blakeana*, 5 March 2012, W.P. Wu (Wu12049); Hunan Province, Zhangjiajie, on rotten wood, 15 October 2012, W.P. Wu (Wu11036); Sichuan Province, on dead culm and leaf sheath of bamboo, 15 December 2013, W.P. Wu (Wu13205, 13,212, 13,255); Yunnan Province, Kunming, Kunming Botanical Garden, on dead leaves of undetermined tree, 24 November 1995, W.P. Wu (W986); Yunnan Province, Kunming, Kunming Botanical Garden, on dead stem of undetermined tree, 10 April 2015, W.P. Wu (Wu12927); Yunnan Province, isolated from soil sample, June 2006, Cai Lei (51525, 51590); Zhejiang Province, Huaian County, Qiandaohu, on dead bark of *Platanus occidentalis*, 8 October 2018, W.P. Wu (Wu16023, Wu16029); Zhejiang Province, Hangzhou, Longjing, on rotten wood, 30 September 2013, W.P. Wu (Wu13022); **Japan**, Mie Prefecture, Tsu, Tsukairaku Park, on dead branches of unidentified tree, 2 October 2019, W.P. Wu (Wu16931). Living strains: 76,204 (from Wu16023), 54,434 (from Wu12056), 54,234 (from Wu12049), C (from Wu12927), 57,329 (from Wu13022), 57,552 (from Wu13205), 57,548 (from Wu13212), 57,592 (from Wu13255), 77,353 (from Wu16931), 53,692, 53,718, 58147, 58148, 72624 and 72666.

Ecology/Substrate/Host: Saprobes on dead material of many different plants.

Geographical distribution: widely distributed species (Ellis 1971; Gams and Holubová-Jechová 1976).

Description and illustration: Ellis (1971); Gams and Holubová-Jechová (1976).

Notes: This species was fully described and illustrated under *Gonytrichum chlamydosporium* by Ellis (1971), and Gams and Holubová-Jechová (1976). It differs from other species in the relevant genera by simple setiform conidiophores without secondary branch and flask-shaped phialides with irregularly curved collar hyphae, and hyaline to very pale colored conidia. Because the name *C. chlamydosporium* (1958) already exists and refers to a different taxon, the next older epithet for this species was taken up and placed in *Chloridium* (Réblová et al. 2016). Both LSU and ITS sequences were obtained from the single spore isolates of many specimens and its affinity to other members of *Chloridium* was confirmed. However, ITS barcode seems to have difficult to distinguish it from the relevant species *C. gonytrii* (=*Gonytrichum macrocladum*).

Chloridium crousii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 115, MycoBank MB841595.

Etymology: Named after the mycologist Pedro Crous.

Diagnosis: Conidiophores solitary or 2–3 in group, 1–3-septate, brown, 40–65×2–3 μ m. Conidiogenous cells terminal, monophialidic, 20–25×2–2.5 μ m wide, collarette funnel-shaped or cylindrical, with a single sporulating locus. Conidia aggregated in slimy head, oblong-ellipsoidal, aseptate, 2.8–3.2×2.5–2.8 μ m.

Typification: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead branches of unidentified plant, 2 January 1997, W.P. Wu (Holotype HMAS 351968 (=Wu1328b), ex-type strain CGMCC3.20701 (=NN42830).

Description on the natural substrate: Colonies on PDA effuse, grey to brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline, pale brown to dark brown, smooth, 1.5–3 µm wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary



Fig. 115 Chloridium crousii (ex-type strain 42830 on PDA). a–i Conidiophores and conidiogenous cells. j–m Conidia. Scale bar: a–e 20 μm, f–m 5 μm

or 2–3 in group, cylindrical, erect, unbranched, straight or slightly flexuous, 1–3-septate, brown, dark brown at the base, becoming paler towards the apex, cylindrical, tapering gradually towards the apex, smooth, 40–65×2–3 μ m, up to 8 μ m wide at the base, narrowing up to 1.5–2 μ m wide at the upper part below the collarette. Conidiogenous cells integrated, terminal, monophialidic, smooth, brown, becoming paler towards the apex, apex pale brown, 20–25×2–2.5 μ m wide, apex 1–1.5 μ m wide, collarette funnel-shaped or cylindrical, with a single sporulating locus, occasionally with 1–2 percurrent proliferation. Conidia produced singly, aggregated in slimy head, oblong-ellipsoidal, straight, aseptate, hyaline, guttulate, 2.8–3.2×2.5–2.8 μ m.

Culture characteristics: Colonies on PDA effuse, colonies 0.8–1.2 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, white, yellow brown in the middle, reverse yellow brown to brown (Fig. 113a, b).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China.

Notes: *Chloridium crousii* is characterized by simple and smooth-walled conidiophores, terminal monophialidic

conidiogenous cells with funnel-shaped or cylindrical collarettes bearing single sporulating locus, and hyaline, aseptate, oblong to ellipsoidal conidia, $2.8-3.2 \times 2.5-2.8 \mu m$. Morphologically it resembles *Chloridium preussi* (conidia $2.5-3.5 \times 1.5-2 \mu m$) and *C. lignicola* (conidia $3.5-5 \times 1.5-2 \mu m$) on conidiophores and conidiogenous cells, but clearly differs on conidial size (Gams and Holubová-Jechová 1976).

Both LSU and ITS sequences were obtained from the single spore isolates of the ex-type strain and its affinity to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 42830 include *Chloridium virescens* (GenBank MT663381, 91% identity) and *Phialocephala* sp. (GenBank MH268056, 90% identity).

Chloridium culmicola W.P. Wu & Y.Z., Diao sp. nov., Fig. 116, MycoBank MB841596.

Etymology: Refers to its occurrence on culm of bamboo.

Diagnosis: Conidiophores cylindrical, verruculose, 2–5-septate, $50-110 \times 3-3.5 \mu m$. Conidiogenous cells terminal, $22-26 \times 3-3.5 \mu m$, collarette funnel-shaped, with multisporulating loci, often with a marked protrusion of



Fig. 116 *Chloridium culmicola* (ex-type strain 45714). **a-f** Conidiophores and conidiogenous cells with developing conidia. **g-k** Conidia. Scale bar: 5 µm

the meristematic tip beyond the collarette in the course of conidium formation. Conidia aggregated in short or long chains, oblong-ellipsoidal, aseptate, $4-5.6 \times 2.2-2.5 \mu m$.

Typification: **China**, Yunnan Province, Kunming, Kunming Botanical Garden, on dead culm of bamboo, 22 October 1999, Wu and Yan Huang, Holotype HMAS 351969 (= Wu2606b), ex-type strain CGMCC 3.20639 (= NN45714).

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1.5–2.5 µm wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or 2–3 in group, cylindrical, erect, unbranched, straight or slightly flexuous, 2–5-septate, brown at the base, becoming pale brown to subhyaline towards the apex, tapering gradually towards the apex, verruculose, thin–walled, $50-110 \times 3-3.5$ µm, swollen up to 5 µm wide at the base. Conidiogenous cells monophialidic, integrated, terminal, lageniform, subcylindrical, pale brown to subhyaline, becoming very paler towards the apex, smooth or verruculose, (15–) $22-26 \times 3.2-3.6 \mu m$; collarette funnel-shaped or cylindrical, with multisporulating loci within the collarette, often with a marked protrusion of the meristematic tip beyond the collarette in the course of conidium formation. Conidia produced singly, aggregated in short or long chains, oblong-ellipsoidal, straight, aseptate, hyaline, guttulate, smooth- and thin-walled, $4-5.6 \times 2.2-2.5 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 2–3 cm diameter in 14 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, brown to dark brown, reverse of the same color (Fig. 113e, f).

Ecology/Substrate/Host: Saprobes on dead culm of bamboo.

Geographical distribution: China.

Notes: On conidiophores, conidiogenous cells and conidia, Chloridium culmicola resembles *C. virescens* var. *chlamydosporum*, but can be distinguished by verruculose



Fig. 117 Chloridium cylindrosporellum (Wu13210, holotype). a-f Conidia. g-o Conidiophores and conidiogenous cells with developing conidia. Scale bar: a-f, i-o 5 μm, g, h 20 μm

conidiophores, oblong conidia, and absence of chlamydospore in pure culture in the former species (Gams and Holubová-Jechová 1976).

Both LSU and ITS sequences were obtained from the single spore isolate of the holotype specimen and its affinity to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the extype strain 45714 include *Gonytrichum mirabile* (GenBank

MH860990, 93%), *G. caesium* var. *chloridioides* (GenBank MH860413, 94% identity), *Chloridium chloroconium* (GenBank KY853435, 94% identity), *Chaetosphaeria inaequalis* (GenBank AF178564, 96% identity).

Chloridium cylindrosporellum W.P. Wu & Y.Z., Diao, sp. nov., Fig. 117, MycoBank MB841597.

Etymology: Refers to its cylindrical conidia and also similarity to *Chloridium cylindrosporum*.

Diagnosis: Conidiophores cylindrical, $170-210 \times 4.5-6.5 \mu$ m, proliferating percurrently through collarettes. Conidiogenous cells monophialidic, cylindrical, $45-50 \times 2.5-3.5 \mu$ m, with single sporulating loci, Conidia hyaline, aseptate, cylindrical, fusiform to ellipsoidal, constricted in the middle, $11-13 \times 3-3.8 \mu$ m.

Typification: **China**, Sichuan Province, Ya An, on dead leaves of bamboo, 15 December 2013, W.P. Wu, Holotype HMAS 351970 (= Wu13210), ex-type strain CGMCC 3.20719 (= NN57621).

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1.5–3 µm wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or 2-5 in group, cylindrical, erect, unbranched, straight or slightly flexuous, 7-9-septate, brown, dark brown to black at the base, becoming paler towards the apex, cylindrical, tapering gradually towards the apex, smooth, $170-210 \times 4.5-6.5 \mu m$, narrowing up to $3-4 \mu m$ wide at the upper part below the collarette, swollen up to 22 µm wide at the base, with up to 5 percurrent proliferation. Conidiogenous cells integrated, terminal, cylindrical, phialidic, pale brown, becoming paler towards the apex, smooth, apex subhyaline, $45-50 \times 2.5-3.5 \mu m$; collarette funnel- or cup-shaped, 3.0-3.5 µm wide, up to 1 µm high, with a single sporulating locus. Conidia produced singly, within the collarette, aggregated in slimy head, cylindrical to ellipsoidal, rounded at both ends, constricted in the middle, straight, aseptate, hyaline, $11-13 \times 3-3.8 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, dark grey to brown, reverse brown to dark brown (Fig. 113i, j).

Other materials examined: **China**, Hubei Province, Shennongjia, on plant litter, Sept 2004, W.P. Wu (Wu8071); Sichuan Province, Ya An, on dead leaves of bamboo, 15 December 2013, W.P. Wu (Wu13211, Wu13213).. Living strains: 57,622 (from Wu13211), 13,213 (from Wu13213) and 47,981 (from Wu8071).

Ecology/Substrate/Host: Saprobes on dead culm of bamboo.

Geographical distribution: China.

Notes: *Chloridium cylindrosporellum* is unique in conidial shape among the known *Chloridium* species. It resembles *Chloridium cylindrosporum* on conidial shape, but differs by absence of short conidiophores and larger conidia with obtuse ends (Gams and Holubová-Jechová 1976). Both LSU and ITS sequences were obtained from the single spore isolates of different specimens and its affinity to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 57621 include *Chloridium virescens* var. *caudigerum* (Gen-Bank MH864068, 95%) and *C. chloroconium* (GenBank AF178542, 95%).

Chloridium gonytrichii (F.A. Fernández & Huhndorf) Réblová & Seifert, IMA Fungus 7: 134, 2016. Figure 118

≡ Melanopsammella gonytrichii F.A. Fernández & Huhndorf, Fungal Divers. 18: 42, 2005.

= *Chloridium aseptatum* M.J. Wei & H. Zhang, Phytotaxa 362: 191, 2018.

= *Gonytrichum macrocladum* (Sacc.) S. Hughes, Trans. Br. Mycol. Soc. 34: 565, 1951.

= Chaetopsis macroclada Sacc. Michelia 1: 79, 1877.

Description on the natural substrate: Colonies on natural substrate effuse, grey-brown at first but becoming grey-olivaceous to dull green with age, abundantly sporulating. Mycelium partly immersed and partly superficial, consisted of hyaline to pale brown, septate, branched, thin- or slightly thick-walled hyphae, up to 4 µm wide. Teleomorph: Not observed. Anamorph: Conidiophores crowded, arising singly, setiform, consisting of a straight erect stipe, a fertile region with lateral phialides in the lower part, and secondary branches in one to three whorls of 3-4 sterile lateral branches in the upper part. The main stipes are dark brown, 10-13-septate, thick- and smooth-wall, bearing several secondary branches just above the fertile part, 250–280 µm long, with a swollen basal cell 11–15 µm wide, 6-7 µm wide at the base, 4-6 µm wide centrally, 2.0-2.5 µm wide above the ramifications, ending in a paler sterile seta or a sporulating phialide; in the lower half part with 7-8 whorls of phialides below each septum; in the upper part of the conidiophores one to three whorls of 3-4 sterile lateral branches which are pale brown to subhyaline, 1-2 septate, 60-85 µm long, 2-3 µm wide, tapering towards the apex. Conidiogenous cells phialidic, integrated, terminal, arising from irregularly curved, pigmented collar hyphae in groups of 3-6, slender flask-shaped, cylindrical, lageniform, pale brown, $13-17 \times 2.5-3.5$ µm. tapering to 2 µm at the collarette; occasionally percurrently proliferating. Conidia holoblastic, solitary, accumulating in dark cirrhi or head on the apex of fertile branches, olivaceous, ellipsoidal to oval, or one side more strongly curved than other, slightly apiculate at the base, guttulate, $3.5-4.0 \times 2-3 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown.

Materials examined: **China**, Beijing, Huairou, Hongluosi, on rotten wood, 29 July 2020, W.P. Wu (Wu17332); Guangdong Province, Guangzhou, Baiyunshan, on rotten wood, 5 March 2012, W.P. Wu (Wu12056, 12,066); Yunnan Province, Simao, on dead branches of unidentified plant, 12 October 1999, W.P. Wu & Yan Huang (Wu2698); Zhejiang



Fig. 118 *Chloridium gonytrichii* (Wu17008). **a–f** Setiform conidiophores with branches. **g–i** Lateral branches and conidiogenous cells. **j–m** Conidia. Scale bar: **a–c** 20 µm, **e, f** 10 µm, **g–m** 5 µm

Province, Huaian County, Qiandaohu, on dead bark of *Platanus occidentalis*, 18 October 2018, W.P. Wu (Wu16030); Zhejiang Province, Hangzhou, Longjing, on leaf sheath of bamboo, 30 September 2013, W.P. Wu (Wu13041); Zhejiang Province, Hangzhou, Longjing, on rotten wood, 30 September 2013, W.P. Wu (Wu13034); Zhejiang Province, Deqing, Moganshan, Luhuadang, on rotten seed pod of unidentified Leguminosae, 16 October 2019, W.P. Wu (Wu17008). Living strains: 45,849 (from Wu2698), 54,434 (from Wu12056), 54,220 (from Wu12066), 76,205 (from Wu16030), 57,339 (from Wu13034), 57,344 (from Wu13041), 77,334 (from Wu17008), 77,977 and 77,978 (from Wu17332).

Ecology/Substrate/Host: Saprobes on dead material of plant and in soil.

Geographical distribution: Bohemia, Canada, Chile, China, Slovakia and South Africa (Hughes 1951; Ellis 1971; Gams and Holubová-Jechová 1976; Persiani and Maggi 1990; Morgan-Jones et al. 1992; Bao et al. 2021).

Description and illustration: Hughes (1951); Ellis (1971); Gams and Holubová-Jechová (1976); Persiani and Maggi (1990); Morgan-Jones et al. (1992); Bao et al. (2021).

Notes: Chloridium gonytrichii was originally described by Fernández and Huhndorf (2005) as Melanopsammella gonytrichii. Réblová et al. (2016) synonymized M. gonytrichii under C. gonytrichii. The fungus was also fully documented under Gonytrichum macrocladum (1971) and Gams and Holubová-Jechová (1976). It differs from other known species in the genus by often branched setae in whorls in the upper part of the conidiophores, 4-8 whorls of phialides below each septum and arising from irregularly curved, pigmented collar hyphae, and olivaceous ellipsoidal to oval conidia (Hughes 1951; Ellis 1971; Gams and Holubová-Jechová 1976). It is a rather common fungus on rotten wood but has not been reported from China. Some variations on sterile or fertile apex, and secondary branches of the setiform conidiophores were seen among different collections. For example, the apex of setiform conidiophore in the specimen Wu13041 is sterile and the secondary branches always present, while in the specimen Wu13034 and Wu13022, the apices of the setiform conidiophores are fertile and some setiform conidiophores bear branches while other are without secondary branches.

Chloridium humicola (S.C. Jong & E.E. Davis) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841724.

 \equiv *Phialocephala humicola* S.C. Jong & E.E. Davis, Mycologia, 64: 1353, 1972.

= Phialocephala gabalongii Sivasith., Trans. Br. Mycol. Soc. 64: 335, 1975.

= Phialocephala xalapensis Persiani & Maggi, Mycotaxon 20: 253, 1984.

= *Chloridium aquaticum* M.J. Wei & H. Zhang, Phytotaxa 362: 192, 2018. = *Chloridium terricola* Yong Wang bis, Jie & K.D. Hyde, Mycotaxon 132: 80, 2017.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores, macronematous, arising singly or in small groups from hyphae, 92-340(-450) µm. Stipe, cylindrical, 5-12-septate, 125-196(-200) µm×8 µm. One to three series of branches, distal series bearing phialides. Primary branches 2 to 3 in number, $3-9.5(-10) \times 2.5-5$ µm; secondary branches, $5-7 \times 2.0-2.5$ µm, tertiary branches, $5-7 \times 2.0-2.5$ µm. Phialides, hyaline, $4-8(-10) \times 1-1.5$ µm and with inconspicuous openings. Conidia, ellipsoid, hyaline, $(1.8-)3-4 \times 1.5-2$ µm.

Material examined: **China**, Guangdong Province, Dinghushan, on dead bark of unidentified plant, 11 October 1998, W.P. Wu (Wu2005a). Living strain: 44,898 (from Wu2005a).

Ecology/Substrate/Host: Saprobes on dead plant material or soil.

Geographical distribution: Australia, China and USA (Jong and Davis 1972; Sivasithamparam 1975; Onofri et al. 1994).

Description and illustration: Jong and Davis (1972); Sivasithamparam (1975); Onofri et al. (1994).

Notes: In a comprehensive study of morphology and phylogeny, Jacobs et al. (2003) clearly concluded that the morphologically variable genus Phialocephala is heterogenous and polyphyletic, and suggested a reclassification. The studied species were clustered into different clades which belong to different fungal orders, including P. dimorphospora (the type species), P. fortinii, P. scopiformis and P. repens closely connected to Pezizales and Helotiales; Phialocephala fusca and P. xylapensis to Sodariales, and P. compacta to Hypocreales. Phialocephala humicola S.C. Jong & E.E. Davis, together with other known species in the genus, was fully studied by Jacobs (2000) for morphology, conidiogenesis and phylogeny. Phylogenetically P. humicola is unrelated to Phialocephala dimorphospora, the type species of the genus, and should be correctly placed in the Ophiostoma*tales.* In our phylogenetic tree generated by the combined LSU and ITS sequences, Phialocephala humicola is closely related with several Chloridium species in Chaetosphaeraceae, thus it is transferred to Chloridium.

The conidiogenesis in *Phialocephala humicola* was studied by Jacobs (2000) and Onofri et al. (1994) and they revealed a replacement wall building development type with a peculiar disposition of conidia at the apex of the conidiogenous cell, a pattern of condiogenesis similar to the one described for *Chloridium virescens* var. *chlamydosporum*. This also supports the transferring of *P. humicola* into *Chloridium*.

Chloridium jilinense W.P. Wu & Y.Z. Diao, sp. nov., Fig. 119, MycoBank MB841598.



Fig. 119 *Chloridium jilinense* (a–d, l Wu5039, holotype; e–k, m–q ex-type strain on PDA). a–d Upper part of conidiophores bearing phialidic conidiogenous cells with multisporulating loci. e–j Con-

idiophores and conidiogenous cells with multisporulating loci. k Chlamydospore formed in PDA. l Conidia on natural substrate. m-q Conidia formed in PDA. Scale bar: 10 μ m

Etymology: Refers to the locality where this fungus was originally discovered.

Typification: **China**, Jilin Province, Dunhua, on dead branches of unidentified tree, 14 August 2012, W.P. Wu & Yang Huang, Holotype HMAS 351971 (=Wu5039), ex-type strain CGMCC 3.20640 (=NN46507).

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1.5–2.5 µm wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or 2-3 in group, cylindrical, erect, unbranched, straight, or slightly flexuous, 2-5-septate, brown, dark brown at the base, becoming paler towards the apex, slightly tapering towards the apex, smooth, 110–150×2.3–2.6 µm. Conidiogenous cells monophialidic, integrated, terminal, pale brown to brown, becoming paler towards the apex, smooth, apex subhyaline, $20-26 \times 3-3.5 \,\mu\text{m}$ wide; collarettes funnel-shaped or inconspicuous, with broad opening, 2.5-2.8 µm wide, with multisporulating loci within the collarettes. Conidia produced in the aggregated wet spore head, ellipsoidal, irregularly shaped, aseptate, hyaline, smooth- and thin-walled, guttulate, $4-5 \times 2.5-3 \,\mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.5 cm diameter in 14 days, circular, radially sulcate, margin entire and pale colored, aerial mycelium less developed, brown to dark brown, reverse of the same color. Conidiophores occasionally with percurrent proliferation. Chlamydospores abundant, terminal, lateral or also intercalary, globose, ellipsoid, brown, smooth– and thin–walled, $4-6 \times 4-5.5 \ \mu m$ (Fig. 113m, n).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China.

Notes: *Chloridium jilinense* resembles *C. virescens* var. *caudigerum* on cylindrical conidiogenous cells with multisporulating loci within the collarettes and ellipsoidal-shaped conidia, but differs in producing slightly broader conidia and unique ITS sequence. Both LSU and ITS sequences were obtained from the single spore isolate of the holotype specimen and its affinity to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain CGMCC3.20640 include *Chloridium virescens* (GenBank MT146479, 98% identity, *C. virescens* (GenBank MH864519, 95% identity) and *C. virescens* var. *caudigerum* (GenBank MH864068, 94% identity).

Chloridium kirkii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 120, MycoBank MB841599.

Etymology: Named after the British mycologist Paul M. Kirk who made great contribution to taxonomy of anamorphic fungi. Diagnosis: Conidiophores cylindrical, $22-65 \times 2-2.5 \mu m$. Conidiogenous cells monophialidic, cylindrical, $20-25 \times 2-2.3 \mu m$; collarettes inconspicuous, with multisporulating loci. Conidia oblong-ellipsoidal, produced in wet spore mass, $3-3.5 \times 2-2.5 \mu m$. Chlamydospore dark brown, lateral or intercalary, globose, $4-5 \mu m$ diam.

Typification: **China**, Guangxi Province, Damingshan, on rotten wood, 20 December 1997, W.P. Wu, Holotype HMAS 351972 (= Wu1459b), ex-type strain CGMCC 3.20703 (= NN43888).

Description on the natural substrate: Colonies on PDA effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1.5-3 µm wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or 2-3 in group, cylindrical, erect, unbranched, straight or slightly flexuous, 1-3-septate, dark brown at the base, becoming paler towards the apex, tapering gradually towards the apex, smooth, $22-65 \times 2-2.5 \,\mu\text{m}$, narrowing to 2 μm wide at the upper part below the collarettes. Conidiogenous cells integrated, terminal, monophialidic, brown, becoming paler towards the apex, smooth, apex pale brown, $20-25 \times 2-2.3 \,\mu\text{m}$ wide, apex 1.8–2.3 μm wide, occasionally with 1-2 percurrent proliferations; collarette inconspicuous, 2-2.3 µm wide, with multisporulating loci within the collarettes, sometimes with a marked protrusion of the meristematic tip beyond the collarette in the course of conidium formation. Conidia produced singly, within the collarette, aggregated in wet spore mass, oblong to-ellipsoidal, straight, aseptate, hyaline, $3-3.5 \times 2-2.5 \mu m$. Chlamydospores dark brown, smooth; lateral and single, globose, 4–5 µm diam; or intercalary and chained, $4-7 \times 4-6 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 1.5–1.8 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey-brown to brown, with pale colored margin, reverse brown to dark brown (Figs. 113c, d).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China.

Notes: *Chloridium kirkii* resembles *Chloridium virescens* var. *chlamydosporum* in producing chlamydospore, conidiogenous cells with multisporulating loci within the collarettes, and oblong to ellipsoidal conidia (Gams and Holubová-Jechová 1976). However, in *C. virescens* var. *chlamydosporum*, the conidia are slightly bigger $(3-4.5 \times 2-2.7)$ and the chlamydospores are terminal or lateral, rarely intercalary. In addition, their ITS sequences are significantly different.

Chloridium lignicola (F. Mangenot) W. Gams & Hol.-Jech., Stud. Mycol. 13: 37, 1976.



 Fig. 120 Chloridium kirkii (ex-type strain 43888 on PDA). a-c, i-n Conidiophores and conidiogenous cells, chlamydospores also found. d-g Conidia. h Superficial hyphae bearing chlamydospore. Scale bar: a-c, g, i-n 10 μm, d-f 5 μm, h 20 μm

 \equiv *Bisporomyces lignicola* F. Mangenot, Revue Mycol., Paris 18: 136, 1953.

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 2–4 µm wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or in group, cylindrical, unbranched, erect, straight, or slightly flexuous, 5-7-septate, brown to dark brown, blackish brown at the base, becoming paler towards the apex, smooth, $100-200 \times 5-6.5 \,\mu\text{m}$. Conidiogenous cells integrated, terminal, monophialidic, pale brown to brown, becoming paler towards the apex, smooth, apex subhyaline, $20-45 \times 4-5 \,\mu\text{m}$ wide, with up to 4 irregular percurrent proliferations; collarettes funnel-shaped or cup-shaped, 3-4 µm wide and 2-3.5 µm deep Conidia produced singly, successively, within the collarette, aggregated in a slimy masses, ellipsoidal, cylindrical, straight or slightly curved, guttulate, smooth-walled, aseptate, hyaline, $4-5 \times 2-2.5 \ \mu m$.

Materials examined: **China**, Hubei Province, Shennongjia, on decaying wood, 18 September 2004, W.P. Wu (Wu8146b); Sichuan Province, Huanglong Nature Reserve, on rotten wood, 8 August 2000, W.P. Wu (Wu3505). Living strain: 50583 (from Wu8146b).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: Canada, China, France and USA (Mongenot 1953; Holubová-Jechová and Gams 1976).

Description and illustration: Mongenot (1953); Holubová-Jechová and Gams (1976).

Notes: *Chloridium lignicola* is characterized by unbranched conidiophores with terminal conidiogenous cells, funnel- or cup-shaped collarette, and hyaline, aseptate and ellipsoidal to cylindrical conidia (Gams and Holubová-Jechová 1976). Its occurrence on submerged wood from Hong Kong was also reported (Ho et al. 2002). Both LSU and ITS sequences were obtained from the single spore isolate of the specimen Wu8146b and its affinity to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 50583 include *Chloridium lignicola* (GenBank AF178544, 99% identity), *Chaetosphaeria lentomita* (GenBank AF178548, 99% identity, *Chloridium pini* (GenBank NR_170050, 95% identity.

Chloridium matsushimae W. Gams & Hol.-Jech., Stud. Mycol. 13: 29, 1976.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores solitary or slightly fasciculate, erect, straight, septate, dark brown near the base, lighter in the upper part, 130–240 μ m long, near the base 5–6 μ m wide, in the upper part 4–5 μ m wide, tapering towards the tip, with a funnel-shaped collarette, frequently once or twice percurrently proliferating. Conidia aggregated in slimy droplets, arising singly in the collarette, cylindricalellipsoidal, 15–19×3.5–5.3 μ m, smooth-walled, hyaline, brownish when dry, with a slimy apical appendage (Matsushima 1975).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Distribution: China and Japan (Matsushima 1975; Tsui et al. 2000).

Description and illustration: Matsushima (1975); Gams and Holubová-Jechová (1976).

Notes: *Chloridium matsushimae* is unique in producing larger cylindrical to ellipsoidal conidia $(15-19 \times 3.6-5.3)$ with a slimy apical appendage (Matsushima 1975; Gams and Holubová-Jechová 1976). Its occurrence on submerged wood in Hong Kong, China was reported by Tsui et al. (2000). Its phylogenetic relationship with the type species of *Chloridium* remains to be studied.

Chloridium mirabile (Hol.-Jech.) W.P. Wu & Y.Z. Diao, comb. nov. Figure 121, MycoBank MB841725.

 \equiv *Gonytrichum mirabile* Hol.-Jech., Stud. Mycol. 13: 84, 1976.

Description on the natural substrate: Colonies on natural substrate effuse, olivaceous-grey, dark brown becoming greenish due to production of conidia. Mycelium partly immersed and partly superficial, consisted of hyaline to pale brown, septate, branched, thin- or slightly thick-walled hyphae, up to 4 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores crowded, arising singly, consisting of a straight erect stipe, irregular branches, and several lateral phialides. The main stipes are brown to dark brown, become paler toward apex, multiseptate, setiform, apex blunt and sterile, 200-290 µm long, 2.5-4.5 µm wide, wall thick and smooth; the irregular branches anastomosing, intricately entangled, 2.5-3.5 µm wide, apex sterile. Conidiogenous cells monophialidic, arising from the straight portions of the conidiophores stipes and branches, directly below septa, with a curved swollen base, or rarely from a collar hypha delimited from the phialide by a septum; phialides mostly in groups of 2-3, pale brown, much lighter than the conidiophores stipes, 6-8 µm long, inflated at the base to 3.5–4.8 μ m and tapering to the 1–1.5 μ m wide collarette. Conidia holoblastic, solitary, accumulating in whitish cirrhi or head on the apex of phialides, hyaline, aseptate, ellipsoidal, smooth-walled, guttulate, $3.5-4 \times 2-2.5 \,\mu\text{m}$.



Fig. 121 Chloridium mirable (WuBJ01). a Branched setiform conidiophores. b, c Part of conidiophores showing branches. a–f Upper part of setae with rounded apex. g–q Conidiogenous cells and collar hyphae; r Branching point of setae. s–w Conidia Scale bar: a 20 μm, b, c 10 μm, d–w 5 μm

Materials examined: **China**, Beijing, Huairou, Beige Village, on rotten wood of undetermined tree, 1 June 2020, W.P. Wu (BJ01–1, BJ01–2, BJ02, BJ04, BJ18, BJ15, BJ24). Living strain: 77,444 (from BJ01–1), 77,247 (from BJ01–2),

77,445 (from BJ01–UN), 77,446 (from BJ02), 77,447 (from BJ04), 77,424 (from WuBJ15), 77,426 and 77,427 (from WuBJ18), 77,430 and 77,431 (from WuBJ24).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: Brazil, China and Europe (Gams and Holubová-Jechová 1976; Cruz and Gusmão 2009).

Description and illustration: Gams and Holubová-Jechová (1976); Cruz and Gusmão (2009).



Fig. 122 Chloridium proliferatum (Wu17053, holotype). a-h Conidiophore and conidiogenous cells. i-o Conidia. Scale bar: 5 µm



Fig. 123 *Chloridium proliferatum* (from the living strain of Wu17684 on PDA). **a–f** conidia. **g–n**, **p–s** Conidiophores and conidiogenous cells bearing inconspicuous collarettes and percurrent proliferation. **o** hyphae. Scale bar: **n–o** 10 μm, **a–l**, **p–s** 5 μm

Notes: *Chloridium mirabile* differs from other species in the genus by irregularly branched conidiophore, phialides directly formed from the conidiophore stipes or sometimes from the collar hyphae, and hyaline, aseptate, ellipsoidal conidia. Compared to other species with branched conidiophores in *Chloridium* and *Gonytrichum*, *C. mirabile* is rarely known with limited report on its occurrence and represents a new record for China (Gams and Holubová-Jechová 1976; Cruz and Gusmão 2009).

Both LSU and ITS sequences were obtained from the single spore isolates of several specimens and its affinity to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 77,444 include *Gonytrichum macrocladum* (GenBank MH859240, 96% identity) and *G. mirabile* (GenBank MH860990, 100% identity).

Chloridium proliferatum W.P. Wu & Y.Z. Diao, sp. nov., Figs. 122, 123, MycoBank MB841600.

Etymology: Refers to its percurrent proliferation of conidiophores.

Typification: **China**, Hainan Province, Sanya, Yalongwan Park, on dead seed pod of *Entada phaseoloides*, 28 December 2020, W.P. Wu (Holotype HMAS 351973 (=Wu17684), ex-type strain CGMCC 3.20766 (=NN78518).

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary, rarely in group, cylindrical, erect, unbranched, straight or slightly flexuous, 2-5-septate, brown, dark brown to black at the base, becoming paler towards the apex, tapering gradually towards the apex, smooth, $35-115 \times 1.5-3$ µm, swollen up to 5 µm wide at the base, narrowing up to $1.5-2.5 \,\mu\text{m}$ wide at the upper part below the collarette, terminated with a conidiogenous cell. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, subcylindrical, lageniform, brown, becoming paler towards the apex, smooth, apex subhyaline, $15-30 \times 1.5-2.5$ µm wide, apex 1-1.5 µm wide, with 1-3 percurrent proliferations; collarette inconspicuous, 1-1.5 µm. Conidia produced singly, ellipsoidal, pyriform, aseptate, pale brown, smooth, $2.5-3.5 \times 1.5-2 \mu m$, apex rounded, base truncated, aggregated in short or long cylindrical slimy mass,

Culture characteristics: Colonies on PDA effuse, brown, hairy. Mycelium partly superficial and partly immersed in the substrate, composed of pale brown to brown, septate, subhyaline to pale brown, smooth hyphae. Conidiophores solitary, rarely in group, cylindrical, erect, unbranched, straight or slightly flexuous, 1–2-septate, dark brown at the base, becoming paler toward the apex, tapering gradually towards the apex, smooth, $35-60 \times 2-3 \mu m$, swollen up to 4 μm wide at the base, narrowing up to 1.5–2 μm wide at the upper part below the collarette, terminated with a condiogenous cells. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, lageniform, brown, becoming paler towards the apex, smooth, thin-walled, $30-40 \times 2-2.5 \mu m$ wide, apex 1.5–2 μm wide, with 1–4 percurrent proliferations; collarettes inconspicuous, with a single sporulating locus within the collarette. Conidia produced singly, successively, within the collarette, aggregated in slimy mass, ellipsoidal, subglobose, aseptate, pale brown, smooth or slightly verrucose, 4–5×2.3–2.5 μm (Fig. 113g, h, k, l).

Other material examined: **China**, Zhejiang Province, Deqing County, Moganshan, Luhuadang, on rotten seed pod of unidentified *Leguminosae*, 16 October 2019, W.P. Wu (Wu17053). Living strains: 77,410 (from Wu17053), 77,411 (from Wu17053), 78,518 and 78,531 (from Wu17684).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China.

Notes: *Chloridium proliferatum* is characterized by unbranched conidiophores, terminal monophialidic conidiogenous cells with inconspicuous collarette, and very pale brown, aseptate, ellipsoid to subglobose conidia with truncated base and produced in cylindrical or globose slimy mass. In pure culture, the conidiophores constantly proliferate percurrently. It differs from other species by pale colored conidia (Gams and Holubová-Jechová 1976; Yuan et al. 2020). *Chloridium cocoicola* (conidia 5.6–10×2.4–4 µm) and *Chloridium phaeosporum* (4–5×1.7–2.2 µm) also produces monophialidic conidiogenous cell and pale colored conidia, but the conidia in *C. cocoicola* are much longer, while the conidia in *C. phaeosporum* are narrower (Gams and Holubová-Jechová 1976; Taylor and Hyde 2003).

Both LSU and ITS sequences were obtained from the single spore isolates of several specimens including the holotype specimen and its affinity to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 78,531 include *Chloridium salinicola* (GenBank MN047125, 91% identity), *Phialocephala humicola* (GenBank NR103570, 91% identity) and *C. aquaticum* (GenBank MH476570, 91% identity.

Chloridium preussii W. Gams & Hol.-Jech., Stud. Mycol. 13: 35, 1976.

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 2–4 μ m wide hyphae. Teleomorph: Not observed. Anamorph: Conidiophores solitary or in group, cylindrical, unbranched, erect, straight, or slightly flexuous, 10–15-septate, brown to dark brown, becoming paler towards the apex, smooth, 200–350×4.5–6.5 μ m. Conidiogenous cells integrated, terminal, monophialidic, pale brown to brown,



Fig. 124 *Chloridium setosum* (Wu17032, holotype). **g–q** Setae, conidiophores and conidia. **d–I** Conidiophores and conidiogenous cells with funnel-shaped collarettes.**j–o** Conidia. Scale bar: **a–c** 20 μm, **d–o** 5 μm

becoming paler towards the apex, smooth, apex subhyaline, 20–25×3–3.5 μ m; collarette funnel-shaped or cylindrical, 2–2.5 μ m wide and 2–2.5 μ m deep. Conidia produced singly within the collarette and aggregated in a slimy masses, ellipsoidal, cylindrical, rod-shaped, guttulate, smooth-walled, aseptate, hyaline, 3×1.5–2 μ m.

Materials examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead branches of unidentified plant, 2 January 1997, W.P. Wu (Wu1236a/b); Ningxia Province, Liupan Monutain, Erlonghe, on dead branch of unidentified plant, 24 August 1997, W.P. Wu (Wu1067); Yunnan Province, Gaoligongshan, on rotten wood of unidentified plant, 12 Oct 2003, W.P. Wu (Wu7049).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: Canada, China, Netherlands and UK (Gams and Holubová-Jechová 1976).

Description and illustration: Gams and Holubová-Jechová (1976).

Notes: *Chloridium preussii* W. Gams & Hol.-Jech. resembles *C. lignicola*, but can be distinguished from it by gradually tapering, dark brown conidiophores, and relatively smaller conidia.

Chloridium setosum W.P. Wu & Y.Z. Diao, sp. nov., Fig. 124, MycoBank MB841601.

Etymology: Refers to presence of setae in the colony.

Typification: **China**, Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead cone of *Pinus* sp., 16 October 2019, W.P. Wu (Holotype HMAS 351974 (=Wu17032), extype strain CGMCC 3.20741 (=NN77407).

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1–3 µm wide hyphae. Teleomorph: Unknown. Anamorph: Setae cylindrical, simple, or occasionally branched, erect, straight, or flexuous, brown to dark brown, unicolored, thick-walled, smooth, 5-11-septate, $80-137 \times 2.5-3.7$ µm, sterile with an obtuse or pointed apex, or fertile and terminating by a conidiogenous cell. Conidiophores 3-7 in group and associated with 1-3 setae, cylindrical, erect, unbranched, straight or slightly flexuous, 5–10-septate, brown to dark brown at the base, becoming paler towards the apex, tapering gradually towards the apex, smooth, $50-125 \times 2-3 \mu m$, swollen up to 7 μm wide at the base, narrowing up to 2–2.5 µm wide at the upper part below the collarette. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, brown, becoming paler towards the apex, smooth, apex pale brown, $13-16 \times 2.5-3 \mu m$, apex 2-2.5 µm wide, occasionally with one percurrent proliferation; collarette funnel-shaped or cylindrical, with a single sporulating locus. Conidia produced singly within the collarette, ellipsoidal, subglobose, aseptate, hyaline, guttulate,

 $3-3.8 \times 2-2.5 \mu m$, aggregated in slimy yellow-colored cylindrical conidial mass.

Culture characteristics: Colonies on PDA effuse, colonies 1.5–2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, grey to grey-brown, with pale colored margin, reverse pale brown to dark brown (Fig. 1130, p).

Other materials examined: **China**, Hunan Province, Zhangjiajie, on plant litter, 15 October 2010, W.P. Wu (Wu11038); Sichuan Province, Ya An, Yucheng, Bifengxia, on dead leaves of bamboo, 15 December 2013, W.P. Wu (Wu13218). Living strains: 57,629 (from Wu13218), 53,381 (from Wu11038), 77,405 (from the holotype Wu17032).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China.

Notes: Chloridium setosum is characterized by presence of sterile or fertile setose, 3-7 conidiophores in group with 1-3 setae, cylindrical and monophialidic conidiogenous cell with a single sporulating locus within the collarette, and hyaline, aseptate, globose to ellipsoidal conidia (Gams and Holubová-Jechová 1976; Ellis 1971, 1976). Among the known Chloridium species, several species including C. botryoideum (Corda) S. Hughes (conidiogenous cell repeatedly sympodially proliferating, conidia elongate-ellipsoidal to cylindrical, 3-4.5×0.8-1 µm), C. cylindrosporum W. Gams & Hol.-Jech. (conidiogenous cells sympodially proliferating, conidia cylindrical with tapering and rounded or truncate ends, slightly constricted, 8.5–11.5×2.2–3 µm), C. transvaalense Morgan-Jones, R.C. Sinclair & Eicker (conidiogenous cell monophialidic, oblong, $4-5 \times 1.5 \,\mu\text{m}$) and C. virescens (Pers. ex. Pers.) W. Gams & Hol.-Jech. (conidiogenous cell monophialidic and with multisporulating loci, conidia $2.5-3.8 \times 2-2.5 \,\mu$ m) produce unbranched sterile setae or setiform conidiophores among the short conidiophores. They differ from C. setosum by a combination of conidiogenesis and conidia morphology (Gams and Holubová-Jechová 1976; Morgan-Jones et al. 1983).

Both LSU and ITS sequences were obtained from the single spore isolates of several specimens including the holotype specimen and its affinity to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,407 include *C. virescens* var. *caudigerum* (GenBank MH857142, 99% identity), *C. chloroconium* (GenBank MAF178542, 99% identity) and *Chloridium* sp. (GenBank MN598810, 99% identity).

Chloridium shangsiense W.P. Wu & Y.Z. Diao, sp. nov., Fig. 125, MycoBank MB841602.

Etymology: Refers to the locality where this fungus was originally discovered.



Fig. 125 Chloridium shangsiense (**a-i** Wu1385b, holotype; **j-w** extype strain 43199 on PDA). **a-d** Conidiophores, conidiogenous cells bearing broad sporulating loci and conidia. **e-i** Upper part of the

conidiophores bearing conidiogenous cells and conidia. **j–q** Conidiophores and conidiogenous cells in pure culture. **r**, **v**, **w** Conidia. **s–u** Chlamydospores in pure culture., Scale bar: **a–d** 10 μm, **e–w** 5 μm
Typification: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead branched of unidentified plant, 2 January 1997, W.P. Wu, Holotype HMAS 351975 (= Wu1285b), ex-type strain CGMCC 3.20632 (= NN43199).

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1.5–3 µm wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, solitary or 2-3 in group, cylindrical, erect, unbranched, straight or slightly flexuous, 6–9-septate, brown to dark brown, becoming paler towards the apex, smooth, 140-170 µm, 4.5-7 µm wide at the base, basal cells 7-12 µm wide, with 1-2 percurrent proliferations. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, brown, becoming paler towards the apex, smooth, $25-30 \times 3-4.5 \mu m$; collarettes inconspicuous, with broad opening 3–4 µm wide, with multisporulating loci within the collarettes. Conidia produced singly within the collarette and aggregated in spore head, oblong-ellipsoidal, straight, aseptate, hyaline, guttulate, $3.8-5 \times 2-2.5 \mu m$.

Culture characteristics: On PDA, the colony effuse, brown, slow growing. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1-3 µm wide hyphae. Conidiophores macronematous, single, or 1-2 in cluster, cylindrical, erect, unbranched, straight, or slightly flexuous, 1-4-septate, brown, dark brown at the base, becoming paler towards the apex, 40–75 (-90) µm long, 2.5–3 µm wide, basal cells 4-6 µm wide, Conidiogenous cells integrated, terminal, monophialidic, cylindrical, brown, becoming paler towards the apex, smooth, $25-30 \times 2.5-3.5 \mu m$, with 1–2percurrent proliferations; collarettes inconspicuous, with broad opening 3-3.6 µm wide, with multisporulating loci within the collarettes. Conidia produced singly within the collarettes and aggregated in spore head, oblong-ellipsoidal, straight, aseptate, hyaline, guttulate, 3.5–4.2×2.5–3.5 µm. Chlamydospores lateral, single or 2-3 in chain, dark brown, smoothand thin-walled, $4.5-7 \times 4.5-5 \mu m$ (Fig. 114a, b).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China.

Notes: *Chloridium shangsiense* is characterized by absence of setae, cylindrical and septate conidiophores, terminal monophialidic conidiogenous cells with inconspicuous collarette and multisporulating loci, and hyaline, oblongellipsoidal conidia. It is similar to *Chloridium virescens* var. *caudigerum* and *C. virescens* var. *chlamydosporum*, but differs from them by conidiogenous cells with broader and inconspicuous collarette, oblong-ellipsoidal conidia and also unique ITS sequences (Gam and Holubová-Jechová 1976).

Both LSU and ITS sequences were obtained from the single spore isolate of the type specimen Wu1285b and its

affinity to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 43199 include *Chloridium gonytrichii* (GenBank MT559106, 94% identity), *Gonytrichum macrocladum* (GenBank MH857954, 94% identity) and *G. mirabile* (GenBank MH860990, 94% identity).

Chloridium sinense W.P. Wu & Y.Z. Diao, sp. nov., Fig. 126, MycoBank MB841603.

Etymology: Refers to the country where this fungus was originally discovered.

Typification: **China**, Zhejiang Province, Deqing, Moganshan, Luhuadang, on rotten seed pods of unidentified Leguminosae, 16 October 2019, W.P. Wu (Holotype HMAS 351351976 (=Wu17056); ex-type strain CGMCC 3.20743 (=NN77481).

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1-3 µm wide hyphae. Teleomorph: Unknown. Anamorph: Setae cylindrical, simple, erect, straight, or flexuous, brown to dark brown, thick-walled at the base, thin-walled at the upper part, smooth, 5-6-septate, $135-200 \times 3-4.5$ µm, fertile at the apex and terminating by a conidiogenous cell. Conidiophores solitary or 2-5 in group, cylindrical, erect, unbranched, straight or slightly flexuous, 2-3-septate, brown, becoming paler towards the apex, tapering gradually towards the apex, smooth, 50-60 $(-80) \times 2.5 - 3.5 \mu m$, swollen up to 5 μm wide at the base, narrowing up to 2.-2.5 µm wide at the upper part below the collarette. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, brown, becoming paler towards the apex, smooth, apex pale brown, $32-42 \times 2.5-3.5 \mu m$, apex 2-2.5 µm wide; collarette inconspicuous, with a single sporulating locus within the collarette. Conidia produced singly within the collarette and aggregated in slimy spore mass, short cylindrical, ellipsoidal, subglobose, aseptate, hyaline, $3.4-3.8 \times 2-2.5 \,\mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown (Fig. 114e, f).

Other studied living strains: 77,482 and 77,483 (all from Wu17056).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China.

Notes: *Chloridium sinense* is characterized by unbranched setae with fertile apex, clustered conidiophores with setae, cylindrical conidiogenous cells with inconspicuous collarette, and hyaline, aseptate, cylindrical, ellipsoidal to subglobose conidia. It differs from other *Chloridium* species



Fig. 126 *Chloridium sinensis* (Wu17056, holotype). **a, b, d–g** Conidiophores and conidiogenous cells. **c** Basal part of conidiophores in clusters. **h–o** Conidia. Scale bar: 5 μm

with setae, *C. botryoideum* (conidiogenous cell repeatedly sympodially proliferating, conidia elongate–ellipsoidal to cylindrical, $3-4.5 \times 0.8-1 \mu m$), *C. cylindrosporum* (conidiogenous cells sympodially proliferating, conidia cylindrical with tapering and rounded or truncate ends, slightly constricted, $8.5-11.5 \times 2.2-3 \mu m$), *C. setosum* (conidiogenous cell monophialidic, conidia cylindrical, ellipsoidal, subglobose, $3.4-3.8 \times 2-2.5 \mu m$), *C. transvaalense* (conidiogenous

cell monophialidic, conidia oblong, $4-5 \times 1.5 \mu$ m) and *C. virescens*(conidiogenous cell monophialidic and with multisporulating loci, conidia $2.5-3.8 \times 2-2.5 \mu$ m) by a combination of morphology of setae, conidiogenesis and conidia (Ellis 1971; Gams and Holubová-Jechová 1976; Morgan-Jones et al. 1983).

LSU and ITS sequences were obtained from the single spore isolate of the type specimen Wu17056 and its affinity



Fig. 127 Chloridium tropicale (YN004, holotype). a-g Conidiophores and conidiogenous cells. h-m Conidia. Scale bar: a, b 10 µm, c-m 5 µm

to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,481 include *Chloridium* sp. (GenBank MN860551, 98% identity), *Gonytrichum macrocladum* (GenBank MH859954, 92% identity) and *G. mirabile* (GenBank MH860990, 94% identity).

Chloridium terricola Yong Wang, Jie & K.D. Hyde, Mycotaxon 132: 80, 2017.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores mononematous, erect arising from the hypha, hyaline to pale brown, smooth. Conidiogenous cells borne directly on the hypha or in divergent forks on the conidiophores, ampulliform or lageniform, pale brown, smooth, $7-15 \times 2.5-4$ µm. Conidia obovoid or ellipsoid, truncate at the base, pale brown, smooth, $2-3 \times 2-2.5$ µm. Sexual stage not observed.

Typification: **China**, Sichuan Province, Jiuzhaigou, isolated from soil, August 2005, Yu-Lan Jiang (Holotype, HGUPd4519 (dried culture); ex-type culture, HGUP4519; GenBank KM434144, KT893302).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China (Wang et al. 2017).

Description and illustration: Wang et al. (2017).

Notes: *Chloridium terricola* is a recently described species with *Penicillium*-like conidiophores, monophialidic conidiogenous cells and obovoid or ellipsoid conidia with truncated base and in slimy heads, which is rather unique in the genus. Morphologically it resembles *Chloridium aquaticum*, which also produces *Penicillium*–like sporulating structure at the apex of the conidiophores. They differ by longer and narrower conidia in *C. aquaticum* (conidia 3.4–5.5 × 1.1–2.7 μ m) (Wang et al. 2017; Wei and Zhang 2018).

Chloridium tropicale W.P. Wu & Y.Z. Diao, sp. nov., Fig. 127, MycoBank MB841604.

Etymology: Refers to its occurrence in tropical area.

Typification: **China**, Yunnan Province, Jinghong, Xishuangbanna, on dead leaves of unidentified tree, 6 December 2018, Zhang Yu, Holotype HMAS 351977 (=Wu15234), ex-type strain CGMCC 3.20725 (=NN76009).

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth hyphae. Setae absent. Teleomorph: Unknown. Anamorph: Conidiophores solitary or in group, cylindrical, erect, unbranched, straight or slightly flexuous, 3–5-septate, brown to dark brown, becoming paler towards the apex, tapering gradually towards the apex, smooth, $70-110 \times 2.5-3.5 \mu m$, swollen up to 7 μm wide at the base, narrowing up to 2–2.5 μm wide at the upper part below the collarette. Conidiogenous cells integrated, terminal, monophialidic, cylindrical to subcylindrical, brown, becoming paler towards the apex, smooth, apex subhyaline, $30-40 \times 3-4 \mu m$ wide; collarettes inconspicuous up to 2.5 μm wide, with a single sporulating locus within the collarettes. Conidia produced singly within the collarette and aggregated into slimy spore mass in globose to cylindrical shape, oblong to\ ellipsoidal, straight, or slightly curved, aseptate, hyaline, guttulate, $3.5-5 \times 1.8-2 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown (Fig. 114c, d).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China.

Notes: *Chloridium tropicale* differs from other species in the genus by cylindrical to subcylindrical conidiogenous cells without conspicuous collarettes, and small oblong to ellipsoidal conidia. It resembles *C. virescens* and *C. lignicola*, but differs from them by inconspicuous collarette and unique ITS sequence. Both LSU and ITS sequences were obtained from the single spore isolate of the type specimen Wu15243 and its affinity to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 76,009 include *Chaetosphaeria* sp. (GenBank MT610981, 92% identity), *Chloridium virescens* (GenBank MT66338, i93% identity) and *Phialocephala* sp. (GenBank MH268056, 92% identity).

Chloridium virescens (Pers.) W. Gams & Hol.-Jech. var. *caudigerum* (Höhn.) W. Gams & Hol.-Jech., Stud. Mycol. 13: 19, 1976. Figures 114o, 128

= Cirrhomyces caudiger Höhn., Annls Mycol. 1: 529, 1903.

= *Chloridium caudigerum* (Höhn.) S. Hughes, Can. J. Bot. 36: 748, 1958.

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1.5–3 µm wide hyphae. Teleomorph: Not observed. Anamorph: Setae cylindrical, dark brown, 5–8(-12)-septate, erect, straight or slightly flexuous, thick-walled, smooth, becoming paler and thin-walled in the upper part, $(64-)100-140 \times 3-4$ µm, with a swollen basal cell up to 10 µm, terminating with a monophialidic condiogenous cell. Conidiophores 3–6 in group with a setae, cylindrical, erect, unbranched, straight, or slightly flexuous, 2–3-septate, pale brown to brown, dark brown at the base, becoming paler towards the apex, smooth, thin-walled, $30-70 \times 1.5-2.5$ µm. Conidiogenous cells integrated, terminal, monophialidic, pale brown to brown, becoming paler towards the apex,



Fig. 128 *Chloridium virescens* var. *caudigerum* (**a**-**i** Wu12125, **j**-**l** 15218). **a**-**g**, **i** Conidiophores and conidiogenous cells bearing developing conidia. **h**, **i** Basal part of conidiophores. **k**, **l** conidia. Scale bar: 10 μm

smooth, apex subhyaline, $15-25 \times 2-2.8 \mu m$; collarettes inconspicuous, $1.8-2.5 \mu m$ wide, up to $1.0 \mu m$ deep, with multisporulating loci within the collarettes. Conidia produced singly within the collarette and aggregated in cirrhi on top of the conidiogenous cell, slimy globose, subglobose, ellipsoidal, sometimes slightly curved, uniguttulate, smoothwalled, aseptate, hyaline, $2.5-4 \times 1.5-2.5 \mu m$.

Materials examined: **China**, Beijing, Mentougou, Baihuashan, on rotten cone of *Pinus* sp., 4 August 2018, W.P. Wu (Wu15218); Guangdong Province, Shaoguan, Danxiashan, on dead bark of unidentified tree, 3 March 2012, W.P. Wu (Wu12125); Jilin Province, Changbaishan, on rotten wood of *?Betula* sp., 5 September 1998, W.P. Wu (Wu1801a); Yunnan Province, on rotten wood of unidentified plant, December 18 1997, W.P. Wu (Wu2065a); Yunnan Province, Simao, on dead branches, 13 October 1999, W.P. Wu & Yan Huang (Wu2811). Living strains: 54,231 (from Wu12125), 76,072 (from Wu15218), 75,663 and 85,045.

Ecology/Substrate/Host: Saprobes on dead material of plants, including Acer, Betula, Cedrus, Fagus, Fraxinus, Picea, Pinus, Populus, Quercus.

Geographical distribution: Widely distributed in Asia, Europe and North America (Gams and Holubová-Jechová 1976; Morgan-Jones et al. 1991).

Description and illustration: Gams and Holubová-Jechová (1976); Morgan-Jones et al. (1991).

Notes: Chloridium virescens var. caudigerum is characterized by presence of setiform conidiophores clustered with 3–6 short conidiophores, monophialidic conidiogenous cells with broad collarette with multisporulating loci, and hyaline, aseptate, globose, subglobose to ellipsoidal conidia $(2.5-4 \times 1.5-2.5 \ \mu\text{m})$ aggregated in cirrhi (Gams and Holubová-Jechová 1976). It is known on rotten material of many different plants, including Acer, Betula, Cedrus, Fagus, Fraxinus, Picea, Populus, Quercus.

Both LSU and ITS sequences were obtained from the single spore isolates of several specimens and its affinity to other members of *Chloridium* was confirmed. The ITS sequences obtained from the two different Chinese collections are with some variation (8 bp difference), but morphologically they cannot be distinguished. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 54231 include *Chloridium virescens* var. *caudigerum* (GenBank MH864068, 99% identity) and *Chaetosphaeria vermicularioides* (GenBank KM056319, 99% identity).

Chloridium virescens (Pers. ex Pers) W. Gams & Hol.-Jech. var. *chlamydosporum* (van Beyma) W. Gams & Hol.-Jech., Stud. Mycol. 13: 21, 1976.

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, $1.5-3 \mu m$ wide hyphae. Teleomorph: Not observed. Anamorph: Conidiophores solitary in small group, cylindrical, erect, unbranched, straight or slightly flexuous, 5–7-septate, brown, dark brown to black at the base, becoming paler and thinner towards the apex, thick-walled, smooth, 78–150×3–4 µm, swollen up to 10 µm wide at the base, terminating with a monophialidic conidiogenous cell, with 1–3 percurrent proliferations. Conidiogenous cells integrated, terminal, monophialidic, brown, becoming paler towards the apex, smooth, apex subhyaline, $10-20(-30) \times 2.5-3$ µm, apex 2–3 µm wide; collarette funnel-shaped or inconspicuous, with multisporulating loci within the collarettes. Conidia produced singly within the collarette, aggregated in slimy head, globose, oblong to ellipsoidal, straight, aseptate, hyaline, 3.5–4×2–2.5 µm.

Culture characteristics: Colonies on PDA effuse, colonies 1.2–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown (Fig. 114n).

Materials examined: **China**, Guangdong Province, Guangzhou, Baiyunshan, on rotten wood, 5 March 2012, W.P. Wu (Wu12033); Jilin Province, Changbaishan, on rotten wood of *Betula* sp., 5 September 1998, W.P. Wu (Wu1822a). Living strain: 54238 (from Wu12033), 53,598, 58,529, 58,557, 58,587, 72,291, 72,279, 75,743, 85,152, 85,146, all isolated from soil samples.

Ecology/Substrate/Host: Saprobes on dead material of plant, including *Betula* sp.

Geographical distribution: China and other countries (Gams and Holubová-Jechová 1976).

Description and illustration: Gams and Holubová-Jechová (1976).

Note: *Chloridium virescens* var. *chlamydosporum* differs from *C. virescens* var. *caudigerum* by absence of setae and conidia aggregated into slimy head (Gams and Holubová-Jechová 1976). Both LSU and ITS sequences were obtained from the single spore isolate of several specimens and its affinity to other members of *Chloridium* was confirmed, although there are some differences between the sequences obtained.

Chloridium xigazense Y.M. Wu & T.Y. Zhang, Mycotaxon 123: 277, 2013.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores brown, paler towards the apex, macronematous, mononematous, solitary or in groups, erect, septate, smooth, $80-140 \mu m \log 2-3 \mu m$ wide. Conidiogenous cells monophialidic, terminal, constricting abruptly and expanding in a flaring collarette, thereafter frequently proliferating 1–4 times. Conidia produced singly but often adhering in chains, 0-septate, smooth, hyaline, ellipsoidal to oblong, obtuse at the apex, with a



Fig. 129 Chloridium xishuangbanaense (YN013). a-h Conidiophores and conidiogenous cells. i-l Conidia. Scale bar: 5 µm

dark hilum at the subtruncate base, $3-5 \times 2-2.5 \mu m$ (Adapted from Wu and Zhang 2013).

Typification: **China**, Tibet, Xigaze, from a grassland soil, altitude 3600 m, 7 September 2007, Y.M. Wu (Holotype HSAUP II 070,874; isotype HMAS 196,268).

Ecology/Substrate/Host: Saprobes in soil.

Geographical distribution: China (Wu and Zhang 2013).

Description and illustration: Wu and Zhang (2013); Zhang and Wu (2019).

Notes: *Chloridium xigazense* is characterized by unbranched conidiophores with frequently sympodial proliferation, and ellipsoidal to oblong, hyaline, and small-sized conidia $(3-5\times2-2.5 \ \mu\text{m})$. It differs from the relevant species *Chloridium smithiae* by its bigger conidia and from *C. phaeosporum* by its frequently proliferating conidiogenous cells and hyaline conidia (Wu and Zhang 2013; Zhang and Wu 2019).

Chloridium xishuangbanaense W.P. Wu & Y.Z. Diao, sp. nov., Fig. 129, MycoBank MB841605.

Etymology: Refers to the locality where this fungus was originally collected.

Diagnosis: Conidiophores cylindrical, $35-50 \times 2.5-3 \mu m$. Conidiogenous cell monophialidic, cylindrical, with funnelshaped collarettes, $25-27 \times 2.5-3 \mu m$. Conidia ellipsoidal, oblong, aseptate, hyaline, $3.8-5 \times 2.2-2.4 \mu m$, produced in slimy head.

Typification: **China**, Yunnan Province, Jinghong, Xishuangbanna, on dead leaves of unidentified tree, 6 December 2018, Zhang Yu, Holotype HMAS 351978 (=Wu15242/ YN13a), ex-type strain CGMCC 3.20723 (=NN75978).

Description on the natural substrate: Colonies on PDA effuse, slow growing, brown, hairy. Mycelium partly superficial and partly immersed in the media, composed of brown, septate, subhyaline to pale brown, smooth, $1-3 \mu m$ wide hyphae. Teleomorph: Unknown. Anamorph: Setae absent. Conidiophores solitary or 2-3 in group, cylindrical, erect, unbranched, straight or slightly flexuous, 1-2(-5)-septate, brown, dark brown at the base, becoming paler towards the apex, tapering gradually towards the apex, smooth, 35-50 $(-70) \times 3.5 - 3 \mu m$, produced from the hyphae. Conidiogenous cells integrated, terminal, monophialidic, brown, becoming paler towards the apex, smooth, apex subhyaline, cylindrical, subcylindrical, $25-27 \times 2.5-3 \mu m$ wide, occasionally with one percurrent proliferation; collarettes funnel-shaped, 2–2.3 µm wide, 1.2–1.5 µm deep, with a single sporulating locus. Conidia produced singly within the collarette and aggregated in slimy head, ellipsoidal, oblong, straight, aseptate, hyaline, $3.8-5 \times 2.2-2.4 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 0.8–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white to yellow brown,

with pale colored margin, reverse pale to yellow (Fig. 114g, h).

Other living strains: 75,979 and 75,980 (from Wu15242). Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China.

Notes: *Chloridium xishuangbanaense* is characterized by short conidiophore consisting of 1–2 basal cells and a terminal conidiogenous cell, long and monophialidic conidiogenous cell with a funnel-shaped collarette, and ellipsoidal, oblong conidia ($3.8-5 \times 2.2-2.4 \mu m$) in wet spore mass. It is similar to *C. lignicola*, but has broader conidia (Gams and Holubová-Jechová 1976). Both LSU and ITS sequences were obtained from the single spore isolate of the holotype specimen Wu15242 and its affinity to other members of *Chloridium* was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 75,978 include *C. virescens* (GenBank MT663381, 97% identity), *C. virescens* var. *chlamydosporum* (GenBank MH864069, 91% identity).

Catenularia Grove in Sacc., Syll. Fung. 4: 303, 1886.

= Haplochalara Linder, Mycologia 25: 347, 1933.

=*Psiloniella* Costantin, Mucéd. Simpl. (Paris) 25: 190, 1888.

Teleomorph: Ascomata perithecia, superficial, solitary or in groups growing among phialophores and capitate hyphae, globose with a short ostiolar papilla, black, bearing radiating and usually upwardly bent capitate hyphae and sometime also phialophores. Asci unitunicate with a non-amyloid annulus near the apex, cylindrical-clavate, 8-spored, subsessile. Ascospores ellipsoidal, hyaline, septate. Anamorph: Colonies effuse, sparse, brown to dark brown, hairy. Capitate hyphae absent or present, cylindrical, erect, straight, brown to dark brown, septate, bearing a hyaline cap of mucilage at the apex. Conidiophores solitary or aggeregated, simple, erect, straight, or flexuous, smooth, dark brown at the base, becoming paler towards the apex, cylindrical, septate, percurrently proliferating. Conidiogenous cells integrated, monophialidic, cylindrical, with a funnel- or cup-shaped and pale brown collarette. Conidia develop singly and successively within the collarette to form a chain which readily secedes, cuneiform, brown to dark brown, smooth, aseptate, base truncate, apex slightly angular with 3-6 blunt corners when viewed from above and at each corner is seen a small circular, thin and pale area of cell wall which presumable functions as a germ pore (Réblová et al. 2021d).

Type species: *Catenularia cuneiformis* (Richon) E.W. Mason (= *Catenularia simplex* Grove).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Ecological distribution: Broadly distributed, especially in subtropical and tropical area (Réblová et al. 2021d).



Fig. 130 Maximum likelihood (ML) tree based on ITS sequence data for *Paragaeumannomyces* and related genera. Bootstrap support values $\geq 60\%$, Bayesian posterior probability values ≥ 0.95 are shown at the nodes. *Nawawia filiformis* MH758196 was chosen as the out-

group. Ex-type strains are indicated with "T" in the end of the taxa labels. Latin names and ex-type strain numbers of the new species described in the current study are shown in font

Description and illustration: Hughes (1965); Ellis (1971, 1976).

Notes: Catenularia was introduced with two species, C. *simplex* (the type species) and *C. atra* (=*Spadicoides atra*) (Hughes 1965). The genus was revised by Hughes (1965) with four accepted species and the other ten species were excluded from the genus. He delimited the genus by presence of capitate hyphae bearing a hyaline cap of mucilage at the distal end; cylindrical, brown, septate conidiophores with percurrent proliferation; cylindrical conidiogenous cells with funnel-shaped collarette; and brown to dark brown, aseptate, cuneiform conidia produced endogenously in chains. A number of species have been added into the genus during the last a few decades, they are C. cubensis., C. cuneiformis var. minor, C. guadalcanalensis, C. hughesii, C. kalakadensis, C. malabarica, C. pidopliczkoi, C. piceae, C. simmonsii, C. variegata (Matsushima 1971; Ellis 1971, 1976; Morgan-Jones 1972; Holubová-Jechová 1978; Sharma 1980; Holubová-Jechová 1973a, b, 1982, 1983; Holubová-Jechová and Mercado Sierra 1984; Subramanian and Bhat 1987; Li et al. 2017a, b; Réblová et al. 2021d). Among them, three species were excluded from the genus and taxonomically reassigned: Catenularia guadalcanalensis into Monilochaetes as *M. guadalcanalensis* (Gams and Holubová-Jechová 1976; Réblová et al. 2011a), *Catenularia simmonsii* into *Sporoschismopsis* as *S. simmonsii* (Holubová-Jechová and Hennerbert 1972), and *Catenularia piceae* into *Exochalara longissima* (Gams and Holubová-Jechová 1976). The remaining species are morphologically matched characters of *Catenularia* as defined by Hughes (1965) but differ from it by lacking capitate hyphae among conidiophores. The genus was recently reviewed by Réblová et al. (2021d) who accepted 11 species with or without capitate hyphae.

Phylogenetically it belongs to Chaetosphaeriaceae (Figs. 3, 130), which has been confirmed by both pure culture study and also molecular phylogenic study (Booth 1957, 1958; Hughes 1965; Holubová-Jechová 1982; Réblová 1999a, 2000, 2004; Réblová and Seifert 2003; Luo et al. 2019; Li et al. 2020). All known teleomorphs of the genus *Catenularia* were placed under *Chaetosphaeria*, i.e., *Chaetosphaeria catenulata*, *C. cubensis*, *C. cupulifera*, *C. novaezelandiae* and *C. trianguloconidia*.

Molecular phylogenic study with inclusion of several species, including *Catenularia angulospora*, *C. minor*, *Chaetosphaeria catenulata* and *Chaetosphaeria cubensis*, supports the separation of *Catenularia* from *Chaetosphaeria*



Fig. 131 Colony of *Chaetosphaeria* and related genera on PDA after 20 days at 25 °C. **a**, **b** *Ejnerjensenia myriocarpa* (44603). **c–f** *Chaetosphaeria innumera* (**c**, **d** 43746, **e**, **f** 43874). **g**, **h** *Paragaeumanno-*

(Réblová et al. 2011b; Luo et al. 2019). Inclusion of more species in the phylogenetic analysis will further clarify the concept of the genus and their relationship (Fernández et al. 2006; Luo et al. 2019). The conidia of these species seem to be difficult to germinate and the fungus grows very slowly on PDA (Fig. 131).

myces minimus (78408). i, j Fuscocatenula sp. (43776). l Fuscocatenula variegata (55332). m, n Craspedodidymum elatum (42874). o, p Chaetosphaeria sp. (43137)

Species of the genus *Catenularia* are saprophytic occurring on the surface of decaying wood or bark. Four species were recorded from China and here we add another 3 species, incl. 2 new species.

. . . .

. ..

Key to accepted species of *Catenularia* and *Fuscocatenula* (Revised from Réblová et al. 2021d)

1.	Conidia with blunt corners at the distal end (<i>Catenu-</i>
1	<i>Laria</i>)
1.	conidia rounded and without blunt corners at the distance of (<i>Fuscocatenula</i>) 13
2	Capitate hyphae present
2.	Capitate hyphae absent
2. 3	Conidia longer than 20 um 4
3	Conidia shorter than 20 µm
2. 4	Conidia rounded-obconic usually with 3 blunt corners
1.	$27-45 \times 16.8-24 \text{ um}$ C longispore
4.	Conidia with 3–5, usually 4 blunt corners.
	$21-28 \times 19-28$ um
5.	Conidia 6 cornered, up to 8 µm long, 6–7 µm wide at
	the distal end
5.	Conidia 2–5 cornered, longer than 8 µm6
6.	Conidia 12.6–17.5×11.4–18.2 µm
	Č. novae–zelandiae
6.	Conidia up to 13.5 µm long and 11 µm wide7
7.	Conidia 9–13.5 \times 7.5–10 µm <i>C. cupulifera</i>
7.	Conidia 9.0–10.0×9.0–11.0 µm
8.	Conidia more than 20 µm long and wide9
8.	Conidia less than 20 µm long and wide10
9.	Conidia $34-42 \times 34-38 \ \mu\text{m}$, $8-9.5 \ \mu\text{m}$ wide at the flat-
	tened base, with 4 cornersC. elegans
9.	Conidia 23–24.5 \times 20.8–24 μ m, 3–4 μ wide at the flat-
	tered base, with five cornersC. elsikin
10.	Conidia less than 9 µm long11
10.	Conidia more than 9 µm long in average12
11.	Conidia up to $8 \times 6-7 \mu m$, 1.5–3.5 μm side at the base,
	with six cornersC. kalakadensis
11.	Conidia $6-8(-9) \times 4.5-6(-7) \mu m$, ca. 2 μm wide at the
	base, with 3 blunt cornersC. angulospora
12.	Conidia $12-18 \times 18-21 \mu m$, $3-4 \mu m$ wide at the base,
	with 4–5 cornersC. malabarica
12.	Conidia $13-15 \times 12-14 \mu m$, with $3-4$ corners
	C. catenulata
13.	Conidia $21-27 \times 12-14 \ \mu m$ <i>F. submersa</i>
13.	Conidia less than 20 µm long14
14.	Conidia $8.5-11 \times 5.5-7.5 \ \mu m$ F. variegata

14. Conidia $10-15 \times 5-5.5 \,\mu\text{m}$*F. bambusicola*

Catenularia angulospora (Linder) Mason, Mycol. Pap. 5: 121, 1941. Figure 132

=*Halachalara angulospora* Linder, Mycologia 25: 347, 1933.

= Sphaeria cupulifera Berk. & Broome, Ann. Mag. Nat. His. 7: 435, 1871.

= Chaetosphaeria cupulifera (Berk. & Broome) Sacc. Syll. Fung. 7: 94, 1883. *=Lasiosphaeria cupulifera* (Berk. & Broome) Coke & Plowr., Grevillea 7: 85, 1879.

Description on the natural substrate: Colonies effuse, sparse, brown, hairy. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, smooth, pale brown to brown hyphae 2-3.5 µm wide. Teleomorph: Not observed. Anamorph: Conidiophores macronematous, simple, erect, straight, cylindrical, smooth, dark brown at the base, becoming paler towards the apex, 3-7-septate, 130-250×6-8 µm wide, percurrently proliferating at the apex. Conidiogenous cells integrated, determinate, monophialidic, lageniform, brown, smooth, $24-35 \times 5-7 \mu m$, percurrently proliferating 1–4 times through the collarette; collarettes funnel-shaped, pale brown, 3-3.5 µm deep and 4-4.5 um wide at the distal end. Conidia develop singly and successively within the collarette to form a chain of up to 10 which readily secedes, smooth, cuneiform, brown, truncate at base, rounded at the apex, 12-13 µm long, 11-13 wide at the widest distal end, $2.5-3 \mu m$ wide at the flattened base, apex slightly angular with 3-4 blunt corners when viewed from above and at each corner is seen a small circular, thin and pale area of cell wall which presumable functions as a germ pore.

Materials examined: **China**, Guangdong Province, Lufushan, on dead culm of bamboo, 14 October 1998, W.P. Wu (Wu1959a); Guangdong Province, Lufushan, on rotten wood, 14 October 1998, W.P. Wu (Wu1978a); Guangdong Province, Lufushan, on dead branches of unidentified plant, 14 October 1998, W.P. Wu (Wu1989a); Guangdong Province, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (Wu2219); Yunnan Province, Xishuangbanna, on dead stem of unidentified plant, 20 October 1999, W.P. Wu & Yan Huang (Wu2802, Wu2842).

Ecology/Substrate/Host: Saprobe on dead plant material, including dead culm of bamboo, dead branch and rotten wood.

Geographical distribution: China, Europe and North America (Réblová et al. 2021d).

Description and illustration: Mason (1941); Réblová et al. (2021d).

Notes: *Catenularia angulospora* belongs to a group of several species with obclavate conidiogenous cells and no capitate hyphae among conidiophores. These species can be distinguished from each other by the size of the cuneiform-shaped conidia (Mason 1941; Matsushima 1971; Ellis 1971, 1976; Morgan-Jones 1972; Sharma 1980; Holubová-Jechová 1982; Holubová-Jechová and Mercado Sierra 1984; Subramanian and Bhat 1987; Réblová et al. 2021d). *Catenularia catenulata* is morphologically very similar to *C. angulospora*. This is the first record from China. No living strain was observed from those fresh collections.

Catenularia catenulata (Z.L. Luo, K.D. Hyde & H.Y. Su) Réblová & A.N. Mill., MycoKeys 81: 13, 2021. Figure 133



Fig. 132 *Catenularia angulospora* (Wu2842). **a**, **b** Conidiophores with percurrent proliferations. **c**–**k** Upper part of conidiophores with conidiogenous cells and developing conidia in chains. **l**, **n** Conidia. **m** Ascospore. Scale bar: **a** 20 µm, **b** 10 µm, **c**–**g** 5 µm



Fig. 133 Catenularia catenulata (WU7260a). a-e Conidiophores. f-k Conidiogenous cells. l-o Conidia. Scale bar: a-e 20 µm, f-o 5 µm



Fig. 134 Catenularia cubensis (Wu5503d). a–d Conidiophores and conidiogenous cells with percurrent proliferations. e–g Conidia. Scale bar: 10 µm

≡ *Chaetosphaeria catenulata* Z.L. Luo, K.D. Hyde & H.Y. Su, Fungal. Divers. 99: 582, 2019.

Description on the natural substrate: Teleomorph: Not observed. Anamorph: Conidiophores 187–283 μ m long, 6–10 μ m wide, cylindrical. Conidiogenous cells monophialidic, integrated, terminal, cylindric-clavate, with flared collarette. Conidia 13–15 μ m long, 12–14 μ m wide, formed in chains, aseptate, turbinate-triangular, with 3 blunt protruding edges at the broader distal end, viewed from above 3-lobed or

cruciform with blunt protruding corners, hyaline to subhyaline when young, greyish brown at mature, smooth-walled.

Typification: **China**, Yunnan Province, Nujiang River, saprobic on submerged decaying wood, October 2016, Z.L. Luo, S–891 (MFLU 18–1620, holotype), ex-type living culture DLUCC 0891.

Material examined: **China**, Yunnan Province, Baoshan, Lujiang, Bawan, Gaoligongshan, on rotten wood, 15 October

2003, W.P. Wu (Wu7260a, Wu7260b, Wu7273b, 7274). Living strain: 47776 (from Wu7260a).

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: China (Luo et al. 2019). Description and illustration: Luo et al. (2019). Notes: *Catenularia catenulata* resembles *C. cubensis* in having septate, unbranched, cylindrical conidiophores, integrated monophialidic conidiogenous cells with percurrent proliferations, and cuneiform, aseptate conidia, but can be distinguished from each other by the relatively larger conidia



Fig. 135 *Catenularia elegans* (Wu6078, holotype). **a** Conidiophores in clusters and conidia. **b–g** Conidiophores, conidiogenous cells and conidia. **h, i** Conidia. Scale bar: **a** 30 μm, **b–d** 20 μm, **e–i** 10 μm

in *C. catenulata* (Holubová-Jechová 1982; Luo et al. 2019; Réblová et al. 2021d).

Catenularia cubensis Hol.-Jech., Mycotaxon 15: 278, 1982. Figure 134

= Chaetosphaeria cubensis Hol.-Jech., Mycotaxon 15: 278, 1982.

Description on the natural substrate: Colonies effuse, sparse, brown, hairy. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, smooth, pale brown to brown hyphae 2-3.5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, simple, erect, straight, cylindrical, smooth, dark brown at the base, becoming paler towards the apex, 5–8-septate, $110-150 \times 4-6 \mu m$, percurrently proliferating at the apex. Conidiogenous cells integrated, monophialidic, cylindrical, obclavate, brown, smooth, $24-32 \times 5-5.5 \mu m$, irregularly percurrently proliferating 1-2 times; collarettes funnel-shaped, pale brown, 4-4.5 µm wide at the distal end. Conidia develop singly and successively within the collarette to form a chain of up to 10 which readily secedes, smooth, cuneiform, brown, truncate at base, rounded at the apex, 6.5-8 µm long, 4.5-6 wide at the widest distal end, $2.5-3 \mu m$ wide at the flattened base, apex slightly angular with 3-4 blunt corners when viewed from above and at each corner is seen a small circular, thin and pale area of cell wall which presumable functions as a germ pore.

Materials examined: **China**: Hainan Province, on rotten wood of unidentified plant, 15 December 2000, W.P. Wu & Yan Huang (Wu5503d).

Ecology/Substrate/Host: Saprobe on dead plant material.

Geographical distribution: China and Cuba (Holubová-Jechová 1982; Xia et al. 2013; Luo et al. 2019; Réblová et al. 2021d).

Description and illustration: Holubová-Jechová (1982); Xia et al. (2013); Luo et al. (2019).

Notes: *Catenularia cubensis* differs from other species by lacking capitate hyphae among conidiophores, and smaller conidia and (Holubová-Jechová 1982; Mercado Sierra et al. 1997a, b; Xia et al. 2013). The fungus was recently reported on submerged decaying wood from Yunnan, China (Luo et al. 2019).

Catenularia elegans W.P. Wu & Y.Z. Diao, sp. nov., Fig. 135, MycoBank MB841606.

Etymology: elegans (L), beautiful, refers to its beautiful conidia.

Diagnosis: Differs from all other species in the genus by wide collarette and larger conidia $(34-42 \times 34-38 \ \mu m)$.

Typification: **China**, Hunan Province, Mangshan, on dead branches of unidentified plant, 21 April 2002, W.P. Wu, Holotype HMAS 351967 (=Wu6078).

Description on the natural substrate: Colonies effuse, sparse, brown. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, smooth, pale brown to brown hyphae, 3–6 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, simple, erect, straight, smooth, dark brown at the base, becoming paler towards the apex, cylindrical, 5-8-septate, $300-500 \times 7-11$ µm wide, percurrently proliferating at the apex. Conidiogenous cells integrated, monophialidic, cylindrical, brown, smooth, percurrently proliferating 1-4 times through the collarette; collarettes funnel- or cup-shaped, pale brown, 3-5 µm deep and 13-15 µm wide at the distal end with a frayed margin. Conidia develop singly and successively within the collarette to form a chain of up to 10 which readily secedes, smooth broadly obovoid to more or less rounded-obconic, with 3 corners at the top, truncate at the basal scar, rounded at the apex, brown to dark brown, smooth, 34-42 µm long, 34-38 µm wide at the distal end, $8-9.5 \,\mu\text{m}$ wide at the flattened base; slightly angular with 3 blunt corners when viewed from above and at each corner is seen a small circular, thin and pale area of cell wall which presumable functions as a germ pore.

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: China.

Notes: Among the described species of the genus *Catenularia*, *Catenularia elegans* resembles *C. macrospora* S. Hughes (conidia 21–28 μ m long, 19–28 μ m wide at the distal end, and 4–7 μ m wide at the flattened base) in conidial size, but differs by lacking capitate hyphae among conidiophores and producing significant bigger conidia in the former species (Hughes 1965; Réblová et al. 2021d). We failed to culture the fungi after some attamp due to no germination of conidia. The phylogenetic relationship of this species with other *Catenularia* remains to be studied.

Catenularia kalakadensis Subram. & Bhat, Kavaka 15: 49, 1989 (1987).

Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, simple, erect, straight or flexuous, smooth, 5–8-septate, $75-200 \times 3.5-5 \mu m$. Conidiogenous cells monophialidic, integrated, terminal, with a distinct collarette, $25-35 \times 4-5 \mu m$. Conidia 6.5–8.5 μm long, 4–6.5 μm wide at the distal broad end, 1.5–2.5 μm wide at the truncate base.

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: China (Xia 2017) and India (Subramanian and Bhat 1989).

Description and illustration: Subramanian and Bhat (1989); Xia (2017).

Notes: *Catenularia kalakadensis* was originally described from India and reported from China by Xia (2017). Based on the description and illustration from both the original description and the documentation by Xia (2017), it can hardly be distinguished from *C. cubensis* (Subramanian and Bhat 1989; Xia, 2017).

Chaetosphaeria Tul. & C. Tul., Select. Fung. Carpol. (Paris) 2: 252, 1863.

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=*Miyoshia* Kawam., J. Coll. Sci. imp. Univ. Tokyo: 10, 1907.

= *Trichocollonema* Höhn., Sitz.-Ber. K. Akad. Wiss. Math.-naturwiss. Kl. Abt. I 111: 1015, 1902.

Type species: *Chaetosphaeria innumera* Berk. & Broome ex Tul. & C. Tul.

Ecology/Substrate/Host: Saprobe on dead material of plants and isolated from ecological samples.

Geographical distribution: Broadly distributed, especially in subtropical and tropical area.

Descriptions and illustration: Réblová et al. (1999) and Maharachchikumbura et al. (2016).

Notes: The genus Chaetosphaeria, as typified by C. innumera, is characterized by non-stromatic, dark, papillate ascomata, persistent paraphyses, unitunicate asci with a shallow, refractive annulus and hyaline, ellipsoidal, fusiform to filiform, one to several-septate hyaline ascospores, although several species with versicolorous ascospores are also accommodated in the genus (Tulasne and Tulasne 1863; Maharachchikumbura et al. 2016). The asexual conidial phases in the genus *Chaetosphaeria* are with tremendous variation in morphology of conidiomata, conidiophores, conidiogenous cells and conidia, and traditionally classified into more than 10 different dematiaceous genera, in which phialidic conidiogenous cells and hyaline or dark-colored conidia are found. These dematiaceous phialidic hyphomycetes include Catenularia, Cryptophiale, Dictyochaeta, Menispora, Chloridium, Thozetella, etc. (Hughes and Kendrick 1968; Réblová et al. 1999, 2006, 2020, 2021a, b, c, d; Réblová and Winka 2000; Huhndorf et al. 2001, 2004; Réblová 2004; Fernández and Huhndorf 2005; Fernández et al. 2006; Réblová and Seifert 2008; Liu et al. 2016; Perera et al. 2016; Luo et al. 2019; Hyde et al. 2020). The members of Chaetosphaeria are lignicolous perithecial ascomycete and the genus has a world-wide distribution. Four species in this genus have been reported from freshwater habitats (Luo et al. 2019).

Our phylogenetic analysis (Fig. 3, 94 and 308) clearly shows that the genus *Chaetosphaeria* Tul. & C. Tul. is

polyphyletic and problematic, which is aligned with what was reported already (Réblová 2000; Fernández and Huhndorf 2005; Fernández et al. 2006; Liu et al. 2016; Lin et al. 2019; Luo et al. 2019; Hyde et al. 2020; Réblová et al. 2020, 2021a, b, c, d). The species included in the analysis are distributed in several different clades on the ML tree. Some of them are grouped together with the genera known only with anamorphs, e.g., Cacumisporium, Catenularia, Chloridium, Codinaea, Craspedodidymum, Dictyochaeta., Exserticlava, Obeliospora, Thozetella and Zanclospora. A systematic revision of the genus is needed towards redelimitation of monophyletic generic concepts, and this has been on its way. For example, based on both morphology and molecular analysis, Réblová et al. (2020) adapted Paragaeumannomyces Matsush. to accommodate 13 known Chaetosphaeria species with scolecospore ascospore which are phylogenetically clustered as a distinct group from other Chaetosphaeria species. The new genus Achrochaeta was created for Chaetosphaeria talbotii with a Dictyochaeta anamorph which proved different from the core of Dictyochaeta and forming a separate lineage in the Chaetosphaeriaceae (Réblová et al. 2021c). It is also clear from our analysis that several species, such as Chaetosphaeria rivularia. and Chaetosphaeria longiseta, should be replaced to other genera.

On the phylogenetic tree (Fig. 3), the *Chaetosphaeria* species with the anamorphic states classified in *Catenularia, Cacumisporium, Dischloridium* and *Exserticlava* are grouped together with *Paragaeumannomyces* and formed a polyphyletic clade with strong support from all analysis and independent from the type species of the genus *Chaetosphaeria*. They probably represent different monotypic genera and different from others including *Chaetosphaeria* and *Paragaeumannomyces*, thus we recommend maintaining the anamorphic generic names for these fungi.

Chaetosphaeria innumera Berk. & Broome ex Tul. & C. Tul., Sel. Fung. Carpol. 2: 252, 1863. Figure 136

=Lasiosphaeria innumera (Berk. & Broome ex Tul. & C. Tul.) Stev., Mycol. Scot.: 391, 1879.

= *Byssosphaeria innumera* (Berk. & Broome ex Tul. & C. Tul.) Cooke, Grevillea 15: 123, 1887.

= Chloridium botryoideum (Corda) S. Hughes, Can. J. Bot. 36: 748, 1958.

= *Chloridium minutisporum* Lindau, Rabenh. Krypt.-Fl. 1: 724, 1906.

= Chloridium botryoideum (Corda) S. Hughes var. minatum (Sacc.) W. Gams & Hol.-Jech. Stud. Mycol. 13: 43, 1976.

= Rhinotrichum minutum Sacc., Michelia 1: 87, 1877.

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, $1.5-2.5 \mu m$ wide hyphae. Teleomorph:



Fig. 136 *Chaetosphaeria innumera* (= *Chloridium botryoideum*, Wu15225). **a–k** Conidiophores and conidiogenous cells bearing funnel-shaped collarettes. l Conidia. Scale bar: **a** 10 μ m, **b–l** 5 μ m

Not observed. Anamorph: Conidiophores solitary or 2–5 in group, cylindrical, erect, unbranched, straight or slightly flexuous, 2–7-septate, brown, dark brown to black at the base, becoming paler towards the apex, cylindrical, tapering gradually towards the apex, smooth, $100-150 \times 3-3.5 \mu m$, swollen up to 6 μm wide at the base, narrowing up to 2–2.5 μm wide at the upper part below the collarette. Conidiogenous cells integrated, terminal, polyphialidic, brown, becoming paler towards the apex, smooth, apex subhyaline, $10-22 \times 2-2.5 \mu m$ wide, apex 1–1.5 μm wide; collarette funnel-shaped or cylindrical, proliferation sympodial and/ or percurrent, giving to the conidiophores a geniculate or annellidic appearance. Conidia produced singly within the collarette and aggregated in short or long chains, oblong-ellipsoidal, straight, aseptate, hyaline, $1.5-2 \times 1 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse pale brown to brown.

Materials examined: China, Beijing, Mentougou, Baihuashan, on rotten wood, 4 August 2018, W.P. Wu (Wu15225); Guangxi Province, Shiwandashan, on dead leaves of ?Cinnamomum sp., 30 December 1997, W.P. Wu (Wu1559b); Hubei Province, Shengnongjia, on rotten wood of unidentified plant, 17 September 2004, W.P. Wu (Wu8296); Hubei Province, Shennongjia, on plant litter, 18 September 2004, W.P. Wu (Wu8290); Hunan Province, Zhangjiajie, on rotten wood, 16 October 2010, W.P. Wu (Wu11034); Jilin Province, Changbaishan, on rotten wood of Betula sp., 5 September 1998, W.P. Wu (Wu1820b); Ningxia Province, Liupan Mountain, Qiuxianjia, on dead stem of Quercus sp., 26 August 1997, W.P. Wu (Wu1104a,b); Ningxia Province, Jingyuan County, Liupan Mountain, Qiuqianjian, on dead stems of herbaceous plant, 26 August 1997, W.P. Wu (Wu1007I). Living strains: 43746 (from Wu1007i), 43874 (from Wu1104b), 44,692 (from Wu1820b), 50679 (from Wu8290), 76,105 and 76,091 (from Wu15225).

Ecology/Substrate/Host: Saprobe on dead plant material.

Geographical distribution: China, Czechoslovakia, Hungary, and widely distributed in other countries from Europe and North America.

Description and illustration: Gams and Holubová-Jechová (1976); Holubová-Jechová and Revay (1987).

Notes: The anamorph of *Chaetosphaeria innumera* is known as *Chloridium botryoideum*, which has a broad distribution and commonly found on rotten wood (Gams and Holubová-Jechová, 1976). In the specimen Wu1820b, we constantly observed the percurrent proliferation through the collarettes and the upper part of the conidiogenous cells with an annellidic appearance, which has not been described in this species in the literature.

Both LSU and ITS sequences were obtained from the single spore isolates of several different specimens and its affinity to other member of *Chaetosphaeria* in Chaetosphaeriae was confirmed from the phylogenetic analysis. The ITS sequences obtained from these strains has almost identical sequence with *Chloridium botryoideum* var. *minutum* strain CBS247.75. No ITS sequence was found for *Chloridium botryoideum* var. *botryoideum*, the two LSU sequences under this name have only 95% identity to our sequences from the strain 1820b.

Chaetosphaeria lentomita W. Gams & Hol.-Jech., Stud. Mycol. 13: 24, 1976.

= *Chloridium pachytrachelum* W. Gams & Hol.-Jech., Stud. Mycol. 13: 26, 1976.

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: Belgium, China, Netherland, Slovakia, and many other countries in Europe (Gams and Holubová-Jechová 1976).

Description and illustration: Gams and Holubová-Jechová (1976).

Notes: Ho et al. (2002) found this species on submerged wood in Hongkong, China, but did not provide description and illustration in their study. The anamorphic status *Chloridium pachytrachelum*, as also discovered from Hong Kong (Ho et al. 2002).

Chaetosphaeria obovoidea J.Y. Zhang & Y.Z. Lu, J. Fungi 8, 643: 10, 2022.

Ecology/Substrate/Host: Saprobe on decaying wood submerged in a stream.

Geographical distribution: China (Zhang et al. 2022).

Description and illustration: Zhang et al. (2022).

Notes: *Chaetosphaeria obvoidea* is an asexually typified species and characterized by solitary and simple conidiophores, terminal phialides with funnel-sahped collarettes and proliferating percurrently, and hyaline, aseptate, obvoid conidia $(10-14.8 \times 5-7.25 \ \mu\text{m})$ and bearing no appendage.

Craspedodidymum Hol.-Jech., Česká Mykol. 26: 70–73, 1972.

Colonies effuse, thin, consisting of isolated, blackish bristles. Mycelium partially superficial and partially immersed, composed of pale brown to brown, septate, branched, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores mononematous, erect, straight, or slightly curved, simple, or branched, cylindrical, septate, brown, smooth. Conidiogenous cells integrated, terminal, monophialidic, clavate, subcylindrical, pale brown to medium brown, smooth, with a thin, pale brown, funnel-shaped and flaring collarette. Conidia holoblastic, aggregated in slimy heads, ovoidal, brown to blackish, smooth- and thick-walled, aseptate or septate. Type species: Craspedodidymum elatum Hol.-Jech.

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: Broadly distributed.

Description and illustration: Holubová-Jechová (1972).

Notes: The genus Craspedodidymum, typified by C. elatum, is characterized by brown, branched or unbranched, cylindrical conidiophores; monophialidic and apically inflated conidiogenous cells with large, funnel-shaped phialidic collarettes; and the brown, aseptate conidia aggregated in slimy heads (Holubová-Jechová 1972). The concept of the genus such as branches of conidiophores, shape and septation of the conidia has become broader with the introduction of other species into the genus (Yanna et al. 2000; Figueroa et al. 2018). The mechanism of percurrent proliferations of conidiogenous cell was described by Sutton (1976). A total of 15 species names have been published under the genus (Holubová-Jechová 1972; Lunghini and Onofri 1980; Kirk 1985; Rao and de Hoog 1986; Subramanian and Bhat 1989; Mercado Sierra and Mena Portales 1992; Bhat and Kendrick 1993; Yanna et al. 2000; Pinruan et al. 2004; Ma et al. 2011a; Figueroa et al. 2018). Among them, C. pulneyense is a synonym of *C. proliferans* (Bhat and Kendrick 1993); C. hyalosporum Bhat & W.B. Kendr. was transferred into the recently described genus Anacraspedodidymum; C. licualae was reported to be the anamorph of Thailandiomyces bisetulosus, which phylogenetically belongs to Diaporthales (Pinruan et al. 2008). Those accepted species can be distinguished by their conidial morphology, as illustrated by Yanna et al. (2000), Pinruan et al. (2004) and Figueroa et al. (2018). A key to the 14 accepted species was provided by Figueroa et al. (2018).

In our phylogenetic tree, Craspedodidymum elatum, the type species of the genus Craspedodidymum, is grouped together with Chaetosphaeria dilabens with strong support. The morphological similarity of *Craspedodidymum* elatum and Chaetosphaeria dilabens is the development of well-developed conidiophores, terminal and monophialidic conidiogenous cell with funnel- or cup-shaped collarette, and ellipsoidal, aseptate and pale brown to brown conidia. It is the first time that the ITS and LSU sequences are obtained for the type species of Craspedodidymum. In the literature the genus Craspedodidymum has been assigned to Chaetosphaeriaceae, but that is based on observation of the similar anamorphs obtained in pure culture for several scolecosporous species of Chaetosphaeria, now known as Paragaeumannomyces (Huhndorf and Fernández 2005; Perera et al. 2016; Réblová et al. 2020). In these species, very similar phialidic structure (broad funnel-shaped collarette) and conidial shape were observed, but they never develop long conidiophores and dark-colored conidia; and phylogenetically they are clustered as a distinct group from the type species of the genus *Craspedodidymum*. Morphologically the known species of *Craspedodidymum* are diverse and future phylogenetical study is needed to clarify their phylogenetic relationship.

The genus was only recently known for China with 4 species, including *Craspedodidymum abigianense*, *C. fujianense*, *C. hyalosporum* (now as *Anacraspedidymum hyalosporum*) and *C. proliferans* (Ma et al. 2011a; Xia et al. 2015; Chang 1995; Yang et al. 2016a, b). Here we added another 3 species as new records for China, including *C. cubense*, *C. fimbriatum* and *C. guatemalense*.

Key to accepted species of *Craspedodidymum* (Based on Figueroa et al. 2018)

1.	Conidia aseptate2
1.	Conidia septate
2.	Conidiogenous cells mono- or rarely poly-phialidic;
	conidia globose or obovoid, papillate at the base,
	brown, 13.5–14.5×14.5–16.5 µm <i>C. abigianense</i>
2.	Conidiogenous cells always monophialidic
3.	Conidia globose or subglobose to broadly obovoid4
3.	Conidia not as above7
4.	Conidia fibrillose with numerous acellular curved
	appendages forming a pile or coat on the surface, mid
	brown, 18–24 µm diamC. fimbriatum
4.	Conidia not fibrillose5
5.	Conidia $\leq 5 \mu\text{m}$ wide, papillate at the base, pale brown,
	5–6.2×3.5–4 µm <i>C. microsporum</i>
5.	Conidia > 5 µm wide
6.	Conidia solitary, sometimes pyriform, dark brown,
	11.5–15×10.5–13 μmC. cubense
6.	Conidia arranged in false chains, brown to dark brown,
	18–22×13.2–19 μm <i>C. seifertii</i>
7.	Conidia obovoid to cuneiform
7.	Conidia not as above9
8.	Conidia not papillate, brown, 10–14×8–11 µm
	C. proliferans
8.	Conidia papillate, brown, $13.7-17.5 \times 7.5-10 \ \mu m$
	C. licualae
9.	Conidia mostly oblong or cylindrical10
9.	Conidia not as above11
10.	Conidia brown, $13-15.5 \times 7.5-10 \ \mu mC.$ fujianense
10.	Conidia brown, $11-17 \times 7-8.5 \ \mu mC.$ pulneyense
11.	Conidia fabiform to allantoid, brown, $8.5-12.5 \times$
	4–5 μm <i>C. guatemalense</i>
11.	Conidia ellipsoid12
12.	Conidia papillate at the base, dark brown, 13.5-
	20×7.5–11.5 µm



Fig. 137 Craspedodidymum carpaticum (Wu8296). **a–c, h, i, m–s** Conidiophores and conidiogenous cells. **d–l** Conidia. Scale bar: **m–s** 20 μm, **a–l** 5 μm

- Conidia 3-septate, with two dark brown distal cells, broadly ellipsoidal to obovoid, truncate at the base, 24–30×13–19 μm.....C. nigroseptatum

Craspedodidymum abigianense Lunghini & Onofri, Trans. Br. Mycol. Soc. 74: 208, 1980.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores cylindrical, dark brown, 4–6-septate, $120-170 \times 5.2-7$ µm. Conidiogenous cells terminal, ellipsoidal, monophialidic or rarely polyphialidic, percurrently proliferating, $20-30 \times 6.5-8$ µm, pale brown, with a distinct funnel-shaped collarette, 1.5-2.0 µm high, 5.5-7.5 µm wide at the open end. Conidia spherical or more often obovoid, smooth, dark brown, generally paler when young, aseptate, $15.5-18.5 \times 5.5-16.5$ µm, papillate at the base (Yang et al. 2016a, b).

Specimens: **China**, Hainan Province, Diaoluoshan, on dead stems of unidentified broadleaf tree, 26 May 2014, X.Y. Li (HSAUP H7566).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China (Yang et al. 2016a, b), West African (Lunghini and Onofri 1980).

Descriptions and illustrations: Lunghini and Onofri (1980); Yang et al. (2016a, b).

Notes: No specimen was examined by us. The above description is based on excellent documentation by Yang et al. (2016a, b). The conidia from the Chinese collection seem to be much bigger than those in the original description ($13.5-14.5 \times 14.5-16.5 \mu m$) (Lunghini and Onofri 1980).

Craspedodidymum carpaticum (Hol.-Jech. & Révay) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 137, MycoBank MB841726.

 \equiv *Chloridium carpaticum* Hol.-Jech. & Révay, Acta Bot. Hung. 33: 63, 1987.

= Craspedodidymum guatemalense Figueroa, Bran, O. Morales & R.F. Castañeda, Mycotaxon 133: 316, 2018.

Description on the natural substrate: Colonies on the natural substrate effuse, hairy, dark brown. Mycelium partly superficial and partly immersed, composed of septate, branched, brown, smooth-walled hyphae. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, solitary, simple, erect, straight or slightly flexuous, cylindrical, 4–7-septate, mid to dark brown near the base, with the upper part pale olivaceous brown, smooth-walled, 100–180×3–5 μ m. Conidiogenous cells integrated, terminal,

monophialidic, cylindrical, pale brown, $8-15 \times 4-5 \mu m$, percurrently proliferating; collarettes funnel-shaped, 1.5–2.5 μm deep, and 1.5–2.5 wide at the open end, narrowing to 1.2–1.5 μm diam at the base. Conidia holoblastic, acrogenous, aggregated in brown to dark brown spore mass,

allantoid to fabiform, unicellular, smooth-walled, brown, $8-12.5 \times 4-5 \mu m$, with a paler and thinner small germ pore at both or only at one end.

Materials examined: **China**, Hubei Province, Shengnongjia, on rotten wood of unidentified plant, August 2000, W.P. Wu (Wu8296).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China, Czechoslovakia, Guatenaka and Hungary.

Descriptions and illustrations: Holubová-Jechová and Revay (1987); Figueroa et al. (2018).

Notes: *Craspedodidymum guatemalense*, originally described on decaying bark of *Quercus* sp. from Guatemala, is no doubt the same fungus named as *Chloridium carpaticum*. Its allantoid- to fabiform-shaped conidia with a paler and thinner small germ pore at both or only at one end clearly differs it from all other known species in the genus (Gams and Holubová-Jechová 1976; Figueroa et al. 2018). The conidia from our collection did not germinate on PDA medium, thus no living culture was obtained for molecular study. Its phylogenetic position remains to be studied in future.

Craspedodidymum elatum Hol.-Jech., Česká Mykol. 26: 70, 1972. Figure 138.

Description on the natural substrate: Colonies effuse, thin, consisting of isolated, blackish bristles. Mycelium partially superficial and partially immersed, composed of pale brown to brown, septate, branched, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary, erect, straight or slightly curved, simple, cylindrical, 8–12-septate, brown, becoming pale brown towards the apex, smoothwalled, $180-260 \times 5-9 \ \mu\text{m}$. Conidiogenous cells integrated, determinate, clavate, pale brown to medium brown, smooth, $18-34 \ \mu\text{m}$ long, $12-13 \ \mu\text{m}$ wide at the widest part, with a thin, pale brown, funnel-shaped and flaring collarette, $6-10 \ \mu\text{m}$ long, $8-9 \ \mu\text{m}$ wide at the apex. Conidia holoblastic, aggregated in slimy heads, ovoidal, brown to blackish, smooth- and thick-walled, aseptate, $12-14 \times 10-11 \ \mu\text{m}$.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–0.7 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, reverse light-yellow brown.

Materials examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, On dead branches of unidentified plant, 2 January 1997, W.P. Wu (Wu1267a, Wu1270b, Wu1322a). Living strain: 42874 (from Wu1322a).



Fig. 138 Craspedodidymum elatum (Wu1270b). **a**, **b** Conidiophores. **c–f** Conidiogenous cells with collarettes and developing conidia. **g–j** Conidia. Scale bar: **a** 20 μm, **b** 10 μm, **c–j** 5 μm

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China and Cuba (Holubová-Jechová 1972; Mercado Sierra and Mena Portales 1992; Mena Portales and Mercado Sierra 1987).

Descriptions and illustrations: Holubová-Jechová (1972); Mercado Sierra and Mena Portales (1992); Mena Portales and Mercado Sierra (1987).

Notes: *Craspedodidymum elatum* resembles *C. cubense*, and can only be distinguished by its branched conidiophores in the former species. The specimen from China bears the fungus with unbranched conidiophores, otherwise it is identical to *C. elatum*. It also resembles *C. proliferans* V. Rao & de Hoog but in the latter species the conidiogenous cells are with percurrent growth through the collarettes (Rao and

de Hoog 1986; Portales and Mercado Sierra 1992, 1997). These three species might represent the same fungus, which needs to be further confirmed by molecular study of the two other species. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 42874 include *Chaetosphaeria dilabens* (GenBank NR159784, 92% identity), *C. hebetiseta* (GenBank AF178549, 89% identity) and *C. innumera* (GenBank AY906956, 88% identity).

Craspedodidymum fimbriatum Bhat & W.B. Kendr., Mycotaxon 49: 33, 1993.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores fasciculate in groups, erect, straight or slightly curved, simple, cylindrical, 4–8-septate, brown, becoming pale brown towards the apex, smooth-walled, percurrently regenerating, $135-210 \times 4-6 \mu m$. Conidiogenous cells integrated, monophialidic, cylindrical to clavate, pale brown to medium brown, smooth, 18–30 µm long, slightly inflated and rounded at the apex, 8–11 µm wide at the widest part, apex bears an inconspicuous collarette. Conidia holoblastic, aggregated in slimy heads, globose, aseptate, pale brown, thick-walled, 19–22 µm diam., with numerous acellular, fibrillose appendages forming a pile or coat on the surface.

Material examined: **China**, Hainan Province, tropical forest of Bawangling, on dead branches of unidentified plant, 8 May 2011, Sh. C. Ren (HMAS146164).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China and India (Bhat and Kendrick 1993; Ren et al. 2012).

Descriptions and illustrations: Bhat and Kendrick (1993); Ren et al. (2012).

Notes: *Craspedodidymum fimbriatum* is very characteristic in processing a cylindrical to clavate conidiogenous cells with inconspicuous collarette, and pale brown, thick-walled, globose conidia with densely fibrillose surface and formed in slimy head (Bhat and Kendrick 1993; Ma et al. 2012).

Craspedodidymum fujianense L.G. Ma & X.G. Zhang, Mycotaxon 117: 351 2011.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores solitary, simple, erect, straight or flexuous, cylindrical, up to 10 septate, brown, becoming pale brown towards the apex, smooth-walled, $175-420 \times 6.5-8.5 \mu m$. Conidiogenous cells integrated, terminate, clavate, subcylindrical, swollen at the subapical region, pale brown to medium brown, smooth, 21–30 μm long, 9–12 μm wide at the widest part; collarettes pale brown, funnel-shaped and flaring, 6–7.5 μm long, 6.5–9.5 μm wide at the apex, 4.5–5.5 μm wide at the base. Conidia holoblastic, aggregated in slimy heads, oblong, brown to blackish, smooth- and thick-walled, aseptate, 13–17.5×7.5–10 μm .

Materials examined: **China**, Fujian Province, The National Forest Park of Wuyishan, on dead branches of *Acacia confusa*, 15 August 2009, L.G. Ma (HMAS 146,089, isotype).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China (Ma et al. 2011a, b; Xia 2017).

Descriptions and illustrations: Ma et al. (2011a, b); Xia (2017).

Notes: The isotype material HMAS 146,089 was examined in our study. As discussed by Ma et al. (2011a, b), this fungus differs from the closely related species *C. siamense* Pinruan by its oblong and aseptate conidia without a papilla (Pinruan et al. 2004). *Craspedodidymum proliferans* Vasant Rao & de Hoog, Stud. Mycol. 28: 64, 1986.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores solitary, simple, erect, straight, or flexuous, simple, cylindrical, septate, mid to dark brown near the base, with the upper part pale olivaceous brown, smooth-walled, up to 390 μ m, 8–10 μ m wide. Conidiogenous cells integrated, terminal, monophialidic, proliferating percurrently, clavate, 20.5–24×9.5–10 μ m; collarettes funnel-shaped, 4.5–6.5 μ m high, and 7–7.5 μ m wide at the open end, narrowing to 4–4.5 μ m diam at the base. Conidia holoblastic, aggregated in slimy heads, obovoid, subglobose to trapezoid, truncate at the base, aseptate, 9.5–13×8.5–12 μ m (Ma et al. 2011a, b).

Material examined: **China**, Fujian Province, The National Forest Park of Wuyishan, on dead branches of *Magnolia paenetalauma*, 15 August 2009, L.G. Ma, HMAS 146090.

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: China and India (Rao and de Hoog 1986; Chang 1995; Ma et al. 2011a, b).

Descriptions and illustrations: Rao & de Hoog (1986); Chang (1995); Ma et al. (2011a, b).

Notes: The specimen HMAS 146,090 preserved in HMAS was examined in this study. It is morphologically similar to *C. cubensis* J. Mena & Mercado but has narrower conidia (Mercado Sierra and Mena Portales 1992). In addition to the report in mainland China, the fungus was also recorded from Taiwan (Chang 1995).

Ejnerjensenia W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB841699.

Etymology: Named after the former Vice President Ejner B. Jensen from Novozymes, who made significant contribution to industrial biotechnology and gave strong encouragement for this mycological research during last 25 years.

Diagnosis: Ascospore hyaline, cylindrical, uniseptate. Conidiophore cylindrical, dark brown, septate, terminated with a monophialidic conidiogenous cell bearing a cupshaped collarettes; Conidia hyaline, aseptate, short cuneate or dacryoid.

Type species: *Ejnerjensenia myriocarpa* (Fr.) W.P. Wu & Y.Z. Diao.

Teleomorph: Perthecia often densely aggregated, with or without a thin, black, basal pseudostroma. Perthecia black, brittle, subglobose, ostiole conical, smooth-walled, glossy; wall consisting of several layers of strongly compressed, pigmented cells of textura epidermoidea. Asci thin-walled, narrow cylindrical. Paraphyses emerging between the asci. Ascospore mostly somewhat obliquely monostichous, chromophilic, cylindrical, with rounded ends, 1-septate, hyaline, smooth-walled. Anamorph: Setae absent. Conidiophore solitary, simple, cylindrical, erect, straight or flexuous, septate, **Fig. 139** *Ejnerjensenia myriocarpa* (= *Chloridium clavaeforme*, Wu15226). **a, f, g, j** Conidiophores and conidiogenous cells with funnel-shaped collarette. **b–e, h, i** Conidia. Scale bar: 5 μm



brown to dark brown, smooth-walled, terminated with a conidiogenous cell, proliferating percurrently. Conidiogenous cells integrated, terminal, monophialidic, brown, becoming paler towards the apex, smooth; collarette flaring or funnelshaped or cup-shaped. Conidia produced singly within the collarette and aggregated in a slimy masses or regular chain, typically short-cuneate or dacryoid with a truncate base and rounded or flatten apex, smooth-walled, aseptate, hyaline (Adapted from Constantinescu et al. 1995).

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: Broadly distributed in worldwide.

Notes: The new genus *Ejnerjensenia* is created for *Chaetosphaeria myriocarpa* and its anamorphic state *Chloridium clavaeforme* In the phylogenetic tree (Figs. 3, 130) forms a

strongly supported linkage distinct from the type species of *Chaetosphaeria* (*C. innumera*) and other genera in Chaetosphaeriaceae species. Morphologically it differs from other related genera by 1-sepate ascospore, monophialidic conidiogenous cells with percurrent proliferation and flaring or funnel-shaped or cup–shaped collarettes, and hyaline aseptate, short-cuneate or dacryoid conidia in slimy head and with a truncate base and rounded or flatten apex (Gams and Holubová-Jechová 1976).

In the phylogenetic analysis, *Ejnerjensenia myriocarpa* is grouped together with two other *Chaetosphaeria* species, *C. pygmaea* and *C. guttulata*. *Chaetosphaeria pygmaea* also produces one-septate ascospore, and *Chloridium*-like anamorph with flask-shaped conidiogenous cells bearing cup-shaped collarettes, and dacryoid conidia in chain and with a truncate base and rounded apex and formed, which is

very similar to *E. myriocarpa* (Constantinescu et al. 1995). While *Chaetosphaeria guttulata* was created for an anamorphic fungus characterized by dark brown and septate conidiophore with a terminal holoblastic and polyblastic conidiogenous cell bearing numerous tiny protuberant conidiogenous loci, and hyaline ovoid or fusiform, 3-sepate conidia (Luo et al. 2019).

Ejnerjensenia myriocarpa (Fr.) W.P. Wu & Y.Z Diao, comb. nov., Fig. 139, MycoBank MB 842,448.

≡ Sphaeria myriocarpa Fr., Kongl. Vetensk. Acad. Handl. 38: 267, 1817.

 \equiv *Chaetosphaeria myriocarpa* (Fr.) C. Booth, Mycol. Pap. 68: 5, 1957.

 \equiv Sphaeria myriocarpa Fr., Syst. Mycol. 2(2): 459, 1823.

= *Chloridium clavaeforme* (Preuss) W. Gams & Hol.-Jech., Stud. Mycol. 13: 31, 1976.

= Gongromeriza clavaeformis Preuss, Linnaea 24: 106, 1851.

= Catenularia beimii Mangenot, Rev. Gen. Bot. 59: 445, 1952.

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1.5–2 µm wide hyphae. Teleomorph: Not observed in our collections. Anamorph: Conidiophores solitary or in group, cylindrical, erect, unbranched, straight or slightly flexuous, 2-5-septate, brown, dark brown at the base, becoming paler towards the apex, smooth, $80-130 \times 2.5-3 \mu m$, swollen up to 8 µm wide at the base, narrowing up to 1.5–2 µm wide at the upper part below the collarette. Conidiogenous cells integrated, terminal, monophialidic, brown, becoming paler towards the apex, smooth, apex subhyaline, 20-30 µm long, 2.5-3 µm wide; collarette funnel-shaped or cup-shaped, 2.5-3 µm long, 2-2.5 µm wide at the widest part, with 1-3 percurrent proliferation. Conidia produced singly within the collarette and aggregated in a slimy masses or regular chain, typically short-cuneate or dacryoid with a truncate base and rounded tip, smooth-walled, aseptate, hyaline, $2.5-3 \times 1.5-1.8 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–0.8 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey, with pale colored margin, reverse brown to dark brown (Fig. 131a, b).

Materials examined: **China**, Ningxia Province, Jingyuan County, Liupan Mountain, Qiuqianjian, on dead stems of unidentified grass, 26 August 1997, W.P. Wu (Wu1007a); Ningxia Province, Jinyuan, Liupan Mountain, Langtianxia, on wood of unidentified plant, 25 August 1997, W.P. Wu (Wu1196B); Guangxi Province, Damingshan, on dead culms of bamboo, 18 December 1997, W.P. Wu (Wu1374c); Jilin Province, Changbaishan, on dead wood of *Betula* sp., 5 September 1998, W.P. Wu (Wu1777b); Jilin Province, Changbaishan, on rotten wood of ?*Betula* sp., 5 September 1998, W.P. Wu (Wu1802). Living strain: 44,603 (from Wu1777b).

Ecology/Substrate/Host: Saprobe on dead material of many plant species, including *Acer*, *Alnus*, *Betula*, *Cedrus*, *Fagus*, *Populus*, *Quercus*, *Sorbus*, bamboo and grass.

Geographical distribution: China, Ukraine, and also widely distributed in Europe and North America (Booth 1957; Gams and Holubová-Jechová 1976; Constantinescu et al. 1995; Crous et al. 2018a, b; Luo et al. 2019).

Description and illustration: Booth (1957); Gams and Holubová-Jechová (1976); Constantinescu et al. (1995); Crous et al. (2018a, b); Luo et al. (2019).

Notes: The anamorphic state of Chaetosphaeria myriocarpa (= Chloridium clavaeforme) can easily be distinguished from all other species in Chaetosphaereriaceae by cylindrical and septate conidiophores, monophialidic conidiogenous cells bearing a funnel-shaped or cup-shaped collarettes, and hyaline, short-cuneate or dacryoid conidia in slimy mass or chains. It has been reported on rotten material of many different plants (Gams and Holubová-Jechová 1976; Crous et al. 2018a, b; Luo et al. 2019). Among the examined specimens, the fungus in some of them such as Wu1777b are always with conidia in regular chain, while the other specimens it is always with conidia in slimy mass. This species was recently reported on submerged decaying wood from Yunnan Province, China (Luo et al. 2019). Both LSU and ITS sequences were obtained from the single spore isolates of Wu1777b and it is almost identical to those from Chaetosphaeria myriocarpa (99.77%) and Chloridium clavaeforme (99.77%) in the GenBank.

Ejnerjensenia pygmaea (P. Karst.) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB842449.

≡ Chaetosphaeria pygmaea (P. Karst.) Constant., K. Holm & L. Holm, Mycol. Res. 99: 590, 1995.

≡ Sphaeria pygmaea P. Karst., Fungi Fenn. Exsicc.: no. 875, 1869.

≡ Zignoëlla pygmaea (P. Karst.) Sacc., Michelia 1: 346, 1878.

 \equiv *Psilosphaeria pygmaea* (P. Karst) Cooke, Grevillea 16: 50, 1887.

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: Europe including Finland (Constantinescu et al. 1995).

Description and illustration: Constantinescu et al. (1995).

Notes: Based on both morphologic similarity and molecular phylogeny, *Chaetosphaeria pygmaea* is transferred into the new genus *Ejnerjensenia*. The anamorph was not discovered from natural substrate, but abundantly formed on CMA or MA from the single ascospore culture (Constantinescu et al. 1995). The anamorph was carefully studied and compared with *Chloridium clavaeforme* (Preuss) W. Gams & Hol.-Jech. and *C. phaeophora* W. Gams (Constantinescu et al. 1995). The cup-shaped collarettes and dacryoid conidia with truncated base and rounded apex in *E. pygmaea* is very similar to the anamorph of *E. myriocarpa*.

Fuscocatenula Réblová & A.N. Mill., MycoKeys 81: 31, 2021.

Colonies effuse, hairy, brown, mycelium partly immersed, partly superficial. Teleomorph: Unknown. Anamorph: Conidiophores solitary, erect, unbranched, brown to dark brown, thick-walled, paler and thinner-walled towards the apex. Conidiogenous cells integrated, terminal, monophialidic, extending percurrently, cylindrical to lageniform, brown; collarettes funnel-shaped, brown. Conidia cuneiform to obovoid, broadly rounded apically, truncate at the base, aseptate, hyaline when young, pale brown at maturity, with protracted maturation, smooth, formed in a basipetal chain.

Type species: *Fuscocatenula submersa* (Z.L. Luo, K.D. Hyde & H.Y. Su) Réblová & A.N. Mill.

Ecology/Substrate/Host: Saprobes on dead material of plant in terrestrial and freshwater environments.

Geographical distribution: China (Réblová et al. 2021d). Description and illustration: Réblová et al. (2021d).

Notes: Fuscocatenula is a newly established genus as a segregate for two fungi distantly related from Catenularia, although morphologically similar (Réblová et al. 2021d). Conidia of Fuscocatenula are obovoid with a truncate base, and lack an angular outline and small, circular, thin-walled pale areas in corners that are present in Catenularia. Conidia of these two accepted species have a protracted maturation; at first, they are hyaline and only later become pale brown, while still attached in a chain. Sometimes the chain consists of hyaline conidia with only one or a few mature pigmented conidia (Li et al. 2017a, b; Luo et al. 2019). While in *Catenularia*, conidia are also hyaline when young but mature soon, and when released from the conidiogenous locus they are usually pigmented. Two species are accepted in the genus and both are reported from China. Here we add another species, and the DNA barcode is provided for F. variegata.

Key to known species of Fuscocatenula.

Fuscocatenula bambusicola W.P. Wu & Y.Z. Diao, sp. nov., Fig. 140, MycoBank MB841607.

Etymology: Refers to the substrate from which this fungus was originally discovered.



Fig. 140 Fuscocatenula bambusicola (holotype). a Conidiophores and conidiogenous cells. b Conidia. a, b 10 µm

Diagnosis: Similar to *Fuscocatenula variegata* (conidia $8.5-11 \times 5.5-7.5 \mu m$) but differs in longer but narrower conidia.

Typification: **China**, Ningxia Province, Liupanshan, Liangdianxia, on dead culms of bamboo, 24 August 1997, W.P. Wu, HMAS 352,009 (= Wu1182b).

Description on the natural substrate: Colonies effuse, sparse, brown, hairy. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, smooth, pale brown to brown hyphae 2–3.5 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores solitary, simple, erect, straight, smooth, dark brown at the base, becoming paler towards the apex, cylindrical, 5–7-septate, 100–220×4–6 μ m wide, percurrently proliferating 1–3 times through the collarettes. Conidiogenous cells integrated, terminal, monophialidic, brown, smooth, 30–35×6–7 μ m;

collarettes funnel-shaped, pale brown,4–5 μ m deep and 4.5–5 μ m wide at the distal end. Conidia develop singly and successively within the collarette to form a chain of up to 10 which readily secedes, smooth, narrowly cuneiform, brown, truncate at base, rounded at the apex, 10–15 μ m long, 5–5.5 μ m wide at the widest distal end, 3–4 μ m wide at the flattened base.

Materials examined: **China**, Ningxia Province, Jingyuan County, Liupan Mountain, Langtianxia, on dead culm of bamboo, 25 August 1997, W.P. Wu (Wu1050a, Wu1187c); Ningxia Province, Liupanshan, Liangdianxia, on dead culms of bamboo, 24 August 1997, W.P. Wu (Holotype WFH Wu1182b).

Ecology/Substrate/Host: Saprobe on dead culm of bamboo.

Geographical distribution: China.

Notes: *Fuscocatenula bambusicola* differs from other known species in the genus by size of conidia (Réblová et al. 2021d). The conidia (8.5–11×5.5–7.5 µm) in *F. variegata* are smaller than those in *F. bambusicola*; while the conidia $(21–27\times12–14 \ \mu\text{m})$ in *F. submersa* are much longer and wider (Luo et al. 2019).

Fuscocatenula submersa (Z.L. Luo, K.D. Hyde & H.Y. Su) Réblová & A.N. Mill., MycoKeys 81: 31, 2021.

 \equiv Chaetosphaeria submersa Z.L. Luo, K.D. Hyde & H.Y. Su, Fungal Divers. 99: 585. 2019.

Teleomorph: Unknown. Anamorph: Conidiophores 380–596(–691) μ m long, 15–21 μ m wide, cylindrical, 9–13-septate. Conidiogenous cells cylindric-clavate. Conidia 21–27×12–14 μ m, cuneiform, aseptate, guttulate, rounded at apex, truncate at base, hyaline when young, light brown at mature, smooth-walled (Adapted from Luo et al. 2019).

Typification: **China**, Yunnan Province, Cangshan Mountain, saprobic on submerged decaying wood in freshwater stream, October 2016, Z.L. Luo, S–824 (MFLU 18–1616, holotype), ex-type living culture MFLUCC 18–1342.

Ecology/Substrate/Host: Saprobes on submerged decaying wood.

Geographical distribution: China (Luo et al. 2019).

Description and illustration: Luo et al. (2019).

Notes: *Fuscocatenula submersa* is known with only anamorph and morphologically resembles some members of *Catenularia* in absence of capitate hyphae and producing cuneiform conidia. However, the conidia in this species have no blunt corners and germ pore when viewed from above, which is very characteristic in the genus *Catenularia*. Furthermore, phylogenetically *C. submersa* and members of *Catenularia* clearly belong to two very different phylogenetic groups.

Fuscocatenula variegata (H.H. Li & X.G. Zhang) Réblová & A.N. Mill., MycoKeys 81: 31, 2021. Figure 141

≡ *Catenularia variegata* H.H. Li & X.G. Zhang, Mycotaxon 132: 621, 2017.

Description on the natural substrate: Saprobic on decaying leave. Colonies on the substratum effuse, dark brown, with chained conidia at the tip of conidiophores. Mycelium partly immersed, partly superficial, composed of branched septate, dark brown, smooth hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary, erect, straight, or slightly flexuous, cylindrical, unbranched, smooth or verruculose, thick-walled, 5-10-septate, brown to dark brown-, pale brown towards the apex, 160-225 µm long, 4.5-7 µm wide at the widest part. Conidiogenous cells integrated, terminal, monophialidic, pale brown to brown, cylindric-clavate, $33-35 \times 5-5.5 \mu$ m; collarette funnel-shaped, $3-3.5 \mu$ m high, up to 4 µm wide. Conidia acrogenous, formed in long chain, cuneiform, aseptate, guttulate, rounded at apex, truncate at base, hyaline when young, light brown at mature, smoothand thick-walled, 8-10 µm long, 5.8-6.2 µm wide at the widest part, $2-2.5 \,\mu\text{m}$ wide at the truncate base.

Culture characteristics: Colonies on PDA effuse, colonies 1.5–2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse pale brown to brown (Fig. 1311).

Typification: **China**, Fujian Province, Wuyishan, on dead stems of an unidentified broadleaf tree, 22 Apr. 2016, J.Y. Wang (Holotype, HSAUP H10178; isotype, HMAS 245,641).

Material examined: **China**, Guangdong Province, Shaoguan, Danxiashan, on dead leaves of palm, 25 December 2012, W.P. Wu (Wu12520). Living strain: CGMCC 3.20652 (=NN 55,332) and 55,381 (from Wu12520).

Ecology/Substrate/Host: Saprobes on dead material of plant, including palm.

Geographical distribution: China (Li et al. 2017a, b).

Description and illustration: Li et al. (2017a, b).

Notes: *Fuscocatenula variegata* was originally described under *Catenularia*. It was recently transferred into the new genus *Fuscocatenula* by Réblová et al. (2021d) based on its similarity to *F. submersa* in solitary conidiophores, terminal and monophialidic conidiogenous cells with broad collarette, and hyaline then brown conidia in chains (Li et al. 2017a, b; Luo et al. 2019; Réblová et al. 2021d). It differs from *F. submersa* by producing smaller conidia (the bigger conidia (8–10×5.8–6.2 µm vs. 21–27×12–14 µm). The conidiophores, conidiogenous cells and conidia in our collection match the original description of *F. variegata*, however we did not find the percurrent proliferation of conidiophores in our collection. The living strain was obtained from the fresh specimen, and the ITS bar code is provided here. On the phylogenetic tree, *F. submersa* is closely linked to *F. variegata*.



Fig. 141 *Fuscocatenula variegata* (Wu12520). **a–e** Conidiophores, conidiogenous cells and developing conidia. **a–e** Part of conidiophores, conidiogenous cells and developing conidia. **k–s** Conidia. Scale bar: **a–e** 20 μm, **f–s** 5 μm

Fusichloridium W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB841536.

Etymology: Refers to its fusiform-shaped conidia.

Diagnosis: Similar to *Chloridium* but differs in producing both long setiform and short conidiophores, and fusiformshaped conidia which are slightly constricted in the middle. Phylogenetically they are also different.

Type species: *Fusichloridium fusiformis* (W. Gams & Hol.-Jech.) W.P. Wu & Y.Z. Diao.

Colonies effuse, brown. Teleomorph: Ascomata perthecia, black, smooth-walled, shining, subglobose, ostiole conical, covered with conidiophores, without a basal stroma, walls consisting of numerous layers of thick-walled, pigmented cells. Paraphyses threadlike, soon evanescente. Asci cylinderical to somewhat fusiform, thin-walled, with a thin apical plate, with spores in 3-4 rows. Ascospores fusiform with a somewhat rounded upper end, mostly 3-septate, each cell 1-2 guttulate. Anamorph: Conidiophores forming two layers: the lower short conidiophores pale brown, cylindrical, 0-1-septate, sympodially or sometime percurrently proliferating, monophialidic or polyphialidic, with funnelshaped collarettes, and produce abundant whitish to yellowish sporulation; the upper with darker, thick-walled setiform conidiophores, septate, tapering towards the apex, terminating in a monophialidic conidiogenous cells with almost hyaline collarettes. Conidia in dry, star-like heads, cylindrical with tapering and rounded or truncate ends, centrally sometime slightly constricted, hyaline, aseptate, smooth-walled (Adapted from Réblová and Gams 1999).

Fusichloridium fusiforme (W. Gams & Hol.-Jech.) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841727.

≡ *Chaetosphaeria fusiformis* W. Gams & Hol.-Jech., Mycotaxon 13: 257, 1981.

 \equiv Chaetosphaeria fusispora W. Gams & Hol.-Jech., Stud. Mycol. 13: 45, 1976.

= *Chloridium cylindrosporum* W. Gams & Hol.-Jech., Stud. Mycol. 13: 46, 1976.

= Chaetopsis cylindrospora (W. Gams & Hol.-Jech.) DiCosmo, S.M. Berch & W.B. Kendr., Mycologia 75:962, 1983.

Typification: **Czech Republic**, Mor., Hruby Jesenik Mts., Mt. Mravenečník, on rotten branches of *Abies alba*, 3 August 1971, PRM 794,008.

Ecology/Substrate/Host: Saprobes on dead material of plant.

Geographical distribution: Czech Republic and Ukraine (Gams and Holubová-Jechová 1976, 1981; Réblová and Gams 1999).

Description and illustration: Gams and Holubová-Jechová (1976, 1981); Réblová and Gams (1999).

Notes: Fusichloridium is created to accommodate the unique fungus Chaetosphaeria fusiformis, which is known

with both anamorph and teleomorph. They are phylogenetically distinct from *Chaetosphaeria innumera*, the type species of *Chaetosphaeria*. Morphologically they are also different from *C. innumera* in both teleomorph and anamorph. In *C. fusiformis*, the ascospores are fusiform to filiform; the conidiophores are two layers, and the conidia are produced in dry mass, cylindrical with tapering and rounded or truncate ends, centrally sometime slightly constricted. While in *C. innumera*, the ascospores are fusiform; the conidiophores are one layer, and the conidia are in slimy head or simple chains, elongate-ellipsoidal to cylindrical (Gams & Holubová-Jechová, 1976).

Nawawia Marvanová, Trans. Br. Mycol. Soc. 75: 227, 1980.

Colonies effuse, hairy, pale brown. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores cylindrical, single or in small groups, erect, straight, unbranched, or occasionally branched irregularly, thickwalled, smooth, medium to dark brown, becoming paler towards the apex, often proliferating percurrently, septate. Conidiogenous cells integrated, terminal, monophialidic, medium brown, smooth, cylindrical; collarettes funnelshaped, often proliferates with a new phialides. Conidia of two types: a) hyaline, aseptate, ellipsoidal to oval, smooth, thin-walled, base truncate, apex rounded or occasionally with a short appendage, formed before the second type; b) hyaline, aseptate, smooth, thin-walled, turbinate to triangular-shaped, viewed from above the conidium is also triangular and from each corner of the triangle as a long, hair-like appendage, truncate.

Type species: *Nawawia filiformis* (Nawawi) Marvanová (≡ *Clavatospora filiformis* Nawawi).

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: Broadly distributed.

Description and illustration: Marvanová (1980).

Notes: *Nawawia* was established by Marvanová (1980) based on *Nawawi filiformis* (Nawawi 1973) and is characterized by septate, cylindrical conidiophores, terminal monophialidic conidiogenous cells, and turbinate–tetrahedral to obpyramidal unicellular hyaline conidia with a filiform appendage at each blunt corner. Six species are known, and they are distinguished by a combination of conidial morphology, including shape, size and setulae (Nawawi 1973; Kuthubutheen et al. 1992; Hyde et al. 1996; Melnik and Hyde 2006; Cruz and Gusmão, 2009; Goh et al. 2014a; Peng et al. 2016).

Chalarodes, Nawawia, and *Phialosporostilbe* are three dematiaceous hyphomycete genera with similar conidial morphology and conidiogenesis (Marvanová 1980; Mercado Sierra and Mena Portales 1985; McKenzie 1991a; Kuthubutheen et al. 1992). They all have phialidic conidiogenous cells and hyaline, aseptate, tetrahedral to pyramidal **Fig. 142** Nawawia filiformis (Wu2069). **a** Conidiophores with wet spore mass at tips. **b** Conidiogenous cells with funnel-shaped collarettes. **c** Macroconidia. **d** Microconidia. Scale bar: **c** 40 μm, **b–d** 20 μm



conidia with 2–4 distal setulae, and sometime also a single basal setula. The chained conidia formed in solitary conidiophores in *Chalarodes* distinguish it from the other two genera, *Nawawia* and *Phialosporostilbe*. The two latter genera can be further distinguished by the solitary conidiophores in *Nawawia* and synnemata in *Phialosporostilbe*. Hyde et al. (1996) pointed out that *Phialosporostilbe* and *Nawawia* may be congeneric, and they placed a new synnematous *Phialosporostilbe*-like species into *Nawawia*, as *N. dendroidea*. Bhat and Kendrick (1993) suggested that a reassessment of these genera is needed.

There are 8 published names under *Nawawia*. Among them, *N. dendroidea* was transferred to *Phialosporostilbe* due to its synnematous conidiomata; *N. nitida* was transferred into *Obeliospora* based on similarity on conidiogenous cells and conidia; and *N. malaysiana* was transferred into a new genus *Neonawawia* based on the phylogenetic analysis. Other species, *N. antennata* Réblová, *N. filiformis*, *N. oviformis*, *N. quatrisetulata* and *N. sasae-kurilensis*, are accepted in the genus (Marvanová 1980; Kuthubutheen et al. 1992; Hyde et al. 1996; Cantillo-Pérez et al. 2017; Yang et al. 2018a).

Key to accepted species of Nawawia.

- 1. Conidia oviform, 13–20×11–15 μm, bearing 1 apical, 4 lateral setulae 3–10 μm long.....*N. oviformis*
- 1. Conidia turbinate, triangular, tetrahedral, or lobbed, with only polar setulae only......2
- 2. Conidia 4–5-lobed, 30–37×22.5–32.5 μm, with 4 apical setulae 30–57 μm long.....N. quatrisetulata
- 2. Conidia not lobed, smaller in size......3
- 3. Conidia round-tetrahedral, 10–14×8–11.5 μm, 3 apical setulae 4–6 μm long.....N. sasae-kurilensis
- Conidial setulae more than 10 μm; conidia turbinate to triangular, obpyramidal......4
- 4. Conidia 3 corners, 13–18×14–18 μm, 3 apical setulae 15–34 μm long.....N. filiformis

4. Conidia (3–)4 corners, 14–17×11–14.5 μm; setulae 14–43 μm long.....*N. antennata*

Nawawia filiformis (Nawawi) Marvanová, Trans. Br. Mycol. Soc. 75: 227, 1980. Figure 142

≡ *Clavatospora filiformis* Nawawi, Trans. Br. Mycol. Soc. 61: 390, 1973.

Description on the natural substrate: Colonies effuse, hairy, pale brown. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae 2-3 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores cylindrical, single or in small groups, erect, straight, unbranched, or occasionally branched irregularly, thickwalled, smooth, medium to dark brown, becoming paler towards the apex, often proliferating percurrently, 3-7-septate, 100-180 µm long, 4-4.5 µm wide. Conidiogenous cells integrated, terminal, monophialidic, medium brown, smooth, cylindrical, 17-50 µm long, 3.5-6.5 µm wide at the widest part, 3-4 µm wide just below the terminal collarette; collarettes terminal, funnel-shaped, 1.5-2 µm long, 3–5 µm wide at the tip. Conidia of two types: (a) hyaline, aseptate, ellipsoidal to oval, smooth, thin-walled, base truncate, apex rounded or occasionally with a short appendage, $7.5-12.5 \times 3.5-6.5 \mu m$, formed before the second type; (b) hyaline, aseptate, smooth, thin-walled, turbinate to triangular-shaped, viewed from above the conidium is also triangular and from each corner of the triangle as a long, hair-like appendage, 10-25 µm long, base truncate, 13-18 µm long and 14-18 µm wide.

Materials examined: **China**, Guangdong Province, Dinghushan, on rotten wood of unidentified plant, 10 October 1998, W.P. Wu (Wu2069); Guangdong Province, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (WU2059); Guangxi, on dead branches of unidentified plant, 23 December 1997, W.P. Wu (Wu2088); Hainan Province, on dead branches, 20 December 2000, W.P. Wu and Yan Huang (Wu5518).

Ecology/Substrate/Host: Saprobe on rotten wood and dead branches.

Geographical distribution: China, Malaysia (Nawawi 1973), Thailand (Yang et al. 2018a).

Description and illustration: Nawawi (1973); Wu and McKenzie (2003); Yang et al. (2018a).

Notes: Two types of conidia were also noted for *N. fili-formis* in the original description; however, the two spore types were not found to be produced together (Marvanová 1980; Mercado Sierra and Mena Portales 1985; McKenzie 1991a; Kuthubutheen et al. 1992; Yang et al. 2018a). On natural substrate only (b) spore was produced, while on 2% malt agar only the (a) spore was formed. In some of our examined specimens collected from nature (Wu2088, Wu2069), both types of conidia were seen from spore head at the top of the same conidiogenous cell. While in other

specimens only (b) type of conidia were seen. Its affinity to Chaetosphaeriaceae has been confirmed by molecular phylogenetic analysis (Yang et al. 2018a).

Nawawia oviformis J. Peng & Z.F. Yu, Mycotaxon 132: 737, 2016.

Teleomorph: Unknown. Anamorph: Conidiophores arise from a small stromatic cushion, cylindrical, single, unbranched, erect, robust, thick–walled, smooth, dark brown, becoming paler towards the apex, 10–13-septate, 246–323×4–9 μ m. Conidiogenous cells monophialidic, integrated, terminal, brown, 21–60×3.5–9 μ m. Conidia oviform to somewhat globose, slightly truncate at the base, unicellular, smooth, hyaline, guttulate, 8–10.5 μ m diam., with four equatorial filiform appendages and an apical filiform appendage, all 3–10 μ m long.

Typification: **China**, Sichuan Province, Gaosun County, Damuling Mountain, 28°92'N 103°88'E, elev. 513 m, on submerged leaves of an unidentified dicotyledonous plant in a stream, July 2015, Z.F. Yu (Holotype, YMF 1.04361).

Ecology/Substrate/Host: Saprobe on submerged leaves. Geographical distribution: China (Peng et al. 2016). Description and illustration: Peng et al. (2016).

Notes: *Nawawia oviformis* is a recently described species from China and it is characterized by unique in oviform-shaped conidia (Peng et al. 2016). All other accepted *Nawawia* Marvanová species including the type species *N. filiformis*, *N. quadrisetulata* and *N. sasae-kurilensis* have round-tetrahedral or obpyramidal conidia that are distally 3–5-lobed and with 1 apical setula at each end (Melnik and Hyde 2006; Goh et al. 2014a). On the oviform-shaped conidia with lateral setulae, *N. oviformis* is closer to members of *Bahusutrabeeja* Subram. & Bhat (Subramanian and Bhat 1977; Li et al. 2012). Its phylogenetic relationship remains to be explored when the living culture and DNA sequence are obtained from fresh collection.

Paragaeumannomyces Matsush., Matsush. Mycol. Mem. 10:156, 2003 (2001); Emend. Réblová & A. N. Miller, MycoKeys 74:34, 2020.

= *Obeliospora* Nawawi & Kuthub., Mycotaxon 37: 395, 1990.

Colonies effuse, pale brown, sparse. Teleomorph: Ascomata perithecial, non-stromatic, superficial, subglobose to conical, solitary, in small groups or aggregated, ranging from white, yellow-white, light fawn-grey, ginger-brown, reddish-brown, russet to dark brown, papillate, glabrous or setose, setae dark brown, acute, opaque, scattered over entire ascoma and/or clustered around the ostiole, centrum sometimes pink to pale red. Ostiole periphysate. Ascomatal wall three-layered. Paraphyses persistent. Asci unitunicate, 8-spored, cylindrical-fusiform, stipitate, apex with a non-amyloid apical annulus. Ascospores asymmetrical, cylindrical-filiform, slightly tapering towards the basal end, multiseptate, hyaline, occasionally light pink, with negative or positive dextrinoid reaction in Melzer's reagent. Anamorph: Setae sterile, simple, erect, straight, dark brown to blackish, thick-walled, smooth, septate, tapered gradually towards the acute to pointed apices, with inflated base. Conidiophores solitary or aggregated in groups, cylindrical, erect, brown, septate, unbranched, reduced to a few supporting cells. Conidiogenous cells monophialidic, obclavate or broadly lageniform, doliiform, subglobose, brown, with an apical opening; collarettes conspicuously flared and cupshaped. Conidia globose, subglobose, subangular to triangular, conical to pyramidal, unicellular, hyaline, furnished with several appendages formed simultaneously about the crown (For teleomorph, adapted from Réblová et al. 2020).

Type species: *Paragaeumannomyces sphaerocellularis* Matsush.

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: Broadly distributed (Réblová et al. (2020).

Description and illustration: Nawawi and Kuthubutheen (1990); Matsushima (2001); Wu and McKenzie (2003); Huhndorf and Fernández (2005); Réblová et al. (2020).

Notes: Based on morphological and phylogenetic analysis, *Paragaeumannomyces* was proposed to accommodate the morphologically and phylogenetically well-delimited group of chaetosphaeriaceous fungi (14 species) with scolecospore ascospores and *Obeliospora*-like anamorph (Réblová et al. 2020). Members of *Paragaeumannomyces* display a wide geographical distribution pattern; they have a predominantly pantropical distribution in Central America and Asia but were also encountered in the subtropical and temperate climate zones of Europe, China, Japan, Malaysia, New Zealand and North America (Huhndorf and Fernández 2005; Réblová et al. 2020).

Our phylogenetic analysis (Fig. 3, 130) shows that Obeliospora minima is closely related to all 14 species of Paragaeumannomyces Matsush., as emended by Réblová et al. (2020). This brought our attention on the teleomorph and anamorph connections between Chaetosphaeria raciborskii and related species with scolecosporous ascospores by Huhndorf and Fernández (2005). In that study, they described the Craspedodidymum-like anamorph for several species with scolecosporous ascospore, including Chaetosphaeria ellisii (Barr.) Huhndorf & F.A. Fernández, C. lapaziana, C. panamensis, C. raciborskii, and C. rubicunda. The so-called Craspedodidymum-like anamorphs from these species in pure culture produce simple phialidic conidiogenous cell on hyphae or dark brown conidiophore, flask-shaped to obclavate phialides with flared or cup-shaped collarettes, and globose, subglobose or triangular conidia with or without elongate setulae. In *C. raciborskii*, the dark-colored setae were also observed. All these characters are very similar to those described in *Obeliospora* species (Kuthubutheen and Nawawi 1990, 1994a, b, c; Wu and McKenzie, 2003; Cantillo-Pérez et al. 2017). The very similar conidiophores, conidiogenous cells and conidia are also reported from the Thailand strain of *P. panamensis* by Perera et al. (2016). *Paragaeumannomyces guttulatus*, a recently described and asexually typified species from China, fits well to the concept of *Obeliospora* (Zhang et al. 2022). Combined with morphology and molecular analysis, it is clear that *Obeliospora* and *Paragaeumannomyces* are congeneric. Although *Obeliospora* represents an earlier name for these fungi, we recommend using *Paragaeumannomyces* to avoid too many changes of names.

Obeliospora was erected by Nawawi & Kuthubutheen (1990) for a single dematiaceous hyphomycete species, O. basispira, colonizing submerged decaying wood in a freshwater stream. The genus is characterized by presence of subulate setae; mononematous, solitary or grouped, pigmented conidiophores; terminate, integrated, monophialidic, doliiform conidiogenous cells ending in conspicuously flared, cup-shaped collarettes; and acrogenous, semi-endogenous, hyaline, globose to subglobose phialoconidia furnished with several non-septate, filiform appendages formed simultaneously about the crown. Obeliospora basispira, O. microappendiculata, O. minima, O. nitida and O. triappendiculata are the only known species described so far in this genus (Nawawi and Kuthubutheen 1990; Kuthubutheen and Nawawi 1994a; Wu and McKenzie, 2003; Cantillo-Pérez et al. 2017).

Key to known *Paragaeumannomyces* species known with only *Obeliospora* anamorph.

1.	Conidia without setulae or with very short setulae $< 5 \mu m$
	long2
1.	Conidia with long setulae, longer than 5 µm4
2.	Setae absent; conidia $20-32 \times 18-30 \ \mu m$; appendage
	0–3, 3–5 µm longP. microappendiculatus
2.	Setae present; conidia less than 15 µm wide3
3.	Conidia 11–13.5 µm wide, 10–12 µm high
	P. asetulus
3.	Conidia 8–9 µm wide, 6–9 µm high <i>P. nawawii</i>
4.	Setae absent; conidia round-tetrahedral or obpyramidal,
	$29-35 \times 20-26 \mu m$, setulae $38-74 \mu m \log \dots P$. nitidus
4.	Setae present
5.	Conidia globose, subglobose or ellipsoidal, with 2-8
	setulae6
5.	Conidia subglobose ro napiform, cuneiform, constantly
	with 3 setulae7
6.	Conidia $13-15 \times 15-19$ µm, with 4-8 setulae of
	25–46 um longP. basispirus



Fig. 143 *Paragaeumannomyces asetulus* (Wu12131, holotype). a–j, m, n Conidia. k, l, o–w Conidiogenous cells arising from superficial hyphae or 1–2 supporting cells. s Setae. Scale bar: $5 \mu m$

- 6. Conidia 9.4–11.5 μm diam., with 2–6 setulae of 8.8– 13.5 μm long.....*P. basispirus*
- 7. Conidia 21–28×21–24 μm, setulae 44–55 μm long... *P. triappendiculatus*
- 7. Conidia 7–9×8–10 μm, setulae 7–12 μm long......*P. minimus*

Paragaeumannomyces asetulus W.P. Wu & Y.Z. Diao, sp. nov., Fig. 143, MycoBank MB841608.

Etymology: Refers to its conidia lacking setulae.

Diagnosis: Similar to *Paragaeumannomyces minimus*, but differs in asetulate conidia.

Typification: **China**, Guangdong Province, Dinghushan, on dead bark of unidentified tree, 3 March 2012, W.P. Wu, Holotype HMAS 352,037 (=Wu12131).

Description on the natural substrate: Colonies effuse, pale brown, sparse. Mycelium immersed or superficial, composed of pale brown, branched, smooth, septate hyphae 2-3.5 µm wide. Teleomorph: Unknown. Anamorph: Setae sterile, solitary, simple, erect, straight, dark brown to blackish, thickwalled, smooth, 1-2-septate near the base, tapered gradually towards the acute to pointed apices, $85-120 \,\mu\text{m} \times 4-5 \,\mu\text{m}$, with inflated base 9-15 µm wide. Conidiophores absent or present then mononematous, occurring singly or in small groups, arising from aggregated hyphae, simple, flexuous, pale brown, smooth, thick-walled, 0-3-septate. Conidiogenous cells integrated, terminal, monophialidic, globose, 8.5-10 µm long, 8-9 µm wide; collarettes cup-shaped, 4-10 µm deep, 5-13 µm wide at the apex, 5.5-6 µm wide at the base. Conidia acrogenous, solitary, dry, subglobose to napiform, smooth, hyaline, thin-walled, 11–13.5 µm wide, 10–12 µm high, no setulae.

Ecology/Substrate/Host: Saprobe on decaying bark.

Geographical distribution: China.

Notes: *Paragaeumannomyces asetulus* differs from other known species with *Obeliospora* anamorph by producing conidia without setulae. In addition, its conidia are larger than those in *P. minimus* but significantly smaller than those in *P. basispirus* and *P. triappendiculatus* (Nawawi and Kuthubutheen 1990; Kuthubutheen and Nawawi 1994a; Wu and McKenzie 2003; Cantillo-Pérez et al. 2017).

Paragaeumannomyces basispirus (Nawawi & Kuthub) W.P. Wu & Y.Z Diao, comb. nov., MycoBank MB841980.

≡ Obeliospora basispira Nawawi & Kuthub., Mycotaxon 37: 397, 1990.

Materials examined: **China**, Guangdong Province, Dinghushan, on rotten wood of unidentified plant, 10 October 1998, W.P. Wu (Wu2086); Hunan Province, Muang Shan, on dead branches, April 2002 W.P. Wu (Wu6082).

Ecology/Substrate/Host: Saprobe on submerged leaves.

Geographical distribution: China and Malaysia (Nawawi and Kuthubutheen 1990).

Description and illustration: Nawawi and Kuthubutheen (1990); Wu and McKenzie (2003).

Notes: *Obeliospora basispira* was originally described as a saprobe occurring on submerged decaying wood in a freshwater stream in Malaysia (Nawawi and Kuthubutheen 1990). Its occurrence in China was reported by Wu and McKenzie (2003). The general appearance of this fungus from Chinese collection agrees well with the original description. However, most conidia have 9 appendages, while this was described as 6–8 in the type collection by Nawawi and Kuthubutheen (1990).

Paragaeumannomyces guttulatus J.Y. Zhang & Y.Z. Lu, J. Fungi 8, 643: 20, 2022.

Ecology/Substrate/Host: Saprobe on dead bamboo culms from a freshwater stream.

Geographical distribution: China (Zhang et al. 2022).

Description and illustration: Zhang et al. (2022).

Notes: *Paragaeumannomyces guttulatus* is an asexually typified species and characterized by presence of sterile and rigit setae, reduced conidiophores with one supporting cell and a phialide, and monophialidic, flask-shaped conidiogenous cells bearing cup-shaped collarette, and hyaline, aseptate, globose to subglobose or ellipaoid conidia (9.4–11.5 µm diam.) and bearing 2–6 setulae (8.8–13.5 µm long).

Paragaeumannomyces microappendiculatus (Cantillo & Gusmão) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841981.

≡ Obeliospora microappendiculata Cantillo & Gusmão, Nova Hedwigia 106: 327, 2018.

Ecology/Substrate/Host: Saprobe on submerged leaves.

Geographical distribution: Brazil (Cantillo-Pérez et al. 2017).

Description and illustration: Cantillo-Pérez et al. (2017).

Notes: *Paragaeumannomyces microappendiculatus* differs from other described species by absence of setae, longer conidiophores and wider size range of conidiogenous cells and collarettes, and shorter conidial appendages, (Cantillo-Pérez et al. 2017). The conidia of *P. microappendiculatus* have similar size with those of *P. triappendiculatus* (Kuthubutheen and Nawawi 1994a, b, c) and also have three appendages, but minor in length and hemiglobose in shape (conical to pyramidal in *P. triappendiculatus*).

Paragaeumannomyces minimus (W.P. Wu & McKenzie) W.P. Wu & Y.Z. Diao, comb. nov. Figures 144–145, Myco-Bank MB841728.

≡ *Obeliospora minima* W.P. Wu & McKenzie, Fungal Divers. 12: 223, 2003.

Description on the natural substrate: On natural substrate, colonies effuse, pale brown, sparse. Mycelium immersed or



Fig. 144 *Paragaeumannomyces minimus* (Wu17577). **a, b, d–e** Setae. **f–h, l–p** Conidia. **c, i–k** Conidiogenous cells directly formed from mycelium. on natural substrate. Scale bar: **a** 40 μm, **c–j** 20 μm, 10 μm, **i–p** 5 μm


Fig. 145 *Paragaeumannomyces minimus* (living strain 78,408 from Wu17577 on PDA). **a–c** Setae. **d–k** Conidiogenous cells directly formed from mycelium. **l–z**, **aa–ab** Conidia. on PDA. Scale bar: **a**, **d** 20 μm, **b**, **c**, **e–h** 10 μm, **i–ac** 5 μm

superficial, composed of pale brown, branched, smooth, septate hyphae $2-3 \mu m$ wide, loosely aggregated at the base of setae and conidiophores. Teleomorph: Unknown.

Anamorph: Setae sterile, simple, erect, straight, dark brown to blackish, thick-walled, smooth, 1-septate near the base, tapered gradually towards the acute to pointed apices, 70–120 μ m × 4–5 μ m, with inflated base 7–10 μ m wide. Conidiophores absent or present then mononematous, occurring singly or in small groups, arising from aggregated hyphae, simple, rarely branched except occasionally at the base, flexuous, pale brown, smooth, thick-walled, 0–1 septate. Conidiogenous cells integrated, terminal, monophialidic, doliiform, 10–12 μ m long, 6–8 μ m wide; collarettes cup–shaped, 5–7 μ m wide and 2.5–3 μ m deep. Conidia acrogenous, solitary, dry, conical to pyramidal, smooth, hyaline, thin-walled, 8–10 μ m wide, 7–9 μ m high and furnished with 3 thin, hyaline setulae 7–12 μ m long.

Culture characteristics: On PDA, the fungus grows slowly and reach up to 1 cm in 20 days, effuse, hairy, with white grey to dark brown aerial hyphae, dark brown to black in the reverse side. From the aerial mycelium, abundant setae and conidiogenous cells are produced. Setae cylindrical, single or in clusters, straight or slightly flexuous, 2-4-septate, with obtuse or acute apex, (50-) 80–173 $(-200) \times 3-5 \mu m$. The conidiogenous cells are directly formed from superficial hyphae or with 1-2 supporting cells, dark brown, doliiform, ellipsoidal to subglobose, smooth-walled, $10-15 \times 6-8 \mu m$, sometimes with 1-2 percurrent proliferations, monophialidic, collarettes funnel-shaped, 5-7 µm wide, 3-4.5 µm deep; conidia varies a lot on shape and size, ellipsoidal, conical to pyramidal, smooth, hyaline, 9-11 µm high, 7-9 µm wide, without setulae, or with 1-3 setulae 2-4 µm long (Figs. 131g, h).

Materials examined: **China**: Guangdong Province, Lufushan, on dead branches of unidentified plant, 6 October 1998, W.P. Wu, (Wu1924b); Guangdong Province, Dinghushan, on rotten wood in water, 9 October 1998, W.P. Wu (Wu4509); Guangdong Province, Guangzhou, Baiyunshan, on rotten wood of unidentified plant, 5 March 2012, W.P. Wu (Wu12055); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on decaying seed of unidentified tree, 17 October 2020, W.P. Wu (Wu17576, Wu17577); Guangxi Province, Shangsi, Shiwandashan, Wangle, on rotten wood, 2 January 1997, W.P. Wu (Wu1268c Holotypus); Guangxi Province, Shiwandashan, on dead bark of *Eucalyptus* sp., 31 December 1997, W.P. Wu (Wu1594a). Living strains: 78,408, 78,519 and 78,520 (from Wu17577).

Ecology/Substrate/Host: Saprobe on dead branches of plants.

Geographical distribution: China (Wu and McKenzie 2003).

Description and illustration: Wu and McKenzie (2003).

Notes: *Paragaeumannomyces minimus* differs from other described species by its shorter conidiophores and smaller conidia with shorter appendages (Nawawi and Kuthubutheen 1990; Kuthubutheen and Nawawi 1994a, b, c; Wu and McKenzie 2003; Cantillo-Pérez et al. 2017).

The living strain was obtained and studied from the fresh specimen Wu17577. The fungus on natural substrate is

identical to the description from the type specimen. In pure culture, the fungus varies a lot on setae, conidiogenous cells, and shape and size of conidia. Both ITS and LSU sequences were obtained from two single spore isolates and the phylogenetic analysis shows that they are closely related to all members of *Paragaeumannomyces*.

Based on ITS blast in NCBI's GenBank, the closest matches to the strain 78520 include *Paragaeumannomyces panamensis* (GenBank KY212752, 93% identity), *P. rubicunda* (GenBank AY906954, 90% identity) and *P. raciborskii* (GenBank AY906953, 90% identity).

Paragaeumannomyces nawawii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 146, MycoBank MB841609

Etymology: Named after the mycologist A. Nawawi, who made great contribution to the dematiaceous phialidic fungi.

Typification: **China**, Guangdong Province, Guangzhou, South China Botanical Garden, on rotten palm material, 12 December 2013, W.P. Wu, Holotype HMAS 352,038 (=Wu12655).

Description on the natural substrate: Colonies effuse, pale brown, sparse. Mycelium immersed or superficial, composed of pale brown, branched, smooth, septate hyphae 2-4 µm wide. Teleomorph: Unknown. Anamorph: Setae sterile, solitary or in small groups, simple, erect, straight, dark brown to blackish, thick-walled, smooth, 1-3-septate near the base, tapered gradually towards the acute to pointed apices, 60–105 μ m × 4–5 μ m, with inflated base 10–13 μ m wide. Conidiophores absent or present then mononematous, occurring singly or in small groups, arising from aggregated hyphae, simple, flexuous, pale brown, smooth, thickwalled, 0-2-septate. Conidiogenous cells integrated, terminal, monophialidic, with a globose to ellipsoidal base and a cup-shaped collarette, 7.5-10 µm long, 5.9-6.5 µm wide; collarettes —cup-shaped, 1–2.5 µm deep, 4–5 µm wide at the apex, $2.5-3 \mu m$ wide at the base. Conidia acrogenous, solitary, dry, subglobose to napiform, smooth, hyaline, thinwalled, 8–9 µm wide, 6–9 µm high, no setulae or with very short setulae of 1–1.5 µm long.

Ecology/Substrate/Host: Saprobe on rotten palm material. Geographical distribution: China.

Notes: *Paragaeumannomyces nawawii* and *P. asetulus* are two species with similar conidial morphology, especially absence of setulae in conidia (Nawawi and Kuthubutheen 1990; Kuthubutheen and Nawawi 1994a; Wu and McKenzie 2003; Cantillo-Pérez et al. 2017). *Paragaeumannomyces nawawii* is in general with smaller size in both conidiogenous cells and conidia than those in *P. asetulus*. In addition, very short appendages are found in some of the conidia in *P. nawawii*, while they are not seen in *P. asetulus*.



Fig. 146 Paragaeumannomyces nawawii (Wu12655, holotype). a-d Setae. e-n Conidiophores and conidiogenous cells. o-q Conidia. Scale bar: a-d 10 µm, e-q 5 µm

Paragaeumannomyces nitidus (Kuthub., G.M. Liew & Nawawi) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841982.

≡ Obeliospora nitida (Kuthub., G.M. Liew & Nawawi) Cantillo & Gusmão, Nova Hedwigia 106: 329, 2017.

 \equiv *Nawawia nitida* Kuthub., G.M. Liew & Nawawi, Can. J. Bot. 70: 96, 1992.

Geographical distribution: Malaysia (Kuthubutheen et al. 1992).

Description and illustration: Kuthubutheen et al. (1992). Notes: Cantillo-Pérez et al. (2017) considered the shape of conidiogenous cell morphology (doliiform, with distinctly flared, conspicuous, cup-shaped collarettes) as an effective diagnostic feature to distinguish *Nawawia* and *Obeliospora*, and transferred *N. nitida* Kuthub. to the latter genus (Nawawi 1973; Marvanová 1980; Goh et al. 2014a). *Paragaeumannomyces nitidus* differs from other known *Obeliospora* species by lacking setae, and relatively larger conidia with longer

Conicomvces pseudotransvaalensis HHUF29956 T

Cryptophiale udagawae 44893 Cryptophiale udagawae 76588 Cryptophiale udagawae 44516 Cryptophiale udagawae 43932 Cryptophiale udagawae 43927

Cryptophiale udagawae 12168 – Cryptophiale udagawae 42912

1/- Cryptophiale udagawae MFLU 18-1497 Cryptophiale udagawae MFLU 18-1498 92/- Cryptophiale udagawae 44819 92/- Cryptophiale udagawae 43906

Cryptophiale udagawae MFLU 19-0209 Cryptophiale udagawae MFLU 18-1497

Cryptophiale udagawae 7598 Cryptophiale udagawae 7826

Cryptophialoidea fasciculata 78251 Cryptophialoidea fasciculata 78327 Cryptophialoidea fasciculata MFLU 18-1499

Cryptophialodiea fasciculata 78247 Cryptophiale fruiticetum 43148 Cryptophiale fruiticetum 42861 Cryptophiale fruiticetum 55340 Cryptophiale fruiticetum 55340

05

92/-

100/1

91/-

83/

100/

98/0 99

96/0 99



MB841729.

Description and illustration: Kuthubutheen & Nawawi (1994a, b, c).

Notes: Paragaeumannomyces triappendiculatus (conidia 21–28 µm high, 21–24 µm wide at the widest points; setulae 44–55 µm long) resembles *P. minimus* (conidia 8–10 µm high, 7–9 µm wide at the widest points; setulae 7–12 µm long), but differs on size of conidia and conidial setulae (Kuthubutheen and Nawawi 1994a, b, c; Wu and McKenzie, 2003; Cantillo-Pérez et al. 2017).

Cryptophiale and related genera with lateral or intercalary phialides

Most of the 89 accepted chaetosphaeriaceous genera produce unbranched conidiophores with terminal conidiogenous cells, while only a few genera are with branched or unbranched conidiophores and lateral or intercalary phialidic conidiogenous cells. These genera are *Brachydicty*ochaeta, Codinaeopsis, Cryptophiale, Cryptophialoidea, Dictyochaetopsis, Menispora, Kionochaeta, Kionochaetiella, Paraceratocladium, Paracryptophiale, Phaeostalagmus, Sporendocladia, Zanclospora. In addition, several species of Chaetosphaeria and Chloridium are also known to produce conidiophores with lateral or intercalary phialides.

Phylogenetically most of these genera are the welldefined monophyletic genera, however these genera are polyphyletic and distributed in six different clades in the phylogenetic trees (Fig. 3, Fig. 147). Species of Dictyochaetopsis and Codinaeopsis are grouped together with Codinaea and Codinaeella, and they were dealt together under Codinaea and Codinaeella in another chapter. Several Chloridium species with branched conidiophores are congeneric with Chloridium species with non-branched conidiophores. Species of Menispora and Arcuatospora showed a close phylogenetic relationship. Species of Brachydictyochaeta, Kionochaeta and Sporendocladia are closely related to species of Chaetosphaeria s. str. and Dictyochaeta s. str.; and all other genera (Cryptophiale, Cryptophialoidea, Paraceratocladium Paracryptophiale, Zanclospora), together with several other genera with branched or non-branched conidiophores (Aunstrupia, Conicomyces, Linkosia, Morrisiella, Riisgaardia, some Chaetosphaeria with branched conidiophores), formed an distinct phylogenetic group with strong bootstrap support value. Some of these genera, such as Brachydictyochaeta, Chloridium, Codinaeopsis and Dictyochaetopsis, are dealt in other sessions, while all other genera are described and illustrated in this chapter.

Morphologically most of these genera are also welldelimited by a combination of setae, conidiophores, conidiogenous cells and conidia. Living strains of many studied species were also studied on PDA (Fig. 148), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Key to all genera with lateral or intercalary phialidic conidiogenous cells in Chaetosphaeriaceae

1.	Phialides always integrated in the conidiophores, api-
1	Phialidas always horne laterally on conidiophores in
1.	where singly or on short branches sometimes incor-
	porated in the conidiophores apical or intercalary 3
2	Conidia cylindrical formed in chain
2.	Sporendocladia
2	Conidia ellipsoid subglobose formed in wet spore
2.	mass Chloridium*
3	Conidiophores adhering and twining around the setae:
5.	conidiogenous cells mostly intercalary 4
3.	Conidiophores not adhering and twining around the
0.	setae: conidiogenous cells terminal
4.	Setae unbranched: conidiophores with spike-like struc-
	ture: conidia obclavate
4.	Setae branched: conidiophores bearing spike-like
	structure: conidia cylindrical with rounded apex
	Paraceratocladiella
5.	Conidia forming at multiple conidiogenous loci within
	the collarette, hyaline or pale brown, short ellipsoid,
	asetulate; phialides in whorls or single
5.	Conidia forming at a single conidiogenous locus within
	the collarette
6.	Phialides borne singly, on 1–3 supporting cells or on
	short branches of the conidiophores; collarette incons-
	picuous or strongly recurved toward the conidiophore
	axis; conidia hyaline, oblong, fusiform, with or without
	setulae, 0–3-septateMenispora
6.	Apex of the phialide not strongly recurved toward the
	conidiophore axis7
7.	Phialides in palisade along the main axis of the conidi-
	ophores
7.	Phialides not in a palisade10
8.	Collarettes inconspicuous; phialides arising around
	the whole conidiophore, surrounded by a shield-like
	aggregation of sterile cells9
8.	Collarettes distinct; phialides formed in a palisade or
	small bundles on one side of the conidiophores, no
_	shield-like structure presentCryptophialoidea
9.	Conidia dictyospores with both transversely and longi-
	tudinal septa, ellipsoid, apical cell with a single apical
0	appendageParacryptophiale
9.	Conidia aseptate or with transversely septa only, vari-
	ous in snape from faicate, fusiform, cylindrical, to glo-
	bose, without or with appendageCryptophiale



Fig. 148 Colony of *Cryptophiale*, *Paracryptophiale*, *Paraceratocladium* and related fungi on PDA after 20 days at 25 °C. **a**, **b** *Cryptophiale fruticetum* (44516). **c–f** *C. udagawae* (43732 and 43015). **g**,

h Paraceratocladium silvestre (44059). i, j Paraceratocladiella polysetosum (44119). k, l Paracryptophiale pirozynskii (ex-type strain 44888)

- 10. Phialides borne on branches or rarely singly......12
- 11. Phialides borne singly along the main axis of conidiophores or directly from superficial hyphae; setiform conidiophores with sterile and swollen apex; conidia falcate.....Brachydictyochaeta

- 13. Phialides on closely or loosely packed branches along the main axis of conidiophores; conidia fusiform, falcate, rod-shaped, without setulae......14
- 14. Conidiophores unbranched; phialides irregularly distributed along the main axis of conidiophores, loosely borne; conidia rod-shaped.....*Kionochaetiella*

(*only some of *Chloridium* with branched conidiophores; **only *Codinaea gonytrichoides*).

Cryptophiale Piroz., Can. J. Bot. 46: 1123, 1968.

Colonies effuse, hairy, inconspicuous. Mycelium partly superficial and partly immersed, sparse, composed of branched, septate, brown, smooth hyphae. Teleomorph: Unknown. Anamorph: Sterile setae absent or present, solitary, erect, straight or flexuous, branched or unbranched, cylindrical, septate, dark brown. Conidiophores setiform, solitary or rarely in groups, erect, straight or curved towards the apices, unbranched or branched, dark brown, smooth, thick-walled, septate, bulbous to irregular at the base, tapered gradually towards the fertile region. Fertile region subapical or apical, cylindrical, consisting of a shield of sterile cells and the obscured conidiogenous cells, often covered by a slimy spore mass. Conidiogenous cell monophialidic, obscured by a shield of sterile, flat, lobed, pale brown cells. Conidia produced in slimy head and adhering to the fertile region of the conidiophores in a lateral droplet, hyaline, smooth, aseptate or septate, clavate, uncinate, filiform, cylindrical, falcate, subulate, fusiform, globose to subglobose, with or without apical appendage.

Type species: Cryptophiale kakombensis Piroz.

Ecology/Substrate/Host: Saprobe on decaying plant material of many different plant species.

Geographical distribution: Broadly distributed, especially in subtropical and tropical areas.

Description and illustration: Pirozynski (1968); Ellis (1976).

Notes: *Cryptophiale* was introduced by Pirozynski (1968) to accommodate *C. kakombensis* and *C. udagawae*, both of which have setiform, simple or apically branched conidiophores and lateral 'phialidic' conidiogenous cells, which are shielded by a plate of modified cells and hyaline, aseptate or septate conidia formed in a slimy mass. *Cryptophiale* is mostly similar to *Cryptophialoidea* and *Paracryptophiale* (Seifert et al. 2011). It differs from *Paracryptophiale* by dictyospores in the latter genus; differs from *Cryptophialoidea* by the conidiogenous cells not covered by sterile shield cells in the latter genus (Whitton et al. 2012).

A lot of 23 legitimate names have been published under the genus Cryptophiale, and among them, two species, C. secunda Kuthub. & B. Sutton and C. manifesta, were transferred into Cryptophialoidea (Kuthubutheen and Nawawi 1987, 1994a, b, c). The rest 21 species can be distinguished by morphology of conidiophores and conidia such as shape, size, septation, etc. (Pirozynski 1968; Kuthubutheen and Sutton 1985; Sutton and Hodges 1977; Farr 1980; Kuthubutheen 1987a, b, c, d; Sutton et al. 1989; Bhat and Kendrick 1993; McKenzie 1993a, b; McKenzie and Kuthubutheen 1993; Goh and Hyde 1996b; Umali et al. 1999). The genus Cryptophiale was reviewed by Goh and Hyde (1996a) who accepted 16 species. Keys to distinguish them were provided by Farr (1980), Kuthubutheen (1987a, b, c, d), Sutton et al. (1989), Goh and Hyde (1996b), and Whitton et al. (2012).

Hyde et al. (1999) connected two *Cryptophiale* species with their *Chaetosphaeria* teleomorph, *Cryptophiale cf. udagawae* with *Chaetosphaeria hongkongensis*, *Cryptophiale kakombensis* with *Chaetosphaeria saltuensis*. These connections were just based on observation of co-occurrence of both anamorph and teleomorph on the same specimen, rather than pure culture study. Recent molecular studies based on rDNA analysis of *C. udagawae* and *C. hamulata* Whitton, K.D. Hyde & McKenzie clearly show that the genus *Cryptophiale* belongs to Chaetosphaeriaceae (Hyde et al. 2018; Yang et al. 2018a). Although many of them seem to be culturable, few species have living strains available for molecular study and this is needed to further clarify their phylogenetic relationship.

In our phylogenetic analysis (Fig. 3 and Fig. 147), all studied species under Cryptophiale, Cryptophialoidea and Paracryptophiale are clustered together with Kionochaeta ivoriensis, Paraceratocladium silvestre and several species of non-phialidic genera (Aunstrupia, Linkosia, Morrisiella, Riisgaardia), form a polyphyletic clade. This is aligned with the previous studies (Yang et al. 2018a; Lin et al. 2019). The species included in our analysis are Cryptophiale fruiticetum, C. guadalcanalensis, C. hamulata, C. kakombensis Piroz., C. udagawae, Cryptophialoidea fasciculata and Paracryptophiale pirozynskii. From the analysis it is clear that these anamorphic fungi are phylogenetically not related to the known Chaetosphaeria species included in this analysis. This supports to maintain Cryptophiale and Cryptophialoidea and Paracryptophiale as separate genera. The separation of Cryptophialoidea from Cryptophiale is poorly supported from our phylogenetic analysis. In contrast to the molecular analysis, these genera are morphologically well defined and can be easily distinguished. Cryptophialoidea differs from Cryptophiale in having obvious monophialidic conidiogenous cells arranged only on one side of the conidiophore and not covered by a shield of sterile cells (Kuthubutheen and Nawawi 1987; Whitton et al. 2012). Paracryptophiale resembles Cryptophiale in having setiform conidiophores and typical Cryptophiale-like conidiogenous cells aggregated into a fertile region with shield cells, but differs by the dictyosporous conidia by Paracryptophiale, and the separation of them as two distinct genera is also supported in the phylogenetic analysis (Kuthubutheen and Nawawi 1994a; Wu and Mckenzie, 2003).

A large number of species have been known under these genera, and future molecular study with inclusion of more of these species will support to clarify their phylogenetic relationship and delimitation of generic concept (Goh and Hyde 1996b; Delgado et al. 2005; Marques et al. 2008; Wu and McKenzie 2003; Whitton et al. 2012; Yang et al. 2018a).

Species of *Cryptophiale* have a worldwide distribution and are commonly found on different plant litter, including leaf litter, bark, decaying seed, rotten wood, and dead branches. Several species are also aquatic and found from submerged wood (Lu et al. 2000). Five species such as *C. aristata*, *C. fruticetum*, *C. iriomoteanum*, *C. sphaerospora* and *C. udagawae* have been recorded in China, including Hong Kong and Taiwan. Living strains of many studied species were also studied on PDA (Fig. 148), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Key to species of *Cryptophiale* (*C.*), *Cryptophialoidea* (*Cr.*) and *Paracryptophiale* (*P.*) (revised after Goh and Hyde 1996b; Delgado et al. 2005; Marques et al. 2008; Whitton et al. 2012)

1. Conidiophore apex branching......2 1 Conidiophore apex simple or rarely 1-times dichoto-2. Conidia 1–2-septate, $28-32 \times 2-3 \mu m$, apex tapered to a 10-18 µm appendage; conidiophore 1-3 times dichotomous.....C. cucullata 2. 3. Conidiophores surrounded by shorter (95–145 µm), 3-7 times dichotomously branched, sterile setae; conidia $14-24 \times 1.3-1.6 \mu m$, tapered to a narrow apex; conidiophores 1–2 times dichotomous.....C. fruticetum 3. Conidiophores not surrounded by sterile setae......4 4. Conidiogenous cells not encircling the conidiophores; conidia $18.5-22.5 \times 1-1.5 \mu m$, falcate, 1-septate; conidiophores 1-3 times dichotomous.....Cr. ramosa 4. Conidiogenous cells encircling the conidio-5. Conidia $15-25 \times 1.5-3$ µm, falcate and tapered to a short narrow appendage, 1-septate; conidiophores up to 250 µm long, 1–3 times dichotomous.....*C. udagawae* 5. Conidia $16-24 \times 1.3-2 \mu m$, falcate tapered to an obtuse apex, 1-septate; conidiophores up to 240 µm long, 1-2 times dichotomous.....C. guadalcanalense 6. Conidia dictyosporous.....7 6. Conidia $15-20 \times 8.5-11.5 \mu m$, with apical appendage 7. up to 12.5 µm long; conidiophores intermixed with steri-le setae.....P. pirozynskii 7. Conidia $28-35 \times 14-16 \mu m$, with apical appendage 4-6 µm long; no setae.....P. kamaruddinii 8. Fertile regions with lateral branches......9 Fertile regions without lateral branches......10 8. 9. Fertile region subapical, lateral branches 30–45 µm long, gently incurved, smooth; conidia falcate, aseptate, $9-14 \times 1.5-2 \mu m$C. apicalis 9. Fertile region median, lateral branches 45–90 µm long, distinctly curved, coarsely verrucose; conidia falcate, aseptate, $9-12 \times 1.5-2 \mu m....C.$ vertucosa 10. Conidia more than 1-septate.....11 10. 11. Conidia elongate-filiform, 7-10-septate, $72-95 \times 2.5-3 \mu m$; fertile region subapical; conidiophores up to 360 µm long.....C. pandanicola 11. Conidia less than 70 µm long.....12 12. Conidia elongate fusoid, 3-8-septate, $30-62 \times 2.5-4 \mu m$; fertile region subapical; conidiophores up to 450 µm long.....C. multiseptata

12. Conidia elongate fusoid, 4–7-septate, apex tapered to a narrow appendage, $55-67 \times 7.5-9 \mu m$; fertile region

	apical to subapical; conidiophores up to 240 μ m
10	longC. enormis
13.	Conidia aseptate14
13.	Conidia 1-septate16
14.	Conidia globose to subglobose, 1.5-2 µm diam.,
	fertile region subapical; conidiophores 69-100 µm
	longC. sphaerospora
14.	Conidia not globose
15	Conidia filiform curved $55-12 \times \pm 0.25$ µm fertile
10.	region median: conidionhores up to 175 um
	C nusilla
15	Conidia fuscid anay tananad to a normaly surved
15.	Contrata fusion, apex tapered to a narrow, curved $(10, 25, \text{vm}) = 20, 28 \times 4, 4, 25, \text{vm}$
	appendage (10–25 μ m), 20–28 x 4–4.25 μ m; lef-
	the region apical; contdiophore up to 250 µm
	longC. caudata
16.	Fertile region extending to apex; conidia fusoid, ends
	rounded, $9.5-18 \times 2-2.25 \ \mu m$
	C. novae–caledoniae
16.	Always with part of the conidiophore apex extending
	beyond the fertile region17
17.	Fertile region subapical
17.	Fertile region median22
18.	Conidia falcate, both ends attenuated and acute,
	$22-27.5 \times 1.7-2 \ \mu$ m; conidiophores up to 260 μ m
	longC. kakombensis
18.	Conidia base rounded, tapered towards the apex19
19.	Conidia more or less cylindrical and straight,
	$14-26.5 \times 1.5-2.5 \ \mu\text{m}$; conidiophores up to 470 μm
	longC. orthospora
19.	Conidial apex distinctly curved
20.	Conidia cylindrical, tapering towards the apex,
	both ends obtuse, apex strongly curved to hooked,
	$14-23 \times 15-2$ µm; conidiophores up to 200 µm
	long C iriomoteanum
20	Conidia with apical appendage 21
21	Conidia fusoid apex attenuated to a parrow flexu-
21.	ous appendage $(7-12 \text{ µm long})$ $23-27 \times 2-3 \text{ µm}$
	conidi-onhores up to 425 µm long
	C aristata
21	Conidia falcate approximated to a parrow strongly
21.	contrat raicate, apex attenuated to a harrow, strongly
	curved to nooked appendage, $14-24 \times 1.3-2$; conditio-
22	phores up to 235 µm longC. namulata
22.	Conidiogenous cells encircling the conidiopho
	res
22.	Conidiogenous cells not encircling the conidio-
22	phores
23.	Conidiogenous cells with clearly visible funnel-shaped
	collarettes; conidia falcate, base obtuse, apex tapered
	and acute $22-29 \times 1.5-2$ µm; conidiophores up to
	2/0 μm longCr. fasciculata
23.	Conidiogenous cells without visible funnel-shaped col-
	larettes24

24.	Fertile region below median, conidiophores extend- ing 100–245 μ m beyond the fertile region; conidia
	falcate, acute at the apex, obtuse at the base,
	$12-16.5 \times 1-1.5 \ \mu m.$
24.	Conidia fusoid to falcate, base acute or rounded, apex
	acute, straight or curved, $12-16 \times \pm 1.2 \ \mu m$; con-
	idio-phores extending 18-32 µm beyond the fertile
	regionC. minor
25.	Conidia falcate, base acute, apex attenuated and
	strongly curved or hooked, $28-35 \times 1.2 \mu m$; conidi-
	ophores up to 300 µm longCr. uncispora
25.	Conidia not hooked at the apex
26.	Conidia falcate, both ends acute, $20-27 \times 1.5-2.5 \mu\text{m}$;
	conidiophores up to 260 µmCr. secunda

26. Conidia straight or falcate, 22–27 × 1.5–2 μm; conidiophores up to 250 μm.....Cr. manifesta

Cryptophiale aristata Kuthub. & B. Sutton, Trans. Br. Mycol. Soc. 84: 303, 1985.

Teleomorph: Unknown. Anamorph: Conidiophores subulate, setiform, 260–390 μ m long, 8–10 μ m wide towards the base, 6.5–8 μ m wide towards the apex, conidiogenous zone at about the upper third of conidiophore. Conidia hyaline, smooth, 1-septate, simple, somewhat fusiform, 18–24×1.2–1.5 μ m (Whitton et al. 2012).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Australia (Whitton et al. 2012), China (Whitton et al. 2012) and Malaysia (Kuthubutheen and Sutton 1985).

Description and illustration: Kuthubutheen and Sutton (1985); Whitton et al. (2012).

Notes: No specimen was examined by us and the above description is based on the documentation by Whitton et al. (2012). The fungus was reported on decaying leaves of *Pandanus tectorius* from Hong Kong (Whitton 1999; Whitton et al. 2012). No living strain for this species is available for phylogenetic study.

Cryptophiale fruticetum Whitton, McKenzie & K.D. Hyde, Fungal Diversity Series 22: Fungi Associated with Pandanaceae: 172, 2012. Figure 149

Description on the natural substrate: Colonies effuse, hairy, conspicuous, consisting of tall, dichotomously branched, fertile setiform conidiophores, surrounded by short, sterile, dichotomously branched setae. Teleomorph: Unknown. Anamorph: Sterile setae solitary, scattered, shorter than the fertile setiform conidiophores, smooth, brown or fading slightly towards the apices, consisting of a cylindrical to slightly tapered stem and a 3–7 dichotomously branching head, stem 2–4-septate, thickened walls and septa, tapering towards acute apices in the branching region, basal



Fig. 149 *Cryptophiale fruticetum* (Wu17591). a, b Sterile setae with branches. c Sterile setae and setiform conidiophores. d–f Setiform conidiophores with fertile regions and branched apex. g Fertile region

with conidiogenous cells. h–n Conidia. Scale bar: a, b 40 $\mu m,$ c–e 20 $\mu m,$ f 10 $\mu m,$ g–q 5 μm

cell bulbous and often forms a knot with the superficial hyphal tissue, always sterile, overall length 95-145 µm, 4–5.2 μ m wide towards the base, 3.5–4.2 μ m wide at the neck. Conidiophores setiform, solitary, scattered, erect, typically straight, sometimes curved or flexuous, dark brown to very dark brown, smooth, thickened walls, 135-230 µm long between the base and the fertile region, 4-6-septate below the fertile region, cell length below the fertile region 16-45 µm, basal cell bulbous and surrounded by a knot of hyphal tissue, dichotomously branching towards the apex and generally above the fertile region, 1-2 dichotomous divisions, cylindrical or slightly tapering towards the apex, tapering to acute apices in the branching portion, overall length 205–300 µm, 6–8 µm wide towards the base. Fertile region subapical, cylindrical, 44-72 µm long, 12-14 µm wide, advancing partially up the first dichotomous division, the remainder of the branching apex projects above the fertile region, cell length $4.5-10 \ \mu\text{m}$, $5-7 \ \mu\text{m}$ wide at the neck. Conidiogenous cells polyphialidic, comprising a series of H-shaped cells which branch, and clasp around the conidiophores, each H-cell generally producing 8 phialides, 4 clasping each side, 6–9 H-cells per fertile region, no septa visible in H-cells, H-cells arising from a single, small, clearly visible pore on one side of the conidiophore, pores situated centrally on the conidiophore cells. Conidia $14-24 \times 1.3-1.6 \mu m$, hyaline, smooth, falcate, aseptate, aggregated into slimy masses, distal end narrower and drawn into a short appendage, basal end obtuse.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, grey to greybrown, reverse brown to dark brown (Fig. 148a, b).

Typification: **China**, Hong Kong, Hong Kong Island, Pokfulam, in forest off Hatton Road above Hong Kong University, on decaying leaves of *Pandanus furcatus*, 25 August 1997, S.R. Whitton HKU(M)12,898 (IFRD9007, holotype).

Materials examined: China, Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead leaves of unidentified broad leaf tree, 17 October 2020, W.P. Wu (Wu17557, Wu17558, Wu17591); Guangdong Province, Shaoguan, Danxiashan, on dead leaves of unidentified tree, 25 December 2012, W.P. Wu (Wu12473); Guangxi Province, Shangsi, Shiwandashan, on dead leaves of ?Magnolia sp., 2 January 1998, W.P. Wu (Wu1941a); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of ?Acer sp., 2 January 1997, W.P. Wu (1313c); Guangxi Province, Shangsi, Shiwandashan, on dead leaves of unidentified tree, 2 January 1998, W.P. Wu (Wu1337g,1337i). Living strains: 42861 (from Wu1337g); 43035 and 43158 (from Wu1491a), 43148 (from Wu1337i), 44,035 (from Wu1601a), 55,340 (from Wu12473); 78,386 and 78,405 (from (Wu17558), 78,391 and 78,392 (from Wu17591),

Ecology/Substrate/Host: Saprobe on dead material of plants, including *Pandanus furcatus*.

Geographical distribution: China (Whitton et al. 2012).

Description and illustration: Whitton et al. (2012).

Notes: This species was originally described from decaying leaves of *Pandanus furcatus* Hong Kong and resembles *C. udagawae* in the setiform conidiophore (Goh and Hyde 1996a). However, the conidial size differs slightly $(20-35 \times 1.5-3 \ \mu\text{m} C. udagawae)$. The most striking difference between *C. fruticetum* and all previously reported species of *Cryptophiale* is the presence of true, sterile setae which are scattered around the base of the fertile setiform conidiophores (Whitton et al. 2012).

Based on ITS blast in NCBI's GenBank, the closest matches to the strain 78,386 include *Cryptophiale udagawae* (GenBank MW133882, 89%), *Cryptophialoidea fasciculata* (GenBank MH758195, 89% identity) and *Kionochaeta ivoriensis* (GenBank NR_160149, 90% identity).

Cryptophiale guadalcanalensis Matsush., Microfungi of the Solomon Islands and Papua-New Guinea: 15, 1971. Figure 150

Description on the natural substrate: Colonies effuse, hairy, inconspicuous. Mycelium partly superficial and partly immersed, sparse, composed of branched, septate, brown, smooth hyphae, 1.5-2 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores setiform, erect, straight or flexuous, arising singly from flat, conical, swollen basal cells up to 18 µm wide, thick- and smooth-walled, dark brown, 8-13-septate, 160-220 µm long and 6-9 µm wide; tapered gradually towards the fertile region, finally abruptly tapered to an acute apex, which is 1-2 times dichotomously furcated. Branches slightly paler in color, acutely pointed above. The setiform axis of the conidiophores typically remain sterile in the lower part and at the furcated apex, but the upper one-half or one-third becomes fertile and modified into a complicated conidiogenous apparatus. Fertile region subapical, cylindrical, $60-750 \times 14-16 \mu m$, the conidiogenous cells obscured by a shield of sterile, flat, lobed, pale brown cells. Conidia produced in slimy head and adhering to the fertile part of the conidiophores in a lateral droplet, hyaline, smooth, 1-septate, narrowly spindle-shaped, falcate, $16-24 \times 1.3-2 \mu m$, with the basal end rounded and the apex acute but without appendage.

Culture characteristics: Colonies on PDA effuse, colonies 0.8–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, brown to dark brown, reverse of the same color.

Materials examined: **China**, Hainan Province, Sanya, Yangtaishan, on dead leaves of unidentified tree, 28 December 2020, W.P. Wu (Wu17646, 17,647, Wu17649); Zhejiang Province, Huaan County, Qiandaohu, on dead leaves



Fig. 150 *Cryptophiale guadalcanalensis* (Wu17649). a–h Setiform conidiophores with fertile regions and branched or unbranched apex. i–k Upper part of setiform conidiophores with fertile region. l–z, aa, ab Conidia. Scale bar: a–h 40 μ m, i–ab 5 μ m

of unidentified tree, 18 October 2018, W.P. Wu (Wu16067) December. Living strains: 76,456 (from Wu16067), 78,468, 78,469, 78,470 and 78,530 (from Wu17647); 78,472 and 78,473 (from Wu17649), 78,509, 78,528 and 78,529 (from Wu17646).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Australia, China and Malaysia (Matsushima 1971).

Description and illustration: Matsushima (1971).

Notes: *Cryptophiale guadalcanalensis* was originally described from decaying leaves from Guadalcanal Island and differs from the most closely related species *C. uda-gawae* by conidia without apical appendage (Matsushima 1971; Kuthubutheen and Sutton 1985; Marques et al. 2008). On the examined specimen Wu16067, the setiform conidiophores and conidia are aligned with the original description. Its occurrence on *Rosa chinesis* in China was reported by Ma et al. (2010), who reported the branched setae, and 1-septate, subulate and non-appendaged conidia (setae 185.5–211.5×7.5–9 µm, fertile region 60–75×15–15.5 µm, conidia 17–25×0.5–2.5 µm).

The LSU and ITS sequences of this species were for the first time obtained from the single spore isolates of different specimens and its phylogenetic affinity to *Cryptophiale* in Chaetosphaeriaceae was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 76,456 include *Cryptophiale udagawae* (GenBank MW133882, 89%), *Cryptophialoidea sasciculata* (GenBank MH758195, 88% identity) and *Kionochaeta ivoriensis* (GenBank NR_160149, 87% identity).

Cryptophiale iriomoteanum Matsush., Icones Microungorum a Matsushima Lectorum: 41, 1975.

Teleomorph: Unknown. Anamorph: Conidiophores m 9–12-septate, tapered gradually towards the fertile region, finally abruptly tapered to an acute apex, $130-185 \times 4.5-7.5 \mu m$. The setiform axis of the conidiophores remain sterile in the lower part, but the upper one-third or more becomes fertile. Fertile region subapical, cylindrical, $40-90 \times 13-16.5 \mu m$. Conidia hyaline, narrowly obclavate, apex uncinate, smooth, 1-septate, $9.5-22 \times 1.0-3.5 \mu m$ (Adapted from Ma et al. 2010, 2015).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Ma et al. 2015) and Japan (Matsushima 1975).

Description and illustration: Matsushima (1975); Ma et al. (2010), Ma and Zhang (2015).

Notes: No specimen was examined by us and the above description is based on description provided by Ma et al. (2010) and Ma and Zhang (2015). *Cryptophiale iriomote-anum* differs from other known species in the genus by its

unbranched setiform conidiophores, and 1-septate, narrowly obclavate conidia with uncinate apex (Matsushima 1975). Its occurrence on submerged wood in a stream was reported in Hong Kong (Lu et al. 2000). Ma et al. (2010) reported this species on dead branches of *Rosa chinensis* from mainland China.

Cryptophiale kakombensis Piroz., Can. J. Bot. 46: 1124, 1968. Figure 151

Description on the natural substrate: Colonies effuse, hairy, inconspicuous. Mycelium partly superficial and partly immersed, sparse, composed of branched, septate, brown, smooth hyphae, 1.5-2 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores setiform, solitary, erect, straight or flexuous, arising singly from flat, conical, swollen basal cells up to 20 µm wide, thick- and smooth-walled, dark brown, septate in the basal part of the no-fertile region, tapered gradually towards the fertile region, finally abruptly tapered to an acute apex, $170-230 \times 6-7 \mu m$. The setiform axis of the conidiophores typically remain sterile in the lower part, but the upper one-third or more becomes fertile and modified into a complicated conidiogenous apparatus. Fertile region subapical, cylindrical, $83-100 \times 15-20 \mu m$, the conidiogenous cells obscured by a shield of sterile, flat, lobed, pale brown cells. Conidia produced in slimy head and adhering to the fertile part of the conidiophores in a lateral droplet, hyaline, lunate, falcate, smooth, 1-septate, $24-27 \times 1.3-1.6 \,\mu\text{m}$, with both the basal end and apex acute.

Material examined: **China**, Guangxi Province, Shangsi, Shiwandashan, on dead leaves of *?Quercus* sp., 2 January 1998, W.P. Wu (Wu1961a). Living strain: 44818 (from Wu1961a).

Ecology/Substrate/Host: Saprobe on dead material of many plants.

Geographical distribution: Widely distributed species, especially in tropical and subtropical area (Pirozynski 1968; Piccolo and Silva Attli 1996).

Description and illustration: Pirozynski (1968); Piccolo Grandi and Silva Attili (1996).

Notes: *Cryptophiale kakombensis* differs from other known species by its unbranched setiform conidiophores, and 1-septate, falcate or lunate conidia (Pirozynski 1968; Goh and Hyde 1996b; Marques et al. 2008; Arias et al. 2018). Its occurrence in Taiwan was also reported (Matsushima 1985). The ITS and LSU sequences were obtained for the first time in this species. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 76,456 include *Cryptophiale udagawae* (GenBank MW133882, 92%), *Cryptophialoidea fasciculata* (GenBank MH758195, 90% identity) and *Kionochaeta ivoriensis* (GenBank NR_160149, 90% identity).



Fig. 151 *Cryptophiale kakombensis* (Wu1961a). **a, b** Setiform conidiophores with fertile region. **c–m** Conidia with 1 septum. Scale bar: **a** 10 μm, **b–m** 5 μm

Cryptophiale orthospora McKenzie, Mycotaxon 49: 309, 1993. Figure 152

Description on the natural substrate: Colonies effuse, hairy, inconspicuous. Mycelium partly superficial and partly immersed, sparse, composed of branched, septate, brown, smooth hyphae, $1.5-2 \mu m$ wide. Teleomorph: Unknown. Anamorph: Conidiophores setiform, erect, straight or flexuous, arising singly from flat, swollen basal cells, thick- and smooth-walled, dark brown, 9–11-septate, tapered gradually towards the fertile region, tapered to an acute apex, $220-250 \times 5-8 \mu m$. The setiform axis of the conidiophores typically remain sterile in the lower part, but the upper one-third or more becomes fertile and modified into a complicated conidiogenous apparatus. Fertile region subapical, cylindrical, the conidiogenous cells obscured



Fig. 152 *Cryptophiale orthospora* (Wu5552c). **a** Conidiophores with fertile regions in the tops. **b** Fertile region with conidiogenous cells. **c**, **d** Conidia. Scale bar: **a** 40 µm, **b–d** 20 µm



Fig. 153 *Cryptophiale udagawae* (Wu11043a). **a–d** Setiform conidiophores with fertile region and branched apex. **e** Fertile region. **f–k** Conidia. Scale bar: **a–d** 20 μm, **e–k** 10 μm

by a shield of sterile, flat, lobed, pale brown cells. Conidia produced in slimy head and adhering to the fertile part of the conidiophores in a lateral droplet, hyaline, obclavate, smooth, 1-septate, $(14-)17-20 \times 1.5-2 \mu m$, with the basal end rounded and apex acute.

Material examined: **China**, Hainan Province, on dead branches of unidentified plant, 15 December 2000, W.P. Wu (Wu5552a).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Australia, China, New Caledonia and New Zealand (McKenzie 1993b).

Description and illustration: Mckenzie (1993b).

Notes: *Cryptophiale orthospora* differs from other known species by its unbranched setiform conidiophores and 1-septate, obclavate conidia (Sutton 1989; Goh and Hyde, 1996a, b, c; Kuthubutheen and Sutton 1985; Marques et al. 2008). *C. novae-caledoniae* is another species with unbranched setiform conidiophores and obclavate conidia with 1 septum, but the conidia in this species are much smaller (McKenzie and Kuthubutheen 1993).

Cryptophiale sphaerospora Umali & D.D. Zhou, Mycoscience 40: 189, 1999.

Ecology/Substrate/Host: Saprobe on dead material of plant including *Schizostachyum dumetorum*.

Geographical distribution: China (Umali et al. 1999). Description and illustration: Umali et al. (1999).

Notes: *Cryptophiale sphaerospora* differs from all other species in the genus by smaller and globose conidia (Umali et al. 1999).

Cryptophiale udagawae Piroz., Can. J. Bot. 46: 1126, 1968. Figure 153

Description on the natural substrate: Colonies effuse, hairy, inconspicuous. Mycelium partly superficial and partly immersed, sparse, composed of branched, septate, brown, smooth hyphae, 1.5–2 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores setiform, erect, straight or flexuous, arising singly from flat, conical, swollen basal cells, thick- and smooth-walled, dark brown, 5-8-septate, tapered gradually towards the fertile region, finally abruptly tapered to an acute apex, which is 1-3 times dichotomously furcated. Branches slightly paler in color, 15-40 µm long, 4-6 µm wide at the base, acutely pointed above. The setiform axis of the conidiophores typically remain sterile in the lower half and at the furcated apex, but the upper one-half or one-third becomes fertile and modified into a complicated conidiogenous apparatus. Fertile region cylindrical, the conidiogenous cells obscured by a shield of sterile, flat, lobed, pale brown cells. Conidia produced in slimy head and adhering to the fertile part of the conidiophores in a lateral droplet, hyaline, smooth, 1-septate, narrowly spindle-shaped, falcate,

 $16-25 \times 1.5-2 \mu m$, with the basal end rounded and the apex drawn into a short appendage which is rather more curved than the rest of the conidium.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, reverse brown to dark brown (Fig. 148c–f).

Materials examined: China, Guangdong Province, Dinghushan, on dead leaves of unidentified plant, 10 October 1998, W.P. Wu (Wu1961b); Guangdong Province, Dinghushan, on rotten hard wood, 11 October 1998, W.P. Wu (Wu1997g); Guangdong Province, Lufushan, on dead branches of unidentified plant, 15 October 1998, W.P. Wu (Wu2012d); Guangdong Province, Dinghushan, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (Wu1854f, Wu2050c); Guangdong Province, Zhaoqing, Dinghushan, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu (Wu12168); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (Wu16255, Wu16253); Guangdong Province, Guangzhou, South China Botanical Garden, on rotten bark of unidentified tree, 2 December 2018, W.P. Wu (Wu16259); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead leaves of Acacia sp., 17 October 2020, W.P. Wu (Wu17559); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead leaves of unidentified broad leaf tree, 17 October 2020, W.P. Wu (Wu17507); China: Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of Cinnamomum sp., 2 January 1997, W.P. Wu (1289a); Guangxi Province, Shiwandashan, on dead leaves of ?Cinnamomum sp., 30 December 1997, W.P. Wu (Wu1559c); Guangxi Province, Shiwandashan, on dead bark of Eucalyptus sp., 31 December 1997, W.P. Wu (Wu1592d); Guangxi Province, Shiwandashan, on dead bark of *Eucalyptus* sp., 31 December 1997, W.P. Wu (Wu1594f); Guangxi Province, Nangning, on dead leaves of Eucalyptus sp., 3 Jan 1998, W.P. Wu (Wu1612f); Guangxi Province, Shiwandashan, on dead leaves of ?Magnolia sp., 28 December 1997, W.P. Wu (Wu1491a); Guangxi Province, Shiwandashan, on dead leaves of ?Magnolia sp., 29 December 1997, W.P. Wu (Wu1207b); Guangxi Province, Shiwandashan, on dead leaves of ?Quercus sp., 31 December 1997, W.P. Wu (Wu1606h); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of unidentified plant, 2 January 1997, W.P. Wu (Wu1320d); Guangxi Province, Shiwandashan, on dead branches of unidentified plant, 30 December 1997, W.P. Wu (Wu1540c); Yunnan Province, Xishuangbanna, on dead leaves of unidentified tree, 28 June 2018, Yu Zhang (Wu15244). Living strains: 42912 (from Wu1289a), 43716 (from Wu1612f), 44,893 (from (Wu2012d), 44,819 (1961b), 43906 (from 1663c), 44,516, 43932 and 43927 (from 1594f), 43716 (from 1612f), 44,893 (from 2012d), 54,346 (from Wu12168), 75,981 (from Wu15244), 76,687

(from Wu16253), 76,688 (from Wu16255), 76,588 (from Wu16259), 78,261 (from Wu17507) and 78,323 (from Wu17559).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: This species is probably most widely distributed species of the genus, especially in tropical and subtropical area.

Description and illustration: Pirozynski (1968); Kuthubutheen and Sutton (1985); Yang et al. (2018a).

Notes: Cryptophiale udagawae differs from other known species by its setiform conidiophores with dichotomous furcated apex, 1-septate and spindle-shaped or falcate conidia with a short apical appendage. Among the known species, C. udagawae, C. guadalcanalense Matsush. and C. cucullata are the three species with dichotomously furcated apex of conidiophores. C. udagawae can be distinguished from them by 2-septate conidia and fertile region reached to branches of conidiophores in C. cucullata, by unappendaged conidia in C. guadalcanalense (Pirozynski 1965; Matsushima 1975; Kuthubutheen 1987a, b, c, d). This species is the most commonly found species in China and variation on conidiophores and conidia were seen among different collections. Its occurrence on decaying material of different plants including palm tree was reported from mainland, Hong Kong, and Taiwan (Matsushima 1980; Lu et al. 2000; Ma et al. 2010). The ITS sequences were obtained from the single spore isolates of many specimens, they show little variation from different strains, and almost identical with the available sequences in GenBank.

Paracryptophiale Kuthub. & Nawawi, Mycol. Res. 98: 125, 1994.

Colonies effuse, hairy, inconspicuous. Mycelium partly superficial and partly immersed, sparse, composed of branched, septate, brown, smooth hyphae. Teleomorph: unknown. Anamorph: Setae erect or slightly curved at base, simple, brown to dark brown, septate, smooth, tapering towards acute apex. Conidiophores setiform, solitary, erect, curved towards the apices, unbranched, dark brown, smooth, thick-walled, septate, bulbous to irregular at the base, tapered gradually towards the fertile region but becoming slightly wider in the fertile region, finally abruptly tapered to an acute apex. Fertile region apical, cylindrical, the conidiogenous cells obscured by a shield of sterile, flat, lobed, pale brown cells. Conidiogenous cell monophialidic, obscured by a shield of sterile, flat, lobed, pale brown cells. Conidia hyaline, smooth, dictyospores with both transversely and longitudinal septa, constricted at transverse septa, ellipsoid, apical cell with a single, apical appendage.

Type species: *Paracryptophiale kamaruddinii* Kuthub. & Nawawi.

Ecology/Substrate/Host: Saprobe on decaying plant material.

Known distribution: China, Malaysia.

Description and illustration: Kuthubutheen and Nawawi (1994a, b, c); Wu and McKenzie (2003); Seifert et al. (2011).

Notes: The genus Paracryptophiale was erected by Kuthubutheen and Nawawi (1994a, b, c) for a dematiaceous hyphomycete, P. kamaruddinii, which is similar to Cryptophiale in setiform conidiophores and lateral 'phialidic' conidiogenous cells shielded by a plate of modified cells. It, however, differs from Cryptophiale by its appendaged dictyospores. Two species have been known in the genus (Kuthubutheen and Nawawi 1994a, b, c; Wu and Sutton 2004). The striking feature of this fungus, the shield-like outgrowth of cells associated with the conidiogenous apparatus, is found in only one other genus, Cryptophiale (Pirozynski 1968; Ellis 1971 1976; Carmichael et al. 1980; Seifert et al. 2011). Development of conidiophores and conidiogenous cells in Cryptophiale were described by Pirozynski (1968), and the very similar development pattern was found in Paracryptophiale. The LSU and ITS sequences of P. pirozynskii were obtained and its phylogenetic affinity to Cryptophiale in Chaetosphaeriaceae was confirmed.

Key to known species of Paracryptophiale.

- Conidia 15–20×8.5–11.5 μm; apical appendage up to 12.5 μm long......*P. pirozynskii* Conidia 28–35×14–16 μm; apical appendages 4–6 μm
- long......P. kamaruddinii

Paracryptophiale pirozynskii W. Wu & B. Sutton, Fungal Divers. 14: 265, 2004. Figure 154

Description on the natural substrate: Colonies effuse, hairy, inconspicuous. Mycelium partly superficial and partly immersed, sparse, composed of branched, septate, brown, smooth hyphae, 2-5 µm diam. Teleomorph: Unknown. Anamorph: Setae erect or slightly curved at base, simple, brown to dark brown, 3-8 septate, smooth, tapering towards acute apex, 175-225 µm long, 5-7.5 µm wide at the base. Conidiophores setiform, solitary or aggregated, erect, straight or slightly curved, unbranched, brown to dark brown, smooth, thick-walled, up to 12 septate, bulbous to irregular at the base, tapered gradually towards the fertile region but becoming slightly wider in the fertile region, finally abruptly tapered to an acute apex, up to 500 µm long, up to 30 μ m wide at the base, tapering to 5–10 μ m wide below the fertile region. Fertile region apical, cylindrical, $37.5-50 \mu m \log \times 17.5-22.5 \mu m$ wide. Conidiogenous cells obscured by a shield of sterile, flat, lobed, pale brown cells varying from 4 μ m diam. up to 10 μ m long $\times 2.5$ –5 μ m wide. Conidia hyaline, smooth, with 2-3 transversely septa and 1-3 longitudinal septa, constricted at transverse septa,



Fig. 154 *Paracryptophiale pirozynskii* (Holotype). **a** Upper part of conidiophore with fertile region and conidia. **b–d**, **h** Upper part of conidiophores. **e–g**, **I** Setiform conidiophores with fertile region, con-

idiogenous cells and developing conidia. Scale bar: $e~g,~i~40~\mu m,~b~\mu m,~d,~h~20~\mu m,~a~10~\mu m$

ellipsoid, $15-20 \times 8.5-11.5 \mu m$, apical cell with a single, apical appendage up to 12.5 μm long.

On PDA the fungus grows slowly and forms a compact colony with a diameter of 10 mm in 14 days at 25°C. The colony is at first colorless but soon becomes olivaceous green to dark gray with a thin margin. The aerial mycelium is grey and composed of pale brown to medium brown, septate, smooth hyphae. No sporulation was observed on PDA within 4 weeks (Fig. 148k, 1).

Materials examined: **China**, Guangdong Province, Dinghushan, 10 October 1998, Wen Ping Wu, Holotype HMAS 352,036 (= Wu2008). Guangdong Province, Dinghushan, 9 October 1998, W.P. Wu (Wu2050). Living strain: ex-type strain CGMCC 3.20706 (= NN 44,888) and 44,902 (from Wu2008a).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Wu and Sutton 2004). Description and illustration: Wu and Sutton (2004).

Notes: Morphologically *Paracryptophiale pirozynskii* is congeneric with *P. kamaruddinii*, but differs from it by the presence of sterile setae mixed together with conidiophores, and smaller conidia $(28-35 \times 14-16 \ \mu m \ in$ *P. kamaruddinii*) with longer apical appendages $(4-6 \ \mu m \ in$ *P. kamaruddinii*) (Kuthubutheen and Nawawi 1994a, b, c; Wu and Sutton 2004). The conidia of*P. pirozynskii*germinated readily on PDA producing germ-tubes from several cells.

The LSU and ITS sequences of *P. pirozynskii* were for the first time also obtained from the single spore isolate and its phylogenetic affinity to *Cryptophiale*, *Cryptophialoidea* and *Kionochaeta* in Chaetosphaeriaceae was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 44888 include *Cryptophiale udagawae* (GenBank MW133882, 92%), *Cryptophialoidea sasciculata* (GenBank MH758195, 91% identity) and *Kionochaeta ivoriensis* (GenBank NR_160149, 85% identity) and *Zanclospora iberica* (GenBank KY853481, 87% identity).

Cryptophialoidea Kuthub. & Nawawi, Trans. Br. Mycol. Soc. 89: 581, 1987.

Colonies effuse, pale to olivaceous brown. Mycelium partly superficial, partly immersed, composed of branched, septate, smooth, pale brown hyphae. Teleomorph: Unknown. Anamorph: Conidiophores setiform, solitary, erect, flexuous, subulate, brown, smooth, simple, thick-walled, septate, with septa arranged more closely in the conidiogenous zone; Fertile region cylindrical, about halfway up consisting of a single row of phialides closely arranged on only one side of the conidiophore. Conidiogenous cells extruded through minute pores on only one side of the conidiophore, monophialidic, polyphialides, lageniform; collarettes funnel-shaped or Type species: *Cryptophialoidea secunda* (Kuthub. & Sutton) Kuthub. & Nawawi (= *Cryptophiale secunda* Kuthubutheen & Sutton).

Ecology/Substrate/Host: Saprobe on decaying plant material.

Geographical distribution: Broadly distributed, especially in subtropical and tropical areas.

Description and illustration: Kuthubutheen and Nawawi (1987).

Notes: Cryptophialoidea was erected to accommodate Cryptophiale secunda and C. uncispora. The absence of the shield of sterile cells and the location of a single row of phialides on one side only of setiform conidiophores are unique for them and unlike any other species of Cryptophiale (Pirozynski 1968; Kuthubutheen and Sutton 1985; Kirk and Sutton 1985; Kuthubutheen and Nawawi 1987). Three additional species have been added into the genus since then, including C. fasciculata Kuthub. & Nawawi, C. manifesta (B. Sutton & Hodges) Kuthub. & Nawawi and C. ramosa Delgado, J. Mena & Gené. The known species in the genus are distinguished by morphology of setiform conidiophores, fertile region, conidiogenous cells and conidia (Delgado et al. 2005; Marques et al. 2008, 2013). The phylogenetic analysis of Cryptophialoidea fasciculata showed that the genus is closely related to Cryptophiale and assigned into Chaetosphaeraceae (Yang et al. 2018a; Liu et al. 2016; Lin et al. 2019).

The genus was recorded from Taiwan with a single species, *C. secunda* on decaying twig (Chang 1990). Here we reported its occurrence with another species, *C. fasciculata*, in mainland China.

Key to accepted species of Cryptophialoidea.

1.	Setiform conidiophores 1-3 times dichotomously
	branchedC. ramosa
1.	Setiform conidiophores unbranched0.2
2.	Conidiogenous cells polyphialidicC. manifesta
2.	Conidiogenous cells monophialidic0.3
3.	Conidia falcate4
3.	Conidia uncinateC. uncispora
4.	Phialides arranged in discrete bundlesC. fasciculata
4.	Phialides not arranged in bundles

Cryptophialoidea fasciculata Kuthub. & Nawawi, Mycol. Res. 98: 686, 1994. Figure 155

Description on the natural substrate: Colonies effuse, hairy, scattered, dark brown to black, glistening, with slimy mass of conidia on one side of the conidiophores. Mycelium mostly immersed, composed of smooth, septate, branched, pale brown to mid brown hyphae. Teleomorph: Unknown. Anamorph: Conidiophores setiform, solitary or aggregated



Fig. 155 *Cryptophialoidea fasciculata* (Wu17489). **a–c** Conidiophores with fertile region. **d–g** Fertile region with conidiogenous cells in groups. **h–m** Conidia. Scale bar: **a–c** 20 μm, **d**, **e** 10 μm, **f–q** 5 μm

in small group, erect, straight or flexuous, thick-walled, smooth, multiseptate, dark brown, $140-182 \times 3.5-4.5 \mu m$, basal cell swollen and 9-16 µm wide, main stipe in the lower part 50-80 µm high, middle fertile region 86-137 µm high, upper sterile part 35-65 µm high, terminating with a sterile obtuse apex. Fertile region about halfway up and restricted only to the middle third of the conidiophore, cylindrical, 86–137 µm long, comprising a row of phialides that are mostly closely arranged in 5-9 discrete bundles and that all open on only one side of the conidiophore. Conidiogenous cells monophialidic, polyphialidic, lageniform, extruded through minute pores on only one side of the conidiophores, light olivaceous brown, $11-14 \times 2.5-3.5 \mu m$; collarettes funnel-shaped, 1.5-2 µm wide, up to 1 µm deep. Conidia hyaline, smooth-walled, 1-septate, falcate, with the base slightly narrower than the apex, sometimes guttulate, 14-20 µm long, 1.5 µm wide in the widest part, tapering gradually toward the apex.

Materials examined: **China**, Guangdong Province, Shenzhen, Yangtaishan Park, on dead leaves of *Acacia* sp., 17 October 2020, W.P. Wu (Wu17487, Wu17489). Living strains: 78,247, 78,248 and 78,249 (from Wu17487), 78,251 and 78,327 (from Wu17489).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China, Malaysia (Kuthubutheen and Nawawi 1994a, b, c) and Thailand (Yang et al. 2018a).

Description and illustration: Kuthubutheen and Nawawi (1994a, b, c); Yang et al. (2018a).

Notes: Cryptophialoidea fasciculata was originally described from Malaysia and it differs from other known species by unbranched setiform conidiophores, phialides arranged in discrete bundles, and falcate conidia with 1 septum (Kuthubutheen and Nawawi 1994a, b, c). The fungus was also discovered and described from Thailand and the phylogenetic analysis showed its close relationship with members of Cryptophiale (Yang et al. 2018a). This is first record from China. The conidia from the Chinese collection are somewhat smaller than those in the original description $(22-29 \times 1.5-2 \ \mu m)$ and the Thailand collection $(26.5-33.5 \times 1.2-2.4 \ \mu m)$ (Kuthubutheen and Nawawi 1994a, b, c; Yang et al. 2018a). The LSU and ITS sequences were also obtained from the single spore isolates of several specimens by us and its phylogenetic affinity to Cryptophialoidea and Cryptophiale in Chaetosphaeriaceae was further confirmed.

Cryptophialoidea secunda (Kuthub. & B. Sutton) Kuthub. & Nawawi, Trans. Br. Mycol. Soc. 89: 583, 1987.

 \equiv *Cryptophiale secunda* Kuthub. & Nawawi, Trans. Br. Mycol. Soc. 84: 303, 1985.

= Chaetopsina unilateralis P.M. Kirk, Mycotaxon 23: 217, 1985.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores setiform up to 200 μ m long, 5.5–6.5 μ m at the base tapering towards the apex; Conidiogenous zone about halfway up the conidiophore, more or less cylindrical and consisting of a single row of phialides closely arranged on only one side of the conidiophore. Conidiogenous cells monophialidic, extruded through minute pores, individual phialide 7.5–10×3.7–4.7 μ m. Conidia hyaline, smooth, 1-septate, simple, falcate, 20–27.5 μ m×1.4–2.3 μ m (Adapted from Chang 1990).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Chang 1990), Kenya (Kirk 1985) and Malaysia (Kuthubutheen and Nawawi 1987).

Illustrations: Kuthubutheen and Sutton (1985); Chang (1990).

Notes: *Cryptophialoidea secunda* differs from other species in the genus by unbranched conidiophores, monophialidic conidiogenous cells, and 1-septate and falcate conidia (Kuthubutheen and Nawawi 1987; Kirk, 1985). This species was reported by Chang (1990). No specimen was examined by us, the above documentation is based on the description by Chang (1990).

Paraceratocladium R.F. Castañeda, Fungi Cubenese II: 8, 1987.

Colonies effuse, brown to dark brown, hairy. Mycelium partly immersed and partly superficial, composed of brown, septate, smooth-walled hyphae. Teleomorph: unknown. Anamorph: Setae solitary, unbranched, cylindrical, erect, straight, or flexuous, smooth or verruculose, septate. Conidiophores irregularly branched, septate, flexuous, ascendant, adhering and twining around the setae, smooth-walled, pale brown, with intercalary conidiogenous cells. Conidiogenous cells monophialidic or polyphialidic, mostly intercalary, lageniform, ampulliform; collarette conspicuous, pale brown, funnel-shaped. Conidia in dry or slimy head, aciculate, or falcate, narrowly fusoid, aseptate or septate, hyaline, smooth, thin-walled.

Type species: *Paraceratocladium silvestre* R.F. Castañeda.

Ecology/Substrate/Host: Saprobe on decaying plant material, including leaves of tree and culm of grass.

Geographical distribution: Brazil, China and Cuba. Probably widely distributed in subtropical and tropical areas.

Description and illustration: Castañeda-Ruiz (1987); Seifert et al. (2011).

Notes: *Paraceratocladium* was erected by Castañeda-Ruiz (1987) with two species, *P. silvestre* and *P. polysetosum*. Both species were found colonizing plant debris from Cuba.

The genus was characterized by hyphae-like conidiophores which arise from the substrate and entwine on dematiaceous, erect setae, monophialidic conidiogenous cells with a conspicuous collarette, and 1-septate conidia (Castañeda-Ruiz 1987; McKenzie and Hyde 1997; Dulymamode et al. 1998; Whitton et al. 2001). The most closely related genus is *Ceratocladium* but can be easily distinguished from the latter genus by its conspicuous collarette and septate conidia (Carmichael et al. 1980; Seifert et al. 2011).

Four additional species, including P. bacilliformis Calduch, Gene, Stichigel & Guarro on decaying rotten twigs in Brazil, P. malayasianum Goh & K.D. Hyde found on submerged wood in Malaysia, P. seychellarum found on decaying leaves of Pandanus seychellarum in Seychelles, and P. triseptata occurring on leaves of Pandanus palustris in Mauritius, have been included into the genus (Dulymamode et al. 1998; Goh and Hyde 2000; Whitton et al. 2001; Calduch et al. 2002b). Morphologically all these fungi producing setae or setiform conidiophores, monophialidic or polyphialidic conidiogenous cells with funnel-shaped collarettes, and hyaline, aseptate or septate conidia, but differ in morphology of setae, conidiophores and conidiogenous cells (Pirozynski 1968; Castañeda-Ruiz 1987; Kuthubutheen and Nawawi 1987, 1994a, b, c; McKenzie and Hyde 1997; Dulymamode et al. 1998; Whitton et al. 2001; Seifert et al. 2011). Paraceratocladium triseptata differs from the rest species of the genus by its polyblastic conidiogenous cells and 3-septate conidia. The other species can be distinguished by their conidial morphology (Castañeda-Ruiz 1987; Calduch et al. 2002b). Key to accepted species was provided by Goh and Hyde (2000) and Whitton et al. (2001).

Two species, P. silvestre and P. polysetosum, were found from China by us. The living strains of both species were obtained by single spore isolation, and both LSU and ITS sequences were also obtained from them. In our phylogenetic analysis, these two species are placed in one big clade together with Cryptophiale, Cryptophialoidea and Paracryptophiale, however the two species are not congeneric (Fig. 3). The genus name *Paraceratocladiella* is introduced to accommodate P. polysetosum. Morphologically P. silvestre produces simple setae, ascendant conidiophores without spike-like structure, and hyaline, 1-septate, aciculate conidia $(26-29 \times 2-3 \ \mu\text{m})$; while in *P. polysetosum*, the setae are branched with several secondary branches, the ascendant conidiophores with spike-like structure, and hyaline, aseptate, cylindrical conidia with slightly swollen and rounded ends $(16-18 \times 1.5-2.2 \,\mu m)$.

Paraceratocladium seychellarum resembles P. polysetosum in branched setae, ascendant conidiophores with spike-like structure, intercalary phialidic conidiogenous cells, and hyaline and aseptate conidia with rounded ends (Whitton et al. 2011). The other three known species under the genus Paraceratocladium, including P. bacilliforme, P. *malaysianum*, *P. triseptata* are morphologically similar to *P. silvestre*, but remain to be studied for their phylogenetic relationship.

Key to species of *Paraceratocladium* (*P*.) and *Paraceratocladiella* (*Pl*.) (Revised from Whitton et al. 2001)

- 4. Conidia septate.....5
- 5. Conidia 1-septate, 21–32×1–2.5 μm.....*P. silvestre*

Paraceratocladium silvestre R.F. Castañeda, Fungi Cubenese II: 9, 1987. Figure 156

Description on the natural substrate: Colonies effuse, brown to dark brown, hairy. Mycelium partly immersed and partly superficial, composed of brown, septate, smoothwalled, 1-3 µm wide hyphae. Teleomorph: Unknown. Anamorph: Setae simple, cylindrical, erect, straight, or flexuous, brown, thick-walled, smooth, 5-7-septate, $200-250 \times 5-6$ µm. Conidiophores hyphae-like, irregularly branched, septate, flexuous, ascendant, adhering and twining around the setae, smooth-walled, pale brown, up to 230 µm long, 2-3 µm wide, bearing intercalary conidiogenous cells. Conidiogenous cells monophialidic or polyphialidic, mostly intercalary, ampulliform; collarette conspicuous, funnel-shaped, pale brown, 2-3 µm deep, 2-2.5 µm wide at apex, with narrow sporulating locus of 1-1.5 µm wide. Conidia in slimy head, 1-septate, aciculate, obclavate, straight, or slightly curved, hyaline, smooth, thin-walled, $26-29 \times 2-3 \mu m$, apex acute, base rounded.

Culture characteristics: Colonies on PDA effuse, colonies 0.7–0.9 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, reverse brown to dark brown (Fig. 148g, h).

Materials examined: **China**, Guangdong Province, Shaoguan, Danxiashan, on dead leaves of unidentified tree, 2 March 2012, W.P. Wu (Wu12472); Guangdong Province, Guangzhou, South China Botanical Garden, on



Fig. 156 *Paraceratocladium silvestre* (Wu17503). **a–d** Setae with conidiophores. **e–l** Part of setae and conidiophores bearing intercalary conidiogenous cells with funnel-shaped collarettes. **m–q** Conidia. Scale bar: **a–c** 20 μ m, **d–e** 10 μ m, **f–q** 5 μ m

rotten wood of unidentified tree, 2 December 2018, W.P. Wu (Wu16259, Wu16260 and Wu16261); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead culm of grass, 17 October 2020, W.P. Wu (Wu17499, Wu17500); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead leaves of unidentified broad leaf tree, 17 October 2020, W.P. Wu (Wu17502, Wu17503); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead leaves of unidentified broad leaf tree, 17 October 2020, W.P. Wu (Wu17502, Wu17503, Wu17508); Guangdong Province, Dinghushan, on dead branches of unidentified plant, 11 October 1998, W.P. Wu (WU1995c); Guangdong Province, Dinghushan, on dead branches of Eucalyptus sp., 11 October 1998, W.P. Wu (Wu0232Aa); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of ?Acer sp., 2 January 1997, W.P. Wu (Wu1261b); Guangxi Province, Shiwandashan, on dead leaves of ?Cinnamomum sp., 30 December 1997, W.P. Wu (Wu1559f); Guangxi Province, Shiwandashan, on dead leaves of ?Quercus sp., 31 December 1997, W.P. Wu (Wu1609f); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead stem and leaves, 2 January 1997, W.P. Wu (Wu1281); Guangxi Province, Shiwandashan, on dead leaves of unidentified plant, 30 December 1997, W.P. Wu (Wu1554i); Living strains: 42906 (from Wu1261b), 44,059 (from 1609f), 55,375 (from Wu12472), 76,689 (from Wu16259), 76,589 (from Wu16261), 78,342 and 78,396 (from Wu17499), 78,344 (from Wu17500), 78,387 and 78,388 (from Wu17502), 78,258 (from Wu12503) and 78,262 (from Wu17508).

Ecology/Substrate/Host: Saprobe on dead material of plants including *Cinnamomum*, *Eucalyptus*, *Quercus* and *Rhododendron*.

Geographical distribution: China (Whitton et al. 2001) and Cuba (Castañeda-Ruiz 1987).

Description and illustration: Castañeda-Ruiz (1987); Whitton et al. (2001); Castañeda-Ruiz et al. (2002).

Notes: *Paraceratocladium silvestre* R differs from the rest species of the genus by its aciculate, obclavate and 1-septate conidia with acute apex and rounded base. In the original description given by Castañeda-Ruiz (1987), it was said the conidiogenous cells are monophialidic, however, the polyblastic conidiogenous cells were constantly found from some Chinese collections. This species seems to be broadly distributed and grows on different substrate, including dead leaves of *Acer*, *Cinnamomum*, *Eucalyptus*, *Quercus* and *Rhododendron*, unidentified grass, and *Pandanus furcatus* (Whitton et al. 2001).

Both LSU and ITS sequences were for the first time generated from the living strains of this species and phylogenetic analysis showed it is closely related to other members of Chaetosphaeriaceae. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 42906 include *Cryptophialoidea fasciculata* (GenBank MH758195, 87% identity), *Kionochaeta ivoriensis* (GenBank NR_160149, 86% identity) and *Zanclospora iberica* (GenBank NR_154543, 87% and *Zanclospora iberica* (GenBank KY853481, 87% identity).

On a megablast search using the ITS sequences from the strain obtained from the strain 42906, the closest matches in NCBI's GenBank nucleotide database were members of *Cryptophialoidea, Zanclospora, Kinochaeta* and *Nawawia* in *Chaetosphaeriales*, including *Kinochaeta ivoriensis* (GenBank MH860988, identities 400/465 (86%), 19 gaps (4%)), *Nawawia filiformis* (GenBank MH758196, identities 402/470 (86%), 13 gaps (2%)).

Paraceratocladiella W.P. Wu & Y.Z. Diao, gen. nov., MB841537.

Etymology: refers to its morphological similarity to the genus *Paraceratocladium*.

Diagnosis: Similar to *Paraceratocladium* in presence of setae, hyphae-like conidiophores adhering and twining around the setae, and intercalary phialidic conidiogenous cells, but differs from it by branched setae, presence of spike-like structure from the conidiophores, and ovoid, cylindrical, ellipsoidal, aseptate conidia with rounded ends.

Type species: *Paraceratocladiella polysetosum* (R.F. Castañeda) W.P. Wu & Y.Z. Diao (≡ *Paraceratocladium polysetosum* R.F. Castañeda).

Description on the natural substrate: Colonies effuse, brown to dark brown, hairy. Mycelium partly immersed and partly superficial, composed of brown, septate, smooth-walled hyphae. Teleomorph: Unknown. Anamorph: Setae solitary or aggregated, branched, cylindrical, erect, straight, or flexuous, smooth or verruculose, septate. Conidiophores hyphae-like, irregularly branched, septate, flexuous, ascendant, adhering and twining around the setae, smooth-walled, pale brown, bearing internal spikelike structure and conidiogenous cells. Conidiogenous cells monophialidic or polyphialidic, mostly intercalary, lageniform, ampulliform; collarette conspicuous, funnelshaped, pale brown. Conidia in slimy head, ovoid, cylindrical, ellipsoidal, aseptate, hyaline, smooth, thin-walled, both ends rounded.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China and Cuba.

Notes: The genus *Paraceratocladiella* is created to accommodate *Paraceratocladium polysetosum* and *Paraceratocladium seychellarum* which are morphologically similar to other members of *Paraceratocladium*, but differs in forming branched setae, intercalary spike-like structure in the conidiophores, and ovoid, cylindrical, ellipsoidal, and aseptate conidia with rounded ends (Castañeda-Ruiz 1987;



Fig. 157 *Paraceratocladiella polysetosa* (Wu1523a). **a** Conidia. **b** Setae and conidiophores bearing intercalary conidiogenous cells. **c** Conidiophores and intercalary conidiogenous cells with funnel-shaped collarettes. Scale bar: **b** 40 μ m, **a**, **c** 20 μ m

McKenzie and Hyde 1997; Dulymamode et al. 1998; Whitton et al. 2001). This is supported by the molecular phylogenetic analysis.

Paraceratocladiella polysetosa (R.F. Castañeda) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 157, MycoBank MB841730.

≡ Paraceratocladium polysetosum R.F. Castañeda, Fungi Cubenese II: 9, 1987.

Description on the natural substrate: Colonies effuse, brown to dark brown, hairy. Mycelium partly immersed and partly superficial, composed of brown, septate, smoothwalled, 1-3 µm wide hyphae. Teleomorph: Unknown. Anamorph: Setae solitary or aggregated, branched, erect, straight or flexuous, arising from a swollen basal cell; the main stipe cylindrical, erect, brown to dark brown, thickwalled, smooth, 4–6-septate, $270-350 \times 6-7 \mu m$; the branches pale brown, smooth, thin- or thick-walled, 1-2-septate, $45-100 \times 2.5-3$ µm. Conidiophores hyphae-like, irregularly branched, septate, flexuous, ascendant, adhering and twining around the setae, thin- and smooth-walled, pale brown, up to the same length as setae, 2-3 µm wide, with intercalary conidiogenous cells and numerous spikelike structure; Spike-like structure intercalary, pale brown, thick- and smooth-walled, with acute apex, 8-12 µm high, 4-6 µm wide at the base. Conidiogenous cells monophialidic, mostly intercalary, lageniform or ampulliform, pale brown, thin- and smooth-walled, $8-10 \times 3-4 \mu m$; collarettes funnel-shaped, 1.5–2.5 µm deep, 3–3.5 µm wide at apex, with narrow sporulating locus of 1.5-2.5 µm wide. Conidia in slimy head, 1-septate, cylindrical, obtuse at both ends, constructed just below apex, straight or slightly curved, hyaline, smooth, thin-walled, $16-18 \times 1.5-2.2 \,\mu\text{m}$.

Culture characteristics: Colonies on PDA effuse, colonies 0.6–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse brown to dark brown (Fig. 148i, j).

Materials examined: **China**, Guangxi Province, Shiwandashan, on dead leaves of *Rhododendron* sp., 29 December 1997, W.P. Wu (Wu1523a). Living strain: CGMCC 3.20634 (=NN 44,119) (from Wu1523a).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Brazil (Barbosa and Gusmão 2003), China and Cuba (Castañeda-Ruiz 1987).

Description and illustration: Castañeda-Ruiz (1987).

Notes: *Paraceratocladiella polysetosum* differs from the other species in the genus, *Paraceratocladiella seychellarum*, in ovoid, cylindrical or ellipsoidal conidia with smaller size in the latter species $(3-5.2 \times 1.2-1.5 \,\mu\text{m})$ (Whitton et al. 2001). The species has been reported from Brazil and Cuba (Castañeda-Ruiz 1987; Barbosa and Gusmão 2003). Here we for the first time recorded its occurrence in China.

The LSU and ITS sequences were for the first time also obtained from the single spore isolate of this species and its phylogenetic affinity to several genera in Chaetosphaeriaceae was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 44119 include *Chaetosphaeria lateriphiala* (GenBank JN673039, 88% identity), *Nawawia filiformis* (GenBank MH758196, 88% identity) and *Zanclospora iberica* (GenBank NR154543, 88% identity),

Paraceratocladiella seychellarum (Whitton, McKenzie & K.D. Hyde) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB843983.

≡ Paraceratocladium seychellarum Whitton, McKenzie & K.D. Hyde, Fungal Divers. 7: 177, 2001.

Typification: Seychelles, Mont Blanc, on decaying leaves of *Pandanus seychellarum*, 1 August 1996, K.D. Hyde (HKU(M) 12,971).

Diagnosis: Similar to *Paraceratocladiella polysetosum* in branched setae, hyphae-like conidiophores adhering and twining around the setae, and bearing intercalary spike-like structure and conidiogenous cells, but differs in producing ovoid, short cylindrical, ellipsoidal conidia in smaller size $(3-5.2 \times 1.2-1.5 \ \mu\text{m})$ and with rounded ends.

Known distribution: Seychelles (Whitton et al. 2001). Description and illustration: Whitton et al. (2001).

Notes: Morphologically *Paraceratocladium seychellarum* fits well to the concept of the new genus *Paraceratocladiella*, typified by *P. polysetosum*. The numerous spike-like structure was clearly illustrated from the holotype specimen by Whitton et al. (2001), although they described them as immature phialides (4–12 μ m long, 1–1.8 μ m wide towards the base).

Zanclospora S. Hughes & W.B. Kendr., N. Z. J. Bot. 3: 151, 1965.

Colonies effuse, hairy, golden-yellow, yellow-brown, tawny, reddish-brown or dark brown with white to light straw conidial masses. Anamorph: Conidiophores setiform, solitary or aggregated in small group, erect, straight or flexuous, cylindrical to cylindrical-fusiform, septate, brown, paler towards the apex, occasionally dark brown and opaque, apex acute, subacute or obtuse, sterile or developed into a phialide, simple or branched; branches setiform, fertile, resemble the main stalk or shorter. Conidiogenous cells monophialidic, sessile, lateral, appressed to the conidiophore, arise just below the septa, arranged in whorls forming one or two compact fertile regions, occasionally integrated, terminal, at the conidiophore apex, ovoid to lageniform, subhyaline to light brown, smooth, collarettes inconspicuous to short-flared. Conidia subcylindrical, obovoid, occasionally bacilliform, straight, gently or strongly curved, aseptate, hyaline, smooth, without setulae or sheaths, accumulating in a slimy mass.

Type species: Zanclospora novae-zelandiae S. Hughes & W.B. Kendr.

Ecology/Substrate/Host: Saprobe on decaying plant material.

Geographical distribution: Broadly distributed, especially in subtropical and tropical areas.

Description and illustration: Hughes and Kendrick (1965); Réblová et al. (2021a).

Notes: Zanclospora was erected by Hughes and Kendrick (1965) to accommodate two dematiaceous hyphomycetous species, Z. novae-zelandiae (the type species) and Z. brevispora collected on lignicolous substrates in New Zealand. The genus is characterized by simple or branched and setiform conidiophores, discrete and phialidic conidiogenous cells arranged in multiple verticils on conidiophores, and falcate or narrowly obovoid, hyaline and aseptate conidia (Hughes and Kendrick 1965; Seifert et al. 2011; Almeida et al. 2013; Hernández-Restrepo et al. 2017; Réblová et al. 2021a). The accepted species are mainly distinguished by morphology of setiform conidiophores, fertile region, conidiogenous cells and conidia (Subramanian and Vittal 1973; Sutton and Hodges 1975; Zucconi and Rambelli 1982; Morgan-Jones et al. 1992; Calduch et al. 2002a; Cooper 2005; Almeida et al. 2013; Hernández-Restrepo et al. 2017; Villavicencio et al. 2020; Réblová et al. 2021a). The genus was recently reviewed by Reblová et al. (2021a) and a comparison of all accepted species was also provided.

There are three known teleomorph-anamorph connections between Zanclospora and Chaetosphaeria s. lat. Chaetosphaeria brevispora was connected to Z. brevispora var. brevispora by Hughes & Kendrick (1967), and C. lateriphiala and C. minuta were connected to two unidentified species of Zanclospora (Fernández & Huhndorf 2005; Fernández et al. 2006). Recent phylogenetic analysis showed that he genus Zanclospora belongs to Chaetosphaeriaceae (Hernández-Restrepo et al. 2017; Réblová et al. 2021a).

In our phylogenetic tree generated by using the combined LSU and ITS data (Fig. 3, 147), members of *Zanclospora* are clustered as sister group with several other genera and species with lateral phialides, including *Cryptophiale*, *Cryptophialoidea*, *Paracryptophiale* and *Chaetosphaeria minuta*. This result is aligned with the previous studies (Fernández and Huhndorf 2005; Lin et al. 2019; Luo et al. 2019; Réblová et al. 2021a). Within the *Zanclospora* clade, the three species of *Zanclospora*, *Z. novae-zelandiae* (the type species), *Z. brevispora* and *Z. iberica* are grouped together with *Chaetosphaeria jonesii*, *C. lateriphiala*, *C. sylvatica*, and *C. tropicalis*, and forms a monophyletic group. This clade in the ML tree represents an independent phylogenetic group from other *Chaetosphaeria* including its type species.

Zanclospora has a temperature, tropical and subtropical distribution, and recorded on leaf litter, decaying wood and bark (Hughes and Kendrick 1965; Almeida et al. 2013; Réblová et al. 2021a). Z. novae-zelandiae was reported on decaying twigs from Taiwan (Chang 1990) and Z. brevispora var. brevispora was reported on submerged wood in Hong Kong (Tsui et al. 2000). Only two species, Z. brevispora and Z. novae-zelandiae, were discovered by us from mainland China.

Zanclospora brevispora S. Hughes & W.B. Kendr., N. Z. J. Bot. 3: 156, 1965. Figure 158

Description on the natural substrate: Colonies on natural substrate effuse, brownish, composed of mostly branched setiform conidiophores bearing straw-colored globules of conidiogenous cells. Teleomorph: Unknown. Anamorph: Conidiophores setiform, simple, arise singly from swollen cells of the repent hyphae, 180-255 µm high, straight, brown to dark brown, paler toward the distal end, septate, smoothwalled, basal cell 13-18 µm wide, 4.5-5.5 µm wide just above the basal cell, tapering gradually to 2.5-4 µm toward the rounded apex; the lower part of the main stipe sterile, 5-6-septate, dark brown, thick-walled; the middle fertile region 130-173 µm long, pale brown to brown, 7-8 septate, cell $5.5-8.5 \times 4.5-5.5 \mu m$; the upper part are sterile, pale brown, 3-6-septate, 2.5-4 µm wide. Conidiogenous cells monophialidic, occur in whorls of up to 7, arise just below the distal septa of a series of up to 8 cells of the conidiophore below the generally sterile apex, sessile, straight, narrowly ovoid to ovoid, generally tightly adpressed to the conidiophore, pale brown, 6.5-9.5 µm long, 3.0-3.5 µm wide, with an apical, hyaline to subhyaline, more or less funnel-shaped collarette 2.0-2.5 µm wide and 1.0-2.0 µm deep. Conidia hyaline, curved, and narrowly obovoid, being blunt at the distal end and tapered at the other, aseptate, $5-7 \times 1.8-2.2 \,\mu$ m, produced in slimy and finally enveloping the phialides as straw-colored mass.

Materials examined: **China**, Guangdong Province, Shenzhen, Yangtaishan Forest Park, on rotten seed pod of *Acacia* sp., 17 October 2020, W.P. Wu (Wu17551, Wu17552, Wu17589). Living strains: 78,357 (from Wu17551a), 78,358 (from Wu17351b), 78,359 (from Wu17352c) and 78,360 (from Wu17352d), 78,402, 78,403 and 78,404 (from Wu17589).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Brazil, Brunei, China, Cuba, Kenya, New Zealand, Seychelles and Thailand (Hughes and Kendrick 1965; Tsui 2000; Almeida et al. 2013).

Description and illustration: Hughes and Kendrick (1965); Almeida et al. (2013).

Notes: Zanclospora brevispora differs from other species in the genus by simple and unbranched setiform



Fig. 158 Zanclospora brevispora (Wu17551). **a–e** Setiform conidiophores with fertile region. **f–h** Fertile regions with conidiogenous cells directly formed from main stipe of setae. **i–t** Conidia. Scale bar: **a–c** 20 μ m, **d, e** 10 μ m, **f–t** 5 μ m



Fig. 159 Zanclospora novae-zelandiae (Wu1337a). a-d Setiform conidiophores and conidiogenous cells. e-i Conidia. j-k Conidiogenous cells. Scale bar: a, b 20 μm, c-k 10 μm

conidiophores with a subapical fertile regions, monophialidic conidiogenous cells arising in whorls of up to 7 just below the distal septa of a series of up to 8 cells of the conidiophore, and ovoid and smaller conidia (Hughes and Kendrick 1965; Mercado Sierra et al. 1997a, b; Whitton et al. 2012; Almeida et al. 2013; Hernández-Restrepo et al. 2017). It differs from Z. brevispora var. transvaalensis by fertile regions with more conidiogenous cells and shorter, regularly curved conidia (Morgan-Jones et al. 1992). Zanclospora austroamericana is also similar to Z. brevispora var. brevispora, but differs by having two fertile regions, and larger, falcate conidia (Sutton and Hodges 1975). Its



Fig. 160 Maximum likelihood (ML) tree based on ITS sequence data for the genus *Kionochaeta*. Bootstrap support values $\geq 60\%$, Bayesian posterior probability values ≥ 0.95 are shown at the nodes. *Chaetosphaeria abietis* CBS42783 was chosen as the outgroup. Ex-

type strains are indicated with "T" in the end of the taxa labels. Latin names and ex-type strain numbers of the new species described in the current study are shown in font

occurrence in China was previously reported by Tsui et al. (2000).

The LSU and ITS sequences were also obtained for the first time from the single spore isolate of this species and its phylogenetic affinity to Chaetosphaeriaceae was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 78,357 include *Nawawia filiformis* (GenBank DQ124120, 93% identity), *Chaetosphaeria jonesii* (GenBank NR154841, 92% identity), *C. iberica* (GenBank NR154543, 89% identity), *Cryptophialoidea sasciculata* (GenBank MH758195, 85% identity) and *Zanclospora iberica* (GenBank KY853481, 90% identity),

Zanclospora novae-zelandiae S. Hughes & W.B. Kendr., N. Z. J. Bot. 3: 152, 1965. Figure 159

Description on the natural substrate: Colonies hairy, brown or blackish brown. Mycelium partly superficial, partly immersed, composed of branched, septate, smooth, pale brown to brown hyphae of $2-3.5 \,\mu\text{m}$ wide. Teleomorph: Unknown. Anamorph: Conidiophores setiform, solitary, erect, straight, or slightly curved, subulate, smooth, up to 15-septate, thick-walled, brown to dark brown or blackish brown, unbranched, $200-300 \times 6-8 \mu m$, apex acute. Fertile usually sub-medium or slightly below medium, comprising irregularly arranged conidiogenous cells. Conidiogenous cells cylindrical, lageniform, pale brown to brown, thinand smooth-walled, with an indistinct collarette at the apex. Conidia acrogenous, formed in a liquid droplet, falcate, sub-cylindrical, slightly curved, attenuated at both ends, hyaline, aseptate, smooth, 20.5–34.5 × 2–2.5 µm.

Materials examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of unidentified plant, 2 January 1997, W.P. Wu (Wu1337b); Guangxi Province, Shangsi, Shiwandashan, Wangle, on wood of unidentified plant, 2 January 1997, W.P. Wu (Wu1338c). Living strain: 44,417 (from Wu1337b).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Brazil, China, Japan, New Zealand and USA. (Hughes and Kendrick 1965; Matsushima 1975; Almeida et al. 2013; Réblová et al. 2021a).

Description and illustration: Hughes and Kendrick (1965); Matsushima (1975); Almeida et al. (2013).

Notes: *Zanclospora novae-zelandiae* S. Hughes & W.B. Kendr. was originally described from New Zealand and the setiform conidiophores are simple or branched (Hughes and Kendrick 1965). This species was also recorded on decaying twigs from Taiwan (Chang 1990).

Zanclosporiella W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB842076.

Etymology: refers to its morphological similarity with Zanclospora.

Diagnosis: Similar to *Zanclospora*, but differs in aseptate, fusiform to narrow-ellipsoidal ascospore, and unilateral phialides produced along the midsection of setiform conidiophores.

Type species: *Zanclosporiella minuta* (F.A. Fernández & Huhndorf) W.P. Wu & Y.Z. Diao (≡ *Chaetosphaeria minuta* F.A. Fernández & Huhndorf).

Teleomorph: Ascomata globose to sub-globose, dark brown, solitary to densely gregarious, superficial on a thin subiculum, distinctly papillate. Ascomatal wall in surface view, opaque in water, textura angularis in lactophenol, composed of pseudoparenchymatic cells. Ascomatal apex papillate, opaque. Paraphyses unbranched, septate, tapering. Asci cylindro-clavate, short stalked, unitunicate, thin-walled, apical ring not observed, with 8 ascospores irregularly arranged. Ascospores hyaline, fusiform to narrow-ellipsoid, one-septate. Anamorph: Conidiophores setiform, solitary, erect, unbranched, multiseptate, brown, tapering to an apical phialide, several unilateral phialides produced along the midsection. Conidiogenous cells mono- or poly-phialides, ovoid, brown, produced along the conidiophore midsection, with several collarettes in a sympodial arrangement, or sometimes with percurrent proliferations; collarettes small, funnel-shaped. Conidia narrow fusiform, hyaline, one-celled.

Ecology/Substrate/Host: Saprobe on decaying wood of branches (Adapted from Fernández and Huhndorf 2005).

Geographical distribution: Panama (Fernández and Huhndorf 2005).

Description and illustration: Fernández and Huhndorf (2005).

Notes: The new genus is created for *Chaetosphaeria minuta*, which in our phylogenetic analysis is closely connected with *Zanclospora* but forms in a distinct linkage. The diagnostic characters for the genus are hyaline, fusiform to narrow-ellipsoid, aseptate ascospore, and *Zanclospora*-like anamorph with setiform conidiophores, several unilateral phialides produced along the midsection, and hyaline, aseptate ascospore and unilaterally arranged phialides in one

side along the midsection of conidiophores (Fernández and Huhndorf 2005; Réblová et al. 2021a).

Zanclosporiella minuta (F.A. Fernández & Huhndorf) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB842077.

≡ *Chaetosphaeria minuta* F.A. Fernández & Huhndorf, Fungal Divers. 18: 35, 2005.

Description on the natural substrate: Teleomorph: Ascomata globose to sub-globose, dark brown, 106-119 µm in diam., 100-109 µm in height, solitary to densely gregarious, superficial on a thin subiculum, distinctly papillate. Paraphyses unbranched, septate, 1.9–2.5 µm wide, tapering. Asci cylindro-clavate, short stalked, $105-150 \times 8.5-15 \mu m$, unitunicate, thin-walled, apical ring not observed, with 8 ascospores irregularly arranged. Ascospores hyaline, fusiform to narrow-ellipsoid, $9.5-10.5 \times 2.5-3.5 \mu m$. Anamorph: Conidiophores solitary, unbranched, multiseptate, brown, $90-120 \times 4.8-5.2 \mu m$, narrowing to $2.7-3.4 \mu m$, tapering to an apical phialide. Conidiogenous cells mono- or poly-phialides, ovoid, brown, several unilateral phialides produced along the midsection, 13-14 µm long, with several collarettes in a sympodial arrangement, or sometimes with percurrent proliferations; collarettes small, funnel-shaped. Conidia narrow fusiform, hyaline, one-celled, $7.5-9.6 \times 1.5-2 \mu m$ on natural substrate, 12-14.3×2.2-2.7 µm on CMA (Adapted from Fernández and Huhndorf 2005).

Typification: **Panama**, Barro Colorado Island National Monument, Fausto trail, 50 to 150 m, 15 September 1997, on branch, S.M. Huhndorf, F.A. Fernández SMH3396 (F; holotype).

Ecology/Substrate/Host: Saprobe on decorticated wood of branches.

Geographical distribution: Panama (Fernández and Huhndorf 2005).

Description and illustration: Fernández and Huhndorf (2005).

Notes: The fungus was well documented by Fernández and Huhndorf (2005). Variation on conidiophores and conidia were observed from the material on natural substrate and relevant living culture on CMA.

Kionochaeta P.M. Kirk & B. Sutton, Trans. Br. Mycol. Soc. 85: 712, 1985.

Colonies hairy, brown or blackish brown. Mycelium partly superficial, partly immersed, composed of branched, septate, smooth, pale brown to brown hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or in groups, erect, straight or flexuous, setiform, consisting of a main stipe and a branched fertile part. The main stipe straight, or slightly curved, subulate, smooth, septate, thick-walled, brown to dark brown or blackish brown, with or without associated lateral setiform branches. The fertile part usually sub-medium, rarely also apical, comprising either compact or loosely and irregularly or penicillately arranged branches bearing the conidiogenous cells. Conidiogenous cells ampulliform, lageniform or cylindrical, pale brown to brown, thinand smooth-walled. Conidia acrogenous, solitary, borne in a liquid droplet, hyaline, aseptate, smooth, ellipsoid, fusiform, falcate or clavate, rarely with a single simple setula at each end.

Type species: *Kionochaeta ramifera* (Matsush.) P.M. Kirk & B. Sutton (= *Chaetopsina ramifera* Matsush.).

Ecology/Substrate/Host: Saprobe on decaying plant material of many different plant species.

Geographical distribution: Broadly distributed, especially in subtropical and tropical areas.

Description and illustration: Kirk and Sutton (1985); Seifert et al. (2011).

Notes: The genus Kionochaeta was introduced by Kirk and Sutton (1985) to accommodate a few dematiaceous species originally placed under Chaetopsina Rambelli but with brown conidiophores and phylogenetically in Chaetosphaeriales. Only a few dematiaceous hyphomycetous genera including Cryptophialoidea, Zanclospora and Cryptophiale showed some morphological similarity with Kionochaeta, but the four genera differ markedly in arrangement of the conidiogenous cells. In Cryptophiale and Cryptophialoidea they are unilateral on a setiform branched or unbranched conidiophore and are obscured (Cryptophiale) or not obscured (Cryptophialoidea) by shield of sterile cells. In Zanclospora and Kionochaeta there is no sterile shield, even though in the latter genus the branches supporting the conidiogenous cells may be lateral. In Zanclospora the conidiogenous cells are sessile and arranged in whorls on a conidiophore which is not setiform (Carmichael et al. 1980; Kirk and Sutton 1985; Rambelli 1987; Kuthubutheen and Nawawi 1988; Okada et al. 1997; Seifert et al. 2011).

Several species have been added into the genus since then and made the genus with 14 legitimate names. The identification keys to the accepted species were provided by different authors (Rambelli and Lunghini 1979; Kirk and Sutton 1985; Kuthubutheen and Nawawi 1988; Crous et al. 1994; Goh and Hyde 1997; Castañeda-Ruiz et al. 1998; Yanna and Hyde 2002; Seifert et al. 2011; Lin et al. 2019).

Recent phylogenetic analysis based on the combined SSU, ITS and LSU sequence data shows that *Kionochaeta* is polyphyletic, and the studied species are phylogenetically located in two groups (Okada 1997; Lin et al. 2019). The group one, consisting of *K. castaneae*, *K. microspora*, *K. ramifera* (the type species) and *K. spissa*, is clearly separated from the second group comprising the ex-type strain of *K. ivoriensis*. (CBS 374.76). Our phylogenetic study also supports this, and a new genus is established to accommodate *K. ivoriensis* which is phylogenetically not related to the type species of the genus *Kinochaeta*. Furthermore, in our phylogenetic tree generated from the combined LSU and ITS

sequences (Figs. 3, 160), all other species of *Kionochaeta* are grouped together and formed a strongly supported sister group with other *Chaetosphaeria* species.

Living strains of many studied species were also studied on PDA (Fig. 161), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Kionochaeta beijingensis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 162, MycoBank MB841610.

Etymology: Refers to one of the locality Beijing where this fungus was collected.

Typification: **China**, Beijing, Huairou, Hongluosi, on dead fruit of *Quercus* sp., 29 July 2020, W.P. Wu, Holo-type HMAS 352,009 (=Wu17342), ex-type strain CGMCC 3.20752 (=NN77954).

Description on the natural substrate: Colonies hairy, brown or blackish brown. Mycelium partly superficial, partly immersed, composed of branched, septate, smooth, pale brown to brown hyphae of 2–3.5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores solitary, erect, straight or slightly curved, subulate, smooth, septate, thick-walled, brown to dark brown or blackish brown, setiform, with a whorl of 6-12 divergent, sterile lateral branches inserted just below the middle, up to 200-275 µm long, 8-12 µm wide; apical part above the fertile region 90-125 µm long, 3-6-septate, with acute apex; lower part below the fertile region 60-75 µm, 2-4 septate, 6.5-8 µm wide; lateral branches pale brown to brown, smooth, 0-2-septate, $30-45 \times 3-4 \mu m$, apex acute. Fertile usually sub-medium, comprising either compact or irregularly arranged branches bearing the conidiogenous cells, 35–40 µm high, 10–15 µm wide, covered with wet spore mass. Conidiogenous cells ampulliform, lageniform, pale brown to brown, thin- and smooth-walled, $5-7.5 \times 2.5-3 \mu m$, with an indistinct collarette at the apex. Conidia acrogenous, formed in a liquid droplet, narrowly falcate, or slightly fusiform, curved, acute at both ends, hyaline, aseptate, smooth, $5-7 \times 1 \,\mu\text{m}$.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse pale brown to brown (Fig. 161a, b).

Other materials examined: **China**, Beijing, Huairou, Hongluosi, on dead fruit of *Quercus* sp., 29 July 2020, W.P. Wu (Wu17305a); Jiangsu Province, Wuxi, Wuxi Forest Park, on dead fruit of *Liquidambar formosana*, 25 August 2019, W.P. Wu (Wu16801, 16,898); Zhejiang Province, Huaian County, Qiandaohu, on dead fruit of *Quercus* sp., 18 October 2018, W.P. Wu (16,120, 16,121); Zhejiang Province, Huaian County, on dead leaves of unidentified tree, 18 Oct 2018, W.P. Wu (Wu16141); **Japan**, Mie Prefecture, Tsu, Mie Center for the Arts, on dead fruit of unidentified tree,



Fig. 161 Colony of *Kionochaeta*, *Kionochaetiella* and *Sporendocladia* species on PDA after 20 days at 25 °C. a, b *Kionochaeta beijingensis* (ex-type strain 77,954). c, d, *K. castaneae* (53,349). e, f *K. ramifera* (e for 43657, f for ex-type strain CBS102618). g. *K. spissa*

(43,916). h Kionochaetiella ivoriensis (ex-type strain CBS374.76). i, j Sporendocladia beijingensis (ex-type strain 77,249). k, l Sporendocladia fumosa (CBS518.93)



Fig. 162 *Kionochaeta beijingensis* (Wu17305, holotype). **a–c** Setiform conidiophores with fertile region in the middle. **d** Lower part of setiform conidiophores with rooted base. **e,f** Fertile region of the seti-

form conidiophores with secondary setae. **g**, **h** Secondary setae and conidiogenous cells. **i–m** Conidia. Scale bar: **a**, **b** 40 µm, **c** 20 µm, **d** 10 µm, **e–m**e–m 5 µm

3 October 2020, W.P. Wu (Wu16898, Wu16917).). Living strains: 77,984 (from Wu17305a); 78,026 (from Wu17342b), 77,345 (from Wu16898a), 77,458 and 77,459 (from Wu16917), 77,198 and 77,153 (from Wu16801), 76,398 (from Wu16121), 76,428 and 76,464 (from Wu16120) and 76,429 (from Wu16141).

Ecology/Substrate/Host: Saprobe on dead material of plants including *Quercus* sp., *Liquidambar formosana*.

Geographical distribution: China.

Notes: *Kionochaeta beijingensis* is characterized by setiform conidiophores with a whorl of 6–12 divergent, sterile lateral branches inserted just below the middle and aseptate, falcate conidia $5-7 \times 1 \mu m$. Its closely related species is *K. ramifera* and *K. castaneae* on appearance of conidiophores, secondary branches and fertile regions, and conidial morphology (Matsushima 1971; Sutton and Hodges 1977 1978; Persiani et al. 1984; Kirk 1985; Kirk and Sutton 1985; Kuthubutheen and Nawawi 1988; Goh and Hyde 1997; Lin et al. 2019). They can only be distinguished by the relatively small-sized conidia in *K. beijingensis* than those in *K. ramifera*. Furthermore, the ITS sequences obtained from several strains of both species are with significant difference.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,954 include *Kionochaeta microspora* (GenBank NR_166293, 98% identity), *K. castaneae* (GenBank NR_166294, 95% identity), *Chaetosphaeria dilabens* (GenBank MH861683, 87% identity).

Kionochaeta castaneae C.G. Lin & J.K. Liu, Mycosphere 10: 675, 2019.

Description on the natural substrate: Colony on natural substrate effuse, brown, scattered. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, setiform, caespitose, erect, straight or slightly curved, dark brown, smooth, thick–walled, $250-350 \times 7-9 \mu m$; branches dark brown, cylindrical, septate, sterile, $45-110 \times 2.5-5.5 \mu m$, apex acute. Fertile region immediately at the middle part of the conidiophores, consisting of a mass of short branches on which conidiogenous cells are borne. Conidiogenous cells monophialidic, rarely terminal, narrowly ellipsoid, pale brown, $5-9 \times 2-2.8 \mu m$. Conidia produced in slimy and adhering to the fertile region, hyaline, smooth, lunate, cylindrical, aseptate, $5-7 \times 1.2-1.8 \mu m$.

Culture characteristics: Colonies on PDA effuse, colonies 0.4–0.6 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey-brown to brown, reverse brown to dark brown (Fig. 161c, d).

Material examined: **China**, Hunan Province, Zhangjiajie, on dead leaves of unidentified tree, 15 October 2010, W.P. Wu (Wu11052). Living strain: 53,349 (from Wu11052).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Lin et al. 2019).

Description and illustration: Lin et al. (2019).

Notes: *Kionochaeta castaneae* resembles *K. ramifera*, but differs in producing setiform conidiophores with fewer branches and smaller conidia (Matsushima 1971; Lin et al. 2019). In addition, their ITS sequences are also with significant difference.

Kionochaeta pughii Kuthub. & Nawawi, Trans. Br. Mycol. Soc. 90: 437, 1988.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Chang 1990) and Malaysia (Kuthubutheen and Nawawi 1988).

Description and illustration: Kuthubutheen and Nawawi (1988); Chang (1990).

Notes: No specimen was examined by us and the above description is based on documentation of the collection from Taiwan (Chang 1990). *Kinochaeta pughii* is very similar to *K. ramifera* (Matsush.) P.M. Kirk & B. Sutton and can only be distinguished by the fertile tips with several conidiogenous cells of the main and branches setiform conidiophores (Kuthubutheen and Nawawi 1988; Kirk and Sutton 1985; Chang 1990).

Kionochaeta ramifera (Matsush.) P.M. Kirk & B. Sutton, Trans. Br. Mycol. Soc. 85: 715, 1985. Figure 163

 \equiv Chaetopsina ramifera Matsush., Microfungi of the Solomon Islands and Papua–New Guinea: 13, 1971.

Description on the natural substrate: Colonies hairy, brown or blackish brown. Mycelium partly superficial, partly immersed, composed of branched, septate, smooth, pale brown to brown hyphae of 2–3.5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, arising from superficial mycelium, erect, straight or slightly curved, subulate, smooth, 6–10-septate, thick-walled, brown to dark brown or blackish brown, setiform, with a whorl of 2-5 divergent, sterile lateral branches inserted just below the middle, up to 400 µm long, 8-12 µm wide, apex acute; branches pale brown to brown, smooth, 1–3-septate, $50-100 \times 3-5 \mu m$. Fertile usually sub-medium, comprising either compact or irregularly arranged branches bearing the conidiogenous cells. Conidiogenous cells ampulliform, lageniform, pale brown to brown, thin- and smooth-walled, $4-6 \times 3-4 \mu m$, with an indistinct collarette at the apex. Conidia acrogenous, formed in a liquid droplet, narrowly falcate, or slightly fusiform, curved, acute at both ends, hyaline, aseptate, smooth, $6-10 \times 1-1.5 \,\mu\text{m}$.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse pale brown to brown (Fig. 161e, f).


Fig. 163 *Kionochaeta ramifera* (Wu1435). **a–c** Setiform conidiophores with fertile regions in the middle. **d** Fertile region with secondary setae, branched conidiophores and conidiogenous cells. **e** Setiform conidiophores with fertile region in the apex only. **f**, **g**

Secondary setae. **h**, **i** Branched conidiophores and conidiogenous cells bearing inconspicuous collarettes. **j–m** Conidia. Scale bar: **a–c** 40 μm, **d–e** 20 μm, **f–g** 10 μm, **h–m** 5 μm



Fig. 164 *Kionochaeta spissa* (Wu17506). **a–d** Setiform conidiophores with fertile region in the middle. **e–f** Fertile region of the setiform conidiophores with branches and terminal conidiogenous cells. **g-h** Branches of conidiophores and conidiogenous cells. **i** Conidia. Scale bar: **a–c** 20 μ m, **d** 10 μ m, **e–i** 5 μ m

Materials examined: **China**, Guangdong Province, Dinghushan, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (Wu1854g); Guangdong Province, Dinghushan, on rotten wood, 11 October 1998, W.P. Wu (Wu2004b, Wu2046b); Guangxi Province, Damingshan, on dead branches of unidentified plant, 19 December 1997, W.P. Wu (Wu1435); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead branch of *Rhododendron* sp., 2 January 1997, W.P. Wu (Wu1220a); Guangxi Province, Shiwandashan, on dead leaves of *?Magnolia* sp., 28 December 1997, W.P. Wu (Wu1491b); Sichuan Province, Ya An, Yucheng, Bifengxia City, on dead leaves of unidentified tree, 15 December 2013, W.P. Wu (Wu13250); Living strain: 43657 (Wu1491b), 44,897 (from Wu2046b), 57,586 (from Wu13250) and CBS102618 (ex-type strain).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Australia, Brazil, China, Malaysia, Papua-New Guinea, Kenya and USA (Kirk and Sutton 1985; Kuthubutheen and Nawawi 1988; Chang 1990; Lin et al. 2019).

Description and illustration: Kirk and Sutton (1985); Kuthubutheen and Nawawi (1988); Chang (1990); Lin et al. (2019).

Notes: Kionochaeta ramifera differs from other known species in the genus by its setiform conidiophores with a whorl of a few divergent, sterile lateral branches inserted just below the middle of conidiophores, and aseptate, falcate conidia in bigger size (Matsushima 1971; Sutton and Hodges 1976; Persiani et al. 1984; Kirk 1985; Kirk and Sutton 1985; Goh and Hyde 1997; Lin et al. 2019). Five known Kionochaeta species have accessory lateral setiform branches, including K. australiensis, K. castaneae, K. keniensis, K. pughii and K. ramifera. Kionochaeta ramifera differs from K. keniensis by its asetulate conidia, and from K. australiensis and K. pughii by its accessory lateral branches being sterile. The recently described species K. castaneae shows mostly similarity with K. ramifera on appearance of conidiophores, fertile regions and conidia, they can only be distinguished by fewer branches of setae and the relatively small-sized conidia in K. castaneae than those in K. ramifera $(5.1-6.5 \times 1.2-1.8 \ \mu m \ vs. (5-) \ 8-12 \times 1-1.5(-1.8)$ μ m) (Lin et al. 2019). Its occurrence in Taiwan (conidia $3.8-5.5 \times 0.4-0.8 \ \mu\text{m}$) was also reported (Chang 1990).

Kionochaeta spissa P.M. Kirk & B. Sutton, Trans. Br. Mycol. Soc. 85: 715, 1985. Figure 164

= Kionochaeta microspora C.G. Lin & K.D. Hyde, Mycosphere 10: 678, 2019.

Description on the natural substrate: Colonies hairy, brown or blackish brown. Mycelium partly superficial, partly immersed, composed of branched, septate, smooth, pale brown to brown hyphae of 2–3.5 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, arising from superficial mycelium, erect, straight, or slightly curved, subulate, smooth, 6–9-septate, thick-walled, brown to dark brown or blackish brown, setiform, unbranched, 220–300×5–8 µm, apex acute, with a swollen base of 10–15 µm wide. Fertile usually sub-medium or slightly below medium, comprising either compact or irregularly arranged branches bearing the conidiogenous cells. Conidiogenous cells ampulliform, lageniform, pale brown to brown, thin- and smooth-walled, 4–6×2.5–3 µm, with an indistinct collarette at the apex. Conidia acrogenous, formed in a liquid droplet, narrowly clavate to fusiform, slightly curved, rounded at the apex, attenuated at the base, hyaline, aseptate, smooth, 5–6×1–1.5 µm.

Culture characteristics: Colonies on PDA effuse, colonies 6–13 mm diameter in 14 days, circular, flat, margin entire, aerial mycelium abundant, grey to soil brown, not only restricted to the inoculation block, brown to dark brown, reverse of the same color (Fig. 161g).

Materials examined: China, Guangdong Province, Shenzhen, Lianhuashan Park, on dead leaves of unidentified tree, 11 November 2019, W.P. Wu (Wu17253); Guangdong Province, Guangzhou, South China Botanical Garden, on dead bark, 3 April 2012 W.P. Wu (Wu12335); Guangdong Province, Guangzhou, South China Botanical Garden, on dead fruit of unidentified tree, 28 February 2016, W.P. Wu (Wu16237); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of Eucalyptus sp., 3 April 2012, W.P. Wu (Wu 12,267); Guangdong Province, Guangzhou, Orchard Garden, on dead leaves of *Eucalyptus* sp., 29 December 2012, W.P. Wu (Wu 12,453); Guangxi Province, Damingshan, on dead branches of unidentified plant, 18 December 1997, W.P. Wu (Wu1383e); Guangxi Province, Shiwandashan, on dead leaves and fruits of ?Quercus sp., 28 December 1997, W.P. Wu (Wu1483e); Guangxi Province, Shiwandashan, on dead bark of Eucalyptus sp., 31 December 1997, W.P. Wu (WU1592a); Guangxi Province, Shiwandashan, on dead bark of Eucalyptus sp., 31 December 1997, W.P. Wu (Wu1594); Guangxi Province, Shiwandashan, on dead leaves of palm, 28 December 1997, W.P. Wu (Wu1494c, this is K. spissa); Guangxi Province, Nangning, on dead fruit sheath of Leguminosae, 3 Jan 1998, W.P. Wu (Wu1661a); Guangxi Province, Shiwandashan, on dead leaves of palm, 28 December 1997, W.P. Wu (Wu1494c); Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead fruit of Cyclobalanopsis sp., 25 August 2019, W.P. Wu (Wu16860, Wu16869); Sichuan Province, Ya An, Yucheng, Bifengxia City, on dead leaves of unidentified tree, 15 December 2013, W.P. Wu (Wu13195); Yunnan, Kunming, Botanical Garden, On dead fruit of ?Quercus sp., 22 October 1999, Wu and Yan Huang (Wu2601b); Yunnan Province, Simao, on dead leaves of ?Quercus sp., 13 October 1999, W.P. Wu & Yan Huang (Wu2777a); China: Yunnan Province, Xishuangbanna, on dead leaves of unidentified tree, 12 June 2018, Zhang Yu (Wu15164, 15,165); Zhejiang Province, Huaian County, Qiandaohu, on dead leaves of unidentified tree, 18 October 2018, W.P. Wu (Wu16170). Living strains: 43042 (from Wu1483e), 46,111 (from Wu2777a), 43916 (from Wu1592a), 42953 (from Wu1494c), 54,396 (from Wu12335), 55,371 (from Wu12453), 57,546 (from Wu13195), 43882 (from 1661a), 75,999 (from (15,165), 54,362 (from 12,267), 76,469 (from Wu16170), 77,237 (from Wu16860), 76,572 (from Wu16237), 76,000 (from Wu16165), 77,237 (from Wu16860), 77,245 (from Wu16869a), 77,666 (from Wu17253) and 78,506 (from Wu1702).

Ecology/Substrate/Host: Saprobe on dead material of many plant species including *Cyclobalanopsis* sp., *Eucalyptus* sp. and *Quercus* sp.

Geographical distribution: Australia, China, India, Kenya, Malaysia, USA, and many other countries.

Description and illustration: Kirk and Sutton (1985); Dorai and Vittal (1987).

Notes: K. spissa differs from other known species in the genus by its unbranched setiform conidiophores and aseptate, obclavate conidia (Kirk and Sutton 1985). Kionochaeta ivoriensis has the similar conidiophores and conidia, but its conidiogenous cells are more or less sessile and scattered on conidiophores and conidia are slightly shorter (Kirk and Sutton 1985). On morphology of conidiophore, conidiogenous cells and conidia, K. spissa is also similar to K. microspora, which was distinguished by having a fertile region at the apex of the setiform conidiophores without accessory lateral branches and aseptate conidia (Kuthubutheen and Nawawi 1988; Subramanian 1993; Castañeda-Ruiz et al. 1998; Yanna and Hyde 2002). Among the many specimens studied here, both types of conidiophores as described in K. spissa and K. microspora were observed from several specimens and their ITS sequences obtained from many collections are identical to those from the ex-type strain of K. microspora. With this result, we treat K. microspora as a synonym of K. spissa. Fertile regions in both apical and middles of the same conidiophores were also reported in other Kionochaeta species, such as K. australiensis Goh & K.D. Hyde, K. pughii Kuthub. & Nawawi and K. nanophora Kuthub. & Nawawi and an indication of limited value of this character for species delimitation (Kuthubutheen and Nawawi 1988; Goh and Hyde 1997).

Based on ITS blast in NCBI's GenBank, the closest matches to the strain 54362 include *Kionochaeta microspora* (GenBank NR166293, 100% identity), *K. castaneae* (GenBank NR166294, 96% identity).

Kionochaetiella W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB841538.

Etymology: Refers to its similarity to the genus *Kionochaeta*.

Diagnosis: Similar to *Kionochaeta* in producing setiform conidiophores, phialidic conidiogenous cells, and hyaline aseptate conidia, but differs in fertile región irregularly distributed along the setiform conidiophores, and rod-shaped conidia. Phylogenetically they belong to different groups.

Type species: *Kionochaetiella ivoriensis* (Rambelli & Lunghini) W.P. Wu & Y.Z. Diao.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores setiform, rigid, erect, or slightly curved, dark brown, thick-walled, septate, apex acute and sterile or fertile; fertile region irregularly distributed, apical or along the setae, consisting of brown, branched hyphae and conidiogenous cells. Conidiogenous cells monoor poly-phialides, grow along the axis of the setiform conidiophores with an irregular distribution. Conidia hyaline, smooth, aseptate, rod-shaped, with rounded apex and truncated base (Adapted from Rambelli and Lunghini 1976).

Ecology/Substrate/Host: Saprobe on bark of tree.

Geographical distribution: Italy.

Description and illustration: Rambelli and Lunghini (1976).

Notes: Phylogenetic analysis showed that *Chaetopsina ivoriensis* is separated from the type species of *Kionochaeta*, thus the new genus is created to accommodate it.

Kionochaetiella ivoriensis (Rambelli & Lunghini) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841731.

 \equiv *Chaetopsina ivoriensis* Rambelli & Lunghini, Gior. Bot. Ital. 110: 253, 1976.

≡ Kionochaeta ivoriensis (Rambelli & Lunghini) P.M. Kirk & B. Sutton, Trans. Br. Mycol. Soc. 85: 713, 1986.

Teleomorph: Unknown. Anamorph: Conidiophores setiform, rigid, erect, or slightly curved, dark brown, thickwalled, 7–11-septate, 70–150×4.5–5.5 µm; apex acute and sterile or fertile; basal cell swollen, 12.5–14 µm wide; fertile region irregularly distributed, apical or along the setae, consisting of brown, branched hyphae and conidiogenous cells. Conidiogenous cells mono- or poly-phialides, $3.5-5\times2.5-4.5$ µm, grow along the axis of the setiform conidiophores with an irregular distribution. Conidia hyaline, smooth, aseptate, rod-shaped, $3.5-5\times(1.2-)2$ (–2.5) µm, with rounded apex and truncated base. In pure culture the phialides are directly produced from the hyphae and variable in shape and size (Adapted from Rambelli and Lunghini 1976).

Culture characteristics: Colonies on PDA effuse, colonies 1–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey-brown to brown, with pale colored margin, reverse brown to dark brown (Fig. 161h).

Materials examined: ex-type strain CBS374.76 (= JCM9876, = NN74400).

Ecology/Substrate/Host: Saprobe on bark of tree.

Geographical distribution: Italy (Rambelli and Lunghini 1976).

Description and illustration: Rambelli and Lunghini (1976); Kirk and Sutton (1985).

Notes: The ex-type strain CBS374.76 of *Chaetopsina ivoriensis* was studied by us, and its ITS sequence is identical to the one deposited in the GenBank. Morphologically it differs from *Kionochaeta* species in morphology of fertile region and shape of conidia (Rambelli and Lunghini 1976; Kirk and Sutton 1985; Lin et al. 2019).

Phaeostalagmus W. Gams, Stud. Mycol. 13: 90, 1976.

Colonies darkly pigmented and very slow growing. Teleomorph: Unknown. Anamorph: Conidiophores stipes dark brown, erect, with branching, giving rise either to whorls of phialides or a series of branches which eventually terminate in verticillate phialides. Conidiogenous cells monophialidic, flask-shaped, pigmented; collarettes conspicuous, flaring, funnel-shaped. Conidia hyaline, aseptate, ellipsoidal, formed in slimy head.

Type species: *Phaeostalagmus cyclosporus* (Grove) W. Gams.

Ecology/Substrate/Host: Saprobe on decaying plant material.

Geographical distribution: Broadly distributed.

Description and illustration: Gams and Holubová-Jechová (1976); Hughes (1978); Wang and Sutton (1982); Minter and Holubová-Jechová (1981); Sutton and Mel'nik (1992).

Notes: The genus Phaeostalagmus was created to accommodate two dematiaceous species P. cyclosporum (Grove) W. Gams and P. tenuissimus (Corda) W. Gams, both with apically branched conidiophores, flask-shaped and monophialidic conidiogenous cells with flaring, funnel-shaped collarettes, and hyaline, aseptate, ellipsoidal conidia in slimy head (Gams & Holubová-Jechová, 1976). Since then, 5 additional species have been described under the genus, including P. altissimus, P. arbusculus, P. novae-zelandiae, P. peregrinus and P. rossicus. These species can be distinguished by manner of arrangement of conidiogenous cells on conidiophores, and conidial morphology (shape and size) (Ellis 1971; Gams and Holubová-Jechová 1976; Hughes 1978; Wang and Sutton 1982; Minter and Holubová-Jechová 1981; Sutton and Mel'nik 1992). In the phylogenetic analysis, it is clearly shown that the type species of Phaeostalagmus, P. cyclosporus, belongs to Chaetosphaeriaceae. However, no DNA sequence data is available for any other species, and the phylogenetic relationship of the remaining species with the type species of the genus remains to be studied.

Key to known species of Phaeostalagmus.

1.	Most phialides formed directly on the conidiophore in whorls of 2–52
1.	Most phialides formed on branches of the conidio- phore
2.	Phialides $10-13 \times 3-4 \mu m$, collarette inconspicuous; conidia $3-4 \times 12-18 \mu m$
2.	Phialides > 15 μ m long, collarette funnel-shaped; conidia > 4 μ m long in average
3.	Phialides concolorous, $16-27 \times 3-4 \mu m$; conidia $4-8 \times 1-2.3 \mu m$
3.	Phialides darker in upper part, $18-30 \times 2.5-3.5 \mu m$; conidia $5-6 \times 1.2-1.5 \mu m$
4.	Conidia > 5 µm long
4.	Conidia < 5 µm long
5.	Phialides up to 5 in clusters, $12.5-18 \times 2.5-3.5 \mu m$; conidia $5-7 \times 1.8-2 \mu m$
5.	Phialides 1–2 in clusters, $21-28 \times 2.5-4$ µm; conidia 5 5–12 5 × 1 25–2 µm
6.	Most branches & phialides formed alternately on the conidiophore; phialides $12-16.5 \times 2.5-3 \mu m$; conidia cyl-indrical to allantoid, hyaline, $2-3 \times 1 \mu m$
6.	Most branches & phialides formed oppositely on the con- idiophore 7
7.	Conidiophores up to 500 μ m high, phialides lageniform, 6. 12 × 1.7.2.5 μ m; conidia ellipsoidal, ovoidal to cylin
7	drical, hyaline, $1.5-3 \times 1-2 \ \mu m$
1.	drical, $10-15 \times 2-3 \ \mu\text{m}$; conidia obovate, brown, $2 \times 1.5 \ \mu\text{m}$ <i>P. altissimus</i>

Phaeostalagmus minimus W.P. Wu & Y.Z. Diao, sp. nov., Fig. 165, MB841611.

Etymology: Refers to its small-sized conidia.

Diagnosis: Differs from other known species by smaller conidia.

Typification: **China**, Guangdong Province, Guangzhou, South China Botanical Garden, on dead leave of unidentified tree, 3 March 2012, W.P. Wu, Holotype HMAS 352,039 (=Wu12182).

Description on the natural substrate: Colonies effuse, pale brown, hairy. Mycelium partly superficial, partly immersed, consisting of pale brown to dark brown, septate hyphae, 1.5–4 μ m wide. Teleomorph: Unknown. Anamorph: Conidiophores arising from pale brown, thick- and smooth-walled hyphae, mononematous, macronematous, single or aggregated in cluster, with a very dark, 5–9-septate, erect or slightly curved main axis, 250–350 long, 3–4 μ m in the middle, up to 7 μ m wide near the base, basal cell swollen and up to 12 μ m wide, bearing a few phialides formed directly on the upper part below the septa of the



Fig. 165 *Phaeostalagmus minimus* (Wu12260, holotype). a, b Conidiophores with branches in the upper part. c–e, i Upper part of conidiophores bearing conidiogenous cells and developing conidia. f–h,

v–x Conidiogenous cells with funnel-shaped collarettes. j–u Conidia. Scale bar: a, b 40 $\mu m,$ c–z 5 μm

conidiophores, occasionally with one supporting cell which are intermediate pigmentation and bearing 1–3 phialides. Phialides integrated, lateral or terminal, pale brown, formed alternatively on main axis, flask-shaped, with a long narrow neck and darker flaring collarette, smooth, thin-walled, $18-30 \times 2.5-3.5 \ \mu\text{m}$; collarettes 2–2.5 $\ \mu\text{m}$ wide, $1.5-2 \ \mu\text{m}$ long, 1–1.5 $\ \mu\text{m}$ at the base. Conidia aggregated in slimy heads at the apex of the phialides, cylindrical, hyaline, aseptate, $5-6 \times 1.2-1.5 \ \mu\text{m}$.

Other material examined: **China**, Guangdong Province, Guangzhou, South China Botanical Garden, on dead leave of unidentified tree, 4 March 2012, W.P. Wu (Wu12260).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China.

Notes: Phaeostalagmus minimus clearly belongs to the genus Phaeostalagmus in branched conidiophores, flask-shaped phialidic conidiogenous cells, and hyaline, aseptate, cylindrical conidia in wet spore mass (Gams and Holubová-Jechová 1976). It differs from the known species in the genus by a combination of arrangement of phialides on conidiophores and conidial morphology (shape and size) (Ellis 1971; Gams and Holubová-Jechová 1976; Hughes 1978; Wang and Sutton 1982; Minter and Holubová-Jechová 1981; Sutton and Mel'nik 1992). Among the known species, only P. tenuissimus and P. peregrinus produce lateral and terminal phialides directly from conidiophores and without supporting cell. Phaeostalagmus *tenuissimus*, with shorter phialides $(10-13 \times 3-4 \mu m)$ and smaller conidia $(3-4 \times 1.2-1.8 \ \mu m)$, can be easily distinguished from P. minimus (Gams and Holubová-Jechová 1976). Phaeostalagmus peregrinus and P. minimus have similar sized phialides, but the former has unicolorous phialides and slightly big conidia $(4-8 \times 1-2.3 \ \mu m)$ (Minter and Holubová-Jechová 1981).

Sporendocladia Arnaud ex Nag Raj & W.B. Kendr., A Monograph of *Chalara* and Allied Genera: 162, 1975.

Colonies effuse, superficial, brown. Teleomorph: Unknown. Anamorph: Conidiophores solitary to aggregated, erect or flexuous, branched at the apex, septate, brown, smooth. Conidiogenous cells integrated, ampulliform, lageniform, obclavate, pale brown to brown, with a deep, cylindrical or subcylindrical collarette. Conidia holoblastic, cylindrical, hyaline, aseptate, smooth, truncate at both ends, extruded in long chain.

Type species: *Sporendocladia fumosa* (Ell. & Everh.) Wingfield (= *Spicaria fumosa* Ell. & Everh.; = *S. castaneae* Arnaud in Nag Raj & W.B. Kendr.)

Ecology/Substrate/Host: Saprobe on decaying plant material.

Geographical distribution: Broadly distributed, including Asia, Europe and US.

Description and illustration: Nag Raj and Kendrick (1975); Sutton (1975); Wingfield et al. (1987); Mouton and Wingfield (1993); Seifert et al. (2011).

Notes: The genus *Sporendocladia* morphologically resembles *Chalara* (Corda) Rabehn., but can be distinguished by its conidiophores with branched fertile region. Morphologically several other dematiaceous genera, including *Leptographium* Lagerb. & Melin and *Phialocephala*, share the similar morphological characters such as terminally branched conidiophores, lageniform or subcylindrical and phialidic condiogenous cells, and hyaline, aseptate and cylindrical conidia with somewhat truncated ends. These genera can be distinguished by a combination of morphology and phylogeny (Kendrick 1961; Sutton 1975; Wingfield et al. 1987; Mouton and Wingfield 1993; Crous et al. 2014; Seifert et al. 2011).

A total of 8 species names have been published for the genus *Sporendocladia*, including *S. fumosa*, *S. bactrospora*, *S. castaneae*, *S. foliicola*, *S. ivoriensis*, *S. kionochaetoides*. Among them, *S. castaneae* is a synonym of *S. fumosa* (Wingfield et al. 1987). The other species can de distinguished by colony on nature substrate, the branching patterns of conidiophores and conidial morphology (Arnaud 1954; Sutton 1975, 1993; Nag Raj and Kendrick 1975; Wingfield et al. 1987).

The phylogenetic analysis indicated that the genus *Sporendocladia* is polyphyletic. The type species, *S. fumosa*, belongs to Chaetosphaeriaceae, while at least three other species, *S. foliicola*, *S. bactrospora* and *S. kionochaetoides* are placed distantly from each other in the phylogenetic tree created by rDNA sequences. *S. foliicola* and *S. kionochaetoides* are grouped together with members of *Leotiales*, while *S. bactrospora* belongs to *Microascales* (Gruenig et al. 2002; Jacobs et al. 2003; Roux et al. 2013). Here we accepted the narrow concept of the genus as typified by *S. fumosa* in Chaetosphaeriaceae. Most other species should be excluded from the genus.

Sporendocladia fumosa (Ell. & Everh.) M.J. Wingf., Trans. Br. Mycol. Soc. 89: 515, 1987.

 \equiv Spicaria fumosa Ell. & Ev., Bull. Torrey Bot. Club 10: 97, 1883.

 \equiv *Phialocephala fumosa* (Ell. & Ev.) Sutton. Trans. Br. mycol. Soc. 64: 411, 1975.

= Sporendocladia castaneae Arnaud, Bull. Soc. Mycol. Fr. 69: 279, 1954 (nom. inval.).

= *Sporendocladia castaneae* Arnaud ex Nag Raj & B. Kendrick, A monograph of *Chalara* and allied genera, p. 162, 1975.

Materials examined: **China**, Yunnan Province, Kunming, Heilongtan Park, 19 October 2003, on dead fruit of *?Quercus* sp., W.P. Wu (Wu7123). Living strain: CBS518.93, 47731 (from Wu7123).



Fig. 166 Sporendocladia beijingensis (Wu17341, holotype). **a** Conidiophores on natural substrate. **c–e** Conidiophores with branched sporulating apex. **e, j–m** Sporulating structure with secondary branches and conidiogenous cells. **g–i** Conidia. Scale bar: **a–d** 20 μm, **e–m** 5 μm

Geographical distribution: China, France, Switzerland and UK (Nag Raj and Kendrick 1975; Crous and Wingfield 1994).

Description and illustration: Nag Raj and Kendrick (1975); Sutton (1975); Crous and Wingfield (1994).

Notes: *S. fumosa* is characterized by cylindrical, brown, and septate conidiophores with branches at the top, *Chalara*-like conidiogenous cell, and hyaline, aseptate, cylindrical, conidia with truncated ends and formed in false chain. This fungus is commonly found on cupules of *Castanea sativa* in Europe. The single strain from China has only 6 bp difference from the ITS sequence from European strain (CBS518.93, Fig. 161k, 1)).

Sporendocladia beijingensis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 166, MB841612.

Etymology: Refers to the locality where this fungus was collected.

Typification: **China**, Beijing, Huairou, Hongluosi, on dead cupules of *Quercus* sp., 11 June 2020, W.P. Wu Holo-type HMAS352054 (=WuBJ19–3), ex-type strain CGMCC 3.20738 (=NN77249).

Description on the natural substrate: Colony on natural substrate effuse, black. Mycelium partly immersed and partly superficial, composed of pale brown, branched, smooth, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or occasionally aggregated in small group, erect, straight, consisting of a main stipe and an apical conidiogenous apparatus. Main stipe cylindrical, smoothwalled, dark brown, becoming paler towards the apex, thickwalled, (80-)170-520 µm high, 3.5-4.5 µm wide at the first septum above the swollen base, 3-10-septate, $3-4 \mu m$ wide below the conidiogenous branches. Conidiogenous apparatus consisting of branches with terminal phialides in a loose arrangement with a 1–3-verticillate branching pattern; primary branches cylindrical, 4-5 µm long, 2-2.8 µm wide, brown, smooth, thick-walled, giving rise to secondary branches or terminal phialides. Conidiogenous cells thinwalled, light brown, smooth, lageniform, $8-11 \times 2-2.5 \,\mu\text{m}$, consisting of an ellipsoid venter and a cylindrical to funnelshaped collarette, transition from venter to collarette abrupt; collarettes funnel-shaped, up to 1 µm wide. Conidia catenate, arranged in false chains with only basal dehiscence scars, not in a mucous droplet, aseptate, smooth, hyaline, cuneiform with rounded apices and truncate bases, widest at their apices, tapering inconspicuously to narrower bases, $2-3 \times 1-1.2 \ \mu m$ (Fig. 161i, j).

Culture characteristics: Colonies on PDA effuse, colonies 0.8–1.3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, with grey to dark brown pitch, with pale colored margin, reverse pale brown.

Other materials examined: China, Beijing, Huairou, Hongluosi, on dead cupules of *Quercus* sp., 29 July 2020, W.P. Wu (Wu17295, Wu17298, Wu17304, Wu17315, Wu17340, Wu17341, Wu17349, Wu17355, Wu17373); Yunnan Province, Kunming, Heilongtan, on dead fruit of *Quercus* sp., 18 October 2003, W.P. Wu (Wu7123). Living strains: 78,004 and 78,005 (from Wu17295), 78,010 (from Wu17304), 78,008 (from Wu78008).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China.

Notes: *Sporendocladia beijingensis* resembles the type species *S. fumosa* of the genus in appearance of conidio-phores, conidiogenous apparatus, conidiogenous cells and conidia. In fact, they are hardly distinguished from each other by morphology, however their ITS sequence has 8 bp difference.

Phylogenetically, *Sporendocladia beijingensis* is related to members of Chaetosphaeriaceae. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,249 include *Sporendocladia fumosa* (GenBank MH862436, 98% identity) and *Chaetosphaeria myriocarpa* (GenBank MH859991, 87% identity).

Excluded species:

Parasporendocladia W.P. Wu & Y.Z. Diao, gen. nov., Myco-Bank MB841540.

Etymology: Refers to its similarity to the genus Sporendocladia.

Type species: *Parasporendocladia bactrospora* (W.B. Kendr.) W.P. Wu & Y.Z. Diao (≡ *Phialocephala bactrospora* W.B. Kendr.).

Colonies effuse, superficial, brown. Teleomorph: Unknown. Anamorph: Conidiophores solitary to aggregated, erect or flexuous, branched at the apex, septate, brown, smooth. Conidiogenous cells integrated, ampulliform, lageniform, obclavate, pale brown to brown, with a deep, cylindrical or subcylindrical collarette. Conidia holoblastic, cylindrical, hyaline, aseptate, smooth, truncate at both ends, extruded in long chain.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Brazil, Japan and Europe.

Parasporendocladia bactrospora (W.B. Kendr.) W.P. Wu & Y.Z. Diao, sp. nov., MycoBank MB841745.

 \equiv *Phialocephala bactrospora* W.B. Kendr., Can. J. Bot. 39: 1083, 1961.

 \equiv Sporendocladia bactrospora (W.B. Kendr.) M.J. Wingf, Trans. Br. Mycol. Soc. 89: 515, 1987.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Brazil, Japan, Europe.

Description and illustration: Kendrick (1961); Matsushima (1975); Barbosa et al. (2009). Notes: Morphologically it is difficult to be distinguished from *Sporendocladia* and *Phialocephala*, but the phylogenetic analysis shows that *Phialocephala bactrospora* belongs to Microascales, while the type species of genus *Phialocephala*, *P. dimorphospora*, belongs to *Mollisiaceae* in Helotiales; and the type species of *Sporendocladia*, *S. fumosa*, belongs to Chaetosphaeriaceae (Wingfield et al. 1987; Mouton and Wingfield 1993; Jacobs et al. 2001, 2003; Day et al. 2012; Seifert et al. 2011; Roux et al. 2013; Tanney et al. 2016). Thus, a new genus, *Parasporendocladia*, is created to accommodate *Phialocephala bactrospora*. Morphologically it is also similar to *Custingophora*, but phylogenetically distinct.

Lareunionomyces foliicola (P.M. Kirk) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841751.

 \equiv *Phialocephala foliicola* P.M. Kirk, Mycotaxon 23: 337, 1985.

≡ Sporendocladia folliicola (P.M. Kirk) M.J. Wingf., Trans. Br. Mycol. Soc. 89: 515, 1987.

Typification: **Kenya**, Mt. Kenya, Castle Forest, on dead leave, 25 January 1984, P.M. Kirk, IMI285199a.

Geographical distribution: Kenya (Kirk 1985).

Description and illustration: Kirk (1985).

Notes: *Phialocephala foliicola* was described for a leaf litter fungi from Kenya and is characterized by solitary and 1-septate conidiophores, apical sporulating apparatus with 1–3 times branching and terminating with 1–2 phialides; gradual transition from venter to collarette; and hyaline, aseptate, cylindrical conidia ($4-6 \times 1.5-2 \mu m$) with rounded apex and produced in wet spore mass (Kirk 1985). Wingfield et al. (1987), based on the conidial development, transferred it to *Sporendocladia*. The phylogenetic analysis based on the rDNA ITS sequences showed that *P. foliicola* was not clustered together with other *Phialocephala* species (Gruenig et al. 2002).

On a megablast search using the ITS sequences from the strain CBS201.95 the closest matches in NCBI's Gen-Bank nucleotide database were members of *Lareunionomyces* Crous & M.J. Wingf. in Helotiales. Morphologically it also fits well to the genus *Lareunionomyces*. Thus, it is officially transferred to the genus *Lareunionomyces* (Crous et al. 2016). It differs from other known species in the genus *Lareunionomyces* by the main stipe of the conidiophores with only 1 septum, and verticillate sporulating head with 1–3 branches, and different conidial size (Crous et al. 2016, 2018a, b, 2019).

Lareunionomyces kionochaetoides (B. Sutton) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841746.

≡ Sporendocladia kionochaetoides B. Sutton, Mycol. Pap. 167:58, 1993. Typification: **Malawi**, Mt. Mulanje, Chambe hut track, south-east on track to Lichenya, S1550, E03450, 2000 m a.s.l., on dead stem of *Rubus ellipticus (Rosaceae)*, 13 Apr. 1991, B.C. Sutton MM28 (IMI347108b, holotypus).

Geographical distribution: Malawi (Sutton 1993). Description and illustration: Sutton (1993).

Notes: *Sporendocladia kionochaetoides* was described for a microfungi from Malawi and is characterized by single and dark colored conidiophores consisting of a main stipe with only 1–2 septum and an apical verticillate sporulating apparatus, which is 2–3 times branched and terminating with 1–2 phialides with graduation transition from venter to collarette, and hyaline, aseptate, cylindrical conidia $(3.5-4 \times 1.5-2 \ \mu m)$ with truncated ends and produced in wet spore mass (Sutton 1993). These characters fit well to the generic concept of *Lareunionomyces*. Thus, it is officially transferred to the *Lareunionomyces* (Crous et al. 2016, 2018a, b, 2019).

Undetermined species:

Sporendocladia ivoriensis (Zucconi & Onofri) M.J. Wingf., Trans. Br. Mycol. Soc. 89: 509, 1987.

 \equiv *Phialocephala ivoriensis* Zucconi & Onofri, Mycotaxon 20: 189, 1984.

Typification: **Tai**, Ora Eboris, on dead leaves, 23 Mar. 1981, H.B.R. 126A (Holotypus).

Geographical distribution: Tai (Onofri and Zucconi 1984).

Description and illustration: Onofri and Zucconi (1984).

Notes: *Phialocephala ivoriensis* morphologically resembles member of *Sporendocladia*. No DNA sequence data is available for the phylogenetic analysis. Its taxonomic position still remains to be explored when the living strain and DNA sequences data will be available.

Sporendocladia truncata (B. Sutton) M.J. Wingf., Trans. Br. Mycol. Soc. 89: 517, 1987.

 \equiv *Phialocephala truncata* B. Sutton, Trans. Br. Mycol. Soc. 64: 414, 1975.

Geographical distribution: UK (Sutton 1975).

Description and illustration: Sutton (1975).

Notes: *Phialocephala truncata* morphologically resembles member of *Sporendocladia* and *Neolauriomyces*. No DNA sequence data is available for the phylogenetic analysis, its taxonomic position still remains to be explored when the living strain and DNA sequences data will be available.

Sporoschisma and related genera

Among the 89 accepted chaetosphaeriaceous genera, eight genera produce multiseptate and dark colored conidia from the terminal phialide of solidary conidiophores. These genera are Anacacumisporium, Cacumisporium, Exserticlava, Monosporoschisma, Phaeodischloridium, Sporoschisma and Stephembruneria. Phylogenetically all these genera are well-defined monophyletic genera, but polyphyletic in the phylogenetic trees generated by using the combined data set of ITS and LSU (Fig. 3). Morphologically most of these genera are also well-delimited by a combination of different morphological characters sch as setae, conidiophores, conidiogenous cells and conidia. Living strains of many studied species were also studied on PDA, some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Key to asexually typified genera with colored and multiseptate conidia

ng conidio-
2
3
ndrical, sep-
Sporoschisma
ia ellipsoidal
sporoschisma
ach arm bear-
haeonawawia
4
oci within the
5
locus within
6
en protruding
umisporium
ot protruding
.Exserticlava
t each end
cumisporium
ipsoidal
hembruneria
cylindrical
lischloridium

Anacacumisporium Y.R. Ma & X.G. Zhang, Crypt. Mycol. 37: 52, 2016.

Teleomorph: Unknown. Anamorph: Conidiophores solitary, cylindrical, unbranched, straight, septate. Conidiogenous cells integrated, terminal, cylindrical, brown, pale brown or subhyaline, smooth or verrucose, phialidic, mono-polyblastic; collarette narrow or flaring, not apparently proliferating. Conidia solitary, dry, apical and/or lateral, simple, smooth, typically reniform, ellipsoidal to fusiform, but sometimes cylindrical, rarely obclavate, brown to dark brown or bicolored, with an appendage at each end (Adapated from Ma et al. 2016). Type species: *Anacacumisporium appendiculatum* Y.R. Ma & X.G. Zhang.

Ecology/Substrate/Host: Saprobe on dead branches of tree.

Geographical distribution: China.

Description and illustration: Ma et al. (2016).

Anacacumisporium appendiculatum Y.R. Ma & X.G. Zhang, Crypt. Mycol. 37: 52, 2016.

Typification: **China**, Hainan Province, Ledong, Jianfengling National Forest Park, on dead branches of unidentified broadleaf tree, 17 May 2014, Yingrui Ma (Holotype HSAUP H4589). Ex-type culture HSAUPmyr4589, HMAS 245,593 (living cultures).

Geographical distribution: China (Ma et al. 2016).

Description and illustration: Ma et al. (2016).

Notes: Anacacumisporium is a recently established genus with A. appendiculatum as the type species, a microfungi found on dead branches of unidentified trees in tropical area of Hainan Province, China. The monotypic genus is characterized by cylindrical conidiophores, terminal monophialidic conidiogenous cells, and euseptate conidia produced in slimy mass and with an appendage at each end (Ma et al. 2016). Morphologically Anacacumisporium is similar to Cacumisporium, but conidia of Cacumisporium are without setulae (DiCosmo et al. 1983; Gams and Holubová-Jechová 1976; Castañeda-Ruíz et al. 2007b; Seifert et al. 2011).

Cacumisporium Preuss, Linnaea (Berl.) 24: 130, 1851.

Lignicolous on rotten wood, colonies effuse, hairy, brown to gravish brown. Teleomorph: Ascomata superficial, solitary or in groups of 3-5, subglobose to conical, papillate, papilla perforated by a rounded pore in old perithecia, ostiolate, dark brown to black, glistening, glabrous or covered with conidiophores of the anamorph, slightly rugose. Perithecial wall brittle, consisting of two layers; an outer layer of thin-walled, dark brown, opaque, polyhedral to bricklike cells, and an inner layer of thin-walled, compressed, hyaline cells. Ostiolar canal periphysate. Paraphyses copious, branching, septate, protruding beyond the tips of the asci. Asci clavate-cylindrical, narrowly rounded at the tip, with a J-, refractive apical annulus. Ascospores cylindrical to cylindrical-fusiform or fusiform, occasionally tapering towards one end, 5-septate, not constricted or very slightly constricted at the septa, smooth-walled, hyaline, 2-3-seriate, overlapping in the upper part of the ascus, germinating by germ tubes at the ends. Anamorph: Conidiophores solitary, erect, straight, or slightly curved, simple, cylindrical, septate, brown, paler towards the apex, smooth. Conidiogenous cells integrated, monoblastic, cylindrical, pale brown to medium brown, smooth, with a pale brown, funnel- or cup-shaped and flaring collarette. Conidia holoblastic, aggregated in slimy heads, allantoid, ellipsoidal, fusiform,

or oblong rounded at the apex, truncate at the base, at first colorless with large guttulate, later brown and transversely septate, smooth.

Type species: *Cacumisporium tenebrosum* Preuss. (=*Cacumisporium capitulatum* (Corda) S. Hughes; anamorph of *Chaetosphaeria decastyla* (Cooke) Réblová & W. Gams).

Ecology/Substrate/Host: Saprobe on decaying plant material, including rotten wood.

Geographical distribution: Broadly distributed.

Description and illustration: Goos (1969a); Ellis (1976); Seifert et al. (2011).

Notes: The genus Cacumisporium, typified by Cacum*isporium tenebrosum* (= *Cacumisporium capitulatum*), is characterized by solitary, dark brown and septate conidiophores, phialidic conidiogenous cells with broad and cupulate collarettes, and brown, septate conidia aggregated in slimy heads (Goos 1969a; Seifert et al. 2011). The genus currently comprises eight species: C. capitulatum, C. fusiforme, C. pleuroconidiophorum (=C. curvularioides), C.sigmoideum, C. spooneri, C. rugosum, C. tropicale and C. uniseptatum (Ellis 1976; Kirk, 1992; Castañeda-Ruiz and Kendrick 1991; Mercado Sierra and Castañeda-Ruiz 1987; Tsui et al. 2001b; Castañeda-Ruiz et al. 2007a, b; Wongsawas et al. 2009; Xu et al. 2019). These species can be distinguished by their conidial morphology, including color, size and septation. A synopsis for all of these species was given by Tsui et al. (2001a, b, c) and an identification key for them was provided by Xu et al. (2019).

Conidiogenous cells of Cacumisporium have been considered to be sympodial-phialides resembling species of Chloridium s. lat., in which conidia are produced in sympodial succession from a conidiogenous cell above a phialidic collarette (Goos 1969a; Hammill 1972; Cole and Samson 1979; Réblová and Gams 1999). Similar phialidic conidiogenous cells were also found in C. rugosum. This is consistent with that illustrated by Goos (1969a, b) for *C. capitulatum*. However, several recently described species are with typical holoblastic conidiogenous cells and sympodial proliferation and denticulate sporulating loci, similar to those in Minimelanolocus (Seifert et al. 2011). Among these known species of *Cacumisporium*, only the type species is with available LSU and ITS sequences for molecular phylogenetic analysis. Its affinity with the teleomorph Chaetosphaeria decastyla in Chaetosphaeriaceae has been confirmed by both pure culture study and molecular phylogenic analysis (Réblová and Gams 1999). Phylogenetic analysis is needed to elucidate the relationships of these species, and this might result in reclassification of several published species. The genus Cacumisporium has been reported in China with three species, C. fusiforme, C. rugosum and C. sigmoideum. Here the type species, C. capitulatum, is added as a new record for China.

Key to known species of *Cacumisporium* (Based on Xu et al. 2019)

1.	Conidia 1-septate, hyaline or versicolorous, ovoid, cylin- drical to clavate
1.	Conidia multiseptate, various shape
2	Conidia hvaline, obclavate, $12.5-15.5 \times 4-5$ µm
2.	
2.	Conidia versicolorous, ovoid, $18-26 \times 11-16$ um
	<i>C</i> uniseptatum
3.	Conidia 7-septate, narrowly ellipsoid to somewhat fusi-
	form $26-32 \times 3-5$ µm C spooneri
3	Conidia 3(-4)-septate
4	Conidia rugose to verrucose, obovoid to broadly ellip-
	sold $28-35 \times 14-20$ µm C rugosum
Δ	Conidia smooth 5
т. 5	Conidia botuliform $16_{22} \times 45_{5}$ um
5.	Contrata bottumorni, $10-22 \times 4.3-5 \mu m$
5	Conidia abturbinata sigmaid or fusiform at least 6 um
5.	diam
c	Conidia conceleration bread fusificare receivaler allin
0.	Contain concolorous, broad fusitorm, navicular, emp-
~	sold, $12-1/x = 0.000$ km
6. -	Conidia versicolorous/
7.	Conidia with one swollen cell strongly pigmented,
	$18-28 \times 8-9 \ \mu mC.$ pleuroconidiophorum
7.	Conidia with two cells strongly pigmented8
8.	Conidia fusiform, 23.5–33.5×7.5–9 μm, 3 (–4) –eusep-
	tate, with a rounded apexC. fusiforme
8.	Conidia falcate, mostly sigmoid, $26-41 \times 7.6-10 \ \mu m$,
	3-septate, apex acuteC. sigmoideum

Cacumisporium acutatum (Réblová & W. Gams) W.P. Wu & Y.Z. Diao, comb. nov., Mycobank MB841732.

≡ Chaetosphaeria acutata Réblová & W. Gams, Czech Mycol. 51: 9, 1999.

Description on the natural substrate: Anamorph: Conidiophores solitary, erect, unbranched, cylindrical, 125–190 µm long, (4–)5–6.5 µm wide in the middle, tapering to 3–4 µm, straight or slightly flexuous, dark brown, paler towards the apex, smooth. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, the percurrently proliferating part above the collarette 4–10.5 µm long and 3.5–5 µm wide, with 5–12 densely annellate proliferations. Primary collarettes hyaline, 4.5–5.5(–6) µm wide and 1 µm deep. Conidia (11–)12.5–15.5(–16.5)×4–5 µm, cylindrical to clavate, straight or slightly curved, tapering and truncate at the proximal end, rounded at the distal end, 1-septate, not constricted, smooth-walled, hyaline. For Teleomorph, see Réblová and Gams (1999).

Typification: **Czech Republic**, Southern Bohemia, Šumava mountain, glacial cirque of the lake Certovo jezero



Fig. 167 *Cacumisporium capitulatum* (Wu7047). a-c, g-j Conidiogenous cells with percurrent proliferation and broad collarettes. d-f Conidiophores. k-m Conidia. Scale bar: a-c, g-m 10 µm, d-f 20 µm

near Zelezna Ruda, on wood of *Fagus sylvatica*, 28 August 1997, M.R. 994/97 (PRM842979, holotype).

Ecology/Substrate/Host: Saprobe on wood of Fagus sylvatica.

Geographical distribution: Czech Republic, France and Ukraine (Réblová and Gams 1999).

Description and illustration: Réblová and Gams (1999).

Notes: In our phylogenetic analysis, *Chaetosphaeria acutata* Réblová & W. Gams is grouped together with *Cacumisporium capitulatum* with strong support. Morphologically, *C. acutata* produces cylindrical conidiophores, monophialidic conidiogenous cells with 5–12 densely annellate proliferations and inconspicuous collarettes, and 1-septate and slightly curved conidia, which are very similar to those seen in *C. capitulatum* (Goos 1969a; Réblová and Gams 1990). *Chaetosphaeria acutata* differs from *C. capitulatum* in that the conidia in *C. capitulatum* are 3-septate, hyaline at the beginning, and eventually becoming brown in the two central cells, while the conidia in *C. acutata* are always hyaline. No specimen was examined by us and the above description is based on publication by Réblová and Gams (1990).

Cacumisporium capitulatum (Corda) S. Hughes, Can. J. Bot. 96: 743, 1958. Figure 167

≡ Helminthosporium capitulatum Corda, Icones Fungorum Hucusque Cognitorum 2: 13, t. 10:58, 1838.

 \equiv Acrothecium capitulatum (Corda) Ferraris, Flora Italica Cryptogamica, Hyphales: 454, 1912.

= Cacumisporium tenebrosum Preuss, Linnaea 24: 130, 1851.

= Chaetosphaeria decastyla (Cooke) Réblová & W. Gams, Czech Mycol. 51: 19, 1999.

= Sphaeria decastyla Cooke, Grevillea 7: 52, 1878.

=*Acanthostigma decastylum* (Cooke) Sacc., Syll. Fung. 2: 210, 1883.

= Melanomma macrosporum Sacc., Hedwigia 14: 73, 1875.

=*Zignoëlla macrospora* (Sacc.) Sacc., Michelia 1: 346, 1878.

Description on the natural substrate: Colonies effuse, hairy, brown to grayish brown. Mycelium partially superficial and partially immersed, composed of pale brown to brown, septate, branched, septate hyphae, 2–4 μ m wide. Teleomorph: Not observed. Anamorph: Conidiophores solitary, erect, straight, or slightly curved, simple, cylindrical, 5–9-septate, brown to dark brown, paler towards the apex, smooth- and thick-walled, 100–250×5–7 μ m, with a flatten basal cell of 10–15 μ m wide, terminating in a conidiogenous cells, percurrently proliferating through collarettes. Conidiogenous cells integrated, monophialidic, cylindrical, pale brown to medium brown, smooth or verruculose, thin-walled, with a pale brown, 35–45×4–5.5; collarettes funnel- or cup-shaped and flaring, 4–7 μ m wide, with multisporulating loci within the collarettes; the meristematic tips within the collarettes often protruding beyond the collarette and producing several conidia side by side from successively formed condiogenous cell. Conidia holoblastic, aggregated in slimy heads around the apex of conidiophores, allantoid, ellipsoidal, fusiform or oblong rounded at the apex, truncate at the base, 3-septate, at first colorless with large guttulate, later brown in the 2 medium cells and subhyaline in each end cell, smooth, $12-22 \times 3.5-5 \mu m$.

Materials examined: **China**, Guangdong Province, Shaoguan, Danxiashan, on rotten wood, 26 December 2012, W.P. Wu (Wu12395); Jilin Province, Changbaishan, on rotten wood, 20 August 1998, W.P. Wu (Wu1741a, Wu1801b); Yunnan Province, on rotten wood, 28 June 2004, W.P. Wu (Wu7048). Living strains: 44,541 (from Wu1741a), 55,410 (from Wu12395).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China, France, Italy, UK and USA (Réblová and Gams 1999).

Description and illustration: Goos (1969a); Hughes (1958); Matsushima (1975); Ellis (1976); Réblová and Gams (1999).

Notes: Four specimens of *Cacumisporium capitulatum* were examined from China and they have some variation on morphology of conidiophore, conidiogenous cells and conidia. Most of these specimens bear the fungus with typical characteristics of the species as described by Goos (1969a), Ellis (1971) and Réblová and Gams (1999); while on the specimen Wu1801b the conidiogenous cells are verruculose, with broad apical collarettes and without percurrent proliferation, and the conidia are slightly larger in average $(18-22 \times 4.5-5.5 \ \mu m)$.

Cacumisporium fusiforme Z.H. Xu, Jian Ma, X.G. Zhang & R.F. Castañeda, Mycotaxon 134: 276, 2019.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores $73-185 \times 4-7$ µm. Conidiogenous cells polyblastic, extending sympodially, with flattened or inconspicuous denticles at the conidiogenous loci, $35-61.5 \times 5.5-6.5$ µm. Conidia fusiform, occasionally curved, 3(-4)-euseptate, end cells subhyaline or pale brown to pale yellow, middle cells yellow-brown, smooth, $23.5-33.5 \times 7.5-9$ µm, apex rounded, base truncate, 2-2.5 µm wide, accumulating in brown, somewhat mucilaginous masses (Adapted from Xu et al. 2019).

Typification: **China**, Jiangxi Province, Jiulianshan National Nature Reserve, on dead branches of an unidentified broadleaf tree, 3 November 2014, J. Ma (Holotype, HJAUP M0307).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Xu et al. 2019).

Description and illustration: Xu et al. (2019).

Notes: *Cacumisporium fusiforme* is a recently described species from China. It is mostly similar to *C. sigmoideum* Mercado & R.F. Castañeda, but can be distinguished by the falcate, mostly sigmoid, and 3-euseptate conidia in slightly larger size $(26-41 \times 7.6-10.2 \ \mu\text{m})$ and with an acute apex in the latter species (Mercado Sierra and Castañeda-Ruiz 1987; Xu et al. 2019). This is one of those species with similar conidiogenesis to *Minimelanolocus*. Living strain needs to be obtained for molecular study to elucidate its phylogenetic relationship with the type species *Cacumisporium capitula-tum* and other similar fungi.

Cacumisporium rugosum K. M. Tsui, Goh, K. D. Hyde & Hodgkiss, Mycologia 93: 389, 2001.

Teleomorph: Unknown. Anamorph: Conidiophores $200-350 \times 7.5-10 \mu m$, cylindrical, 4–6-septate, often with 1–2 percurrent proliferations. Conidiogenous cells monophialidic, the meristematic tips within the collarettes often protruding beyond the collarette and producing several conidia side by side in sympodial succession above cylindrical, phialidic collarettes. Conidia $28-35 \times 14-20 \mu m$, obovoidal to broadly ellipsoidal, 3-euseptate, with two central dark brown cells and pale brown proximal and distal cells, rugose to verrucose throughout except at the proximal cells (Adapted from Tsui et al. 2001a, b, c).

Typification: **China**, Hong Kong, Lantau Island, Tung Chung River, on submerged wood, 28 Jul. 1997, K. M. Tsui, KM208 (Holotype, HKU(M) 5548), culture of holotype (HKUCC 2299).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Tsui et al. 2000).

Description and illustration: Tsui et al. (2000).

Notes: *Cacumisporium rugosum* resembles *C. capitulatum* in producing 3-septate, versicolorous conidia, but differs in its brown and rugose conidia (Tsui et al. 2000). Same as in *C. capitulatum*, the meristematic tips within the collarettes often protrude beyond the collarette and producing several conidia side by side in sympodial succession above cylindrical, phialidic collarettes in *C. rugosum* (Goos 1969a; Tsui et al. 2000).

Cacumisporium sigmoideum Mercado & R.F. Castañeda, Acta Bot. Cuba. 50: 1, 1987.

Teleomorph: Unknown. Anamorph: Conidiophores 250–340 μ m long, 5–5.5 μ m wide. Conidiogenous cells with multiple percurrent proliferations. Conidia broadly fusiform to ellipsoidal, slightly to moderately curved, 23–30.5×8–10 μ m, smooth, 3-septate, versicolored, the two central cells larger and pale reddish brown, end-cells smaller and subhyaline or very pale brown, conically rounded at

the apex, obconically truncate at the base (Adapted from Chang 1997).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Australia, China and Cuba (Mercado Sierra and Castañeda-Ruiz 1987; Raja et al. 2007; Hyde and Goh 1998).

Description and illustration: Mercado Sierra and Castañeda-Ruiz (1987); Raja et al. (2007); Hyde and Goh (1998).

Notes: This fungus was reported on decaying twigs from stream in Taiwan, China (Chang 1997). No specimen was examined by us, the above short description is based on the original description.

Exserticlava S. Hughes, N. Z. J. Bot. 16: 332, 1978.

Lignicolous. Teleomorph: Ascomata globose to broadly ovoid, dark brown, separate, scattered to gregarious, superficial on the substratum, papillate, with scattered setae, brown, multiseptate, apex capitate, globose to subglobose. Yellow pruina covering apices of setae and surface of ascomata. Ascomatal wall opaque in surface view in water, of textura angularis in lactophenol. Ascomatal apex papillate, short. Paraphyses sparse, simple, septate. Asci cylindrico-clavate, short-stalked, unitunicate, thin-walled, with a distinctive apical ring, with 8 ascospores irregularly arranged. Ascospores fusiform, with rounded end cells, sub-hyaline to light brown, septate. Anamorph: Colonies effuse, brown, hairy. Mycelium partly immersed and partly superficial, composed of smooth, septate, dark-brown, thin- to thick-walled hyphae. Conidiophores cylindrical, solitary, erect, sometimes curved, unbranched, scattered to gregarious, septate, thick-walled, dark brown below, paler above, smooth-walled. Conidiogenous cells integrated, terminal, phialidic, swollen, cupulate, brown, smooth-walled, polyblastic, with multiple conidiogenous loci active within the collarette, collarette conspicuous. Conidia holoblastic, distoseptate or aseptate, spherical to ellipsoidal, oblong-ellipsoid, ovoid, rounded at both ends, brown, smooth- and thick-walled.

Type species: *Exserticlava vasiformis* (Matsush.) S. Hughes

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Broadly distributed and commonly known.

Description and illustration: Hughes (1978); Seifert et al. (2011).

Notes: The genus *Exserticlava* was erected by Hughes (1978) to accommodate *Cordana vasiformis* Matsush. and *C. triseptata* Matsush., two species on wood and bamboo from Japan (Matsushima 1975). It is characterized by solitary, simple, septate conidiophores, monophialidic conidiogenous cells with funnel-shaped collarettes, and distoseptate conidia

(Hughes 1978; Kirk 1985; Tsui et al. 2001b). Conidiogenesis in Exserticlava species is unusual as the outer wall of the conidiophore apex is broken by the initial conidium, leaving a fertile area and collarette developed from the ruptured outer wall. Conidia are produced successively from the fertile conidiogenous loc at the conidiophore apex (Bhat and Sutton 1985a; Nakagiri and Ito 1995). A total of eight species, including Exserticlava aquatica, E. globosa, E. keniensis, E. manglietiae, E. triseptata, E. uniseptata, E. vasiformis and E. yunnanensis are known in the genus and the species separation is mainly based on shape, size and septation of conidia (Hughes 1978; Bhat and Sutton 1985b; Kirk 1985; Rao and de Hoog 1986; Nakagiri and Ito 1995; Holubová-Jechová 1990; Tsui et al. 2001b; Cai and Hyde 2007; Ma et al. 2011a, b; Carmo et al. 2020). A key to all known species was provided by Tsui et al. (2001a, b, c).

The genus Exserticlava, originally defined for asexual morph have been connected with Chaetosphaeria sexual morph (Hughes 1978; Matsushima 1985; Réblová and Seifert 2003; Fernández & Huhndorf 2005; Seifert et al. 2011). The type species Exserticlava vasiformis was found on the holotype specimen of Chaetosphaeria capitata but without a common mycelial link between them (Sivanesan and Chang 1995). Fernández and Huhndorf (2005) confirmed the sexual-asexual connection between C. capitata and E. vasiformis by culturing ascospores in vitro. This was further supported by recent phylogenetic analysis with E. vasiformis and C. capitata. The second species with sexual and asexual connection is E. triseptata with C. hiugensis as sexual morph (Matsushima 1985; Réblová 1999a, 2000, 2004; Tsui et al. 2001b; Réblová and Seifert 2003; Fernández and Huhndorf 2005). The sexual states for other species have not been found and are remained to be known only with asexual state.

The recently described monotypic genus *Anaexserticlava* T.S. Santa Izabel, R.F. Castañeda & Gusmão, typed with *A. caatingae*, is morphologically very similar to the type species of *Exserticlava* in holoblastic conidiogenous cells with percurrent extensions and distoseptate conidia, but they can be distinguished by rhexolytic conidial secession and resulted pedicellate conidia in *Anaexserticlava*, while the conidial secession is schizolytic and conidia without pedicellate in *Exserticlava* (Santa Izabel et al. 2015).

Key to accepted species of *Exserticlava* (Based on Tsui et al. 2001a, b, c)

 Conidiophores with hyaline apical extension; conidia ellipsoid, 3-septate, 29–34×17–21 μm......*E. vasiformis* Conidiophores without hyaline apical extension......2
Conidia 3-distoseptate.......3
Conidia 0–1-distoseptate......4 3. Conidia ellipsoid, $28-37 \times 14-16 \mu m$E. hiugensis 3. Conidia pale brown, obovoid to obclavate, 23–30×19–22 µm..... E. keniensis 4. Conidia aseptate, pale brown, spherical, verrucose, 16–22×16–20 µm.....Е. globosa 4. 5. Conidia versicolorous, with bigger and darker basal cells than apical cells......E. yunnanensis Conidia pale brown, broadly obovoid, $15-20 \times$ 6. 11–14 µm.....*E. uniseptata* Conidia ellipsoid, 14–16×9–11 µm.....E. manglietiae 6.

Exserticlava exserticlavoides (Réblová & Seifert) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841733.

≡ *Chaetosphaeria exserticlavoides* Réblová & Seifert, Sydowia 55: 316, 2003.

Typification: **Thailand**, Nakhon Nayok Province, Khao Yai National Park NE of Bangkok, trail to Haew Suwat waterfall, on decayed bamboo culm, 2 August 2001, M. R., G. J. S., R. N. (PRM 900,540). Ex-type strain CBS 112,963, DAOM 231,138.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Thailand (Réblová and Seifert 2003).

Description and illustration: Réblová and Seifert (2003).

Notes: The *Exserticlava* anamorph was connected with its teleomorph *Chaetosphaeria exserticlavoides* Réblová & Seifert in pure culture by Réblová & Seifert (2003). Conidia of this *Exserticlava* anamorph resembles those from *E. vasiformis*, the type species of the genus *Exserticlava*. These two species, *E. vasiformis* and *E. exserticlavoides*, differs by conidiogenous cells lacking cup-shaped collarettes in the latter species. They are also very different on ascospore morphology: fusiform, subhyaline to pale brown, 7–10 septate, $48-100 \times 3-5 \mu m$ in *E. vasiformis*; ellipsoidal to fusiform, subhyaline to pale brown, 3–7-septate, $28-32 \times 3.5-4 \mu m$ in *C. exserticlavoides* (Réblová and Seifert 2003; Fernández and Huhndorf 2005).

Exserticlava globosa Vasant Rao & de Hoog, Stud. Mycol. 28: 51, 1986.

Teleomorph: Unknown. Anamorph: Conidiophores cylindrical, 2–6-septate, dark brown, up to 270 μ m long and 13 μ m wide at the base. Conidiogenous cells terminal, integrated, clavate, polyblastic with several indistinct, unthicken conidiogenous loci. Conidia solitary, dry, globose to subglobose, most with rather thick medium septa, regularly verruculose, 18–25 × 17–24 μ m (Adapted from Chang 1995).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Chang 1995; Lu et al. 2000), India (Rao and de Hoog 1986).

Description and illustration: Rao and de Hoog (1986); Chang (1995).

Notes: No specimen was examined by the author, the above description is based on description by Chang (1995). Its occurrence on decaying twig in Taiwan and on submerged wood in Hong Kong was also recorded (Chang 1995; Lu et al. 2000).

Exserticlava manglietiae S.C. Ren & X.G. Zhang, Mycotaxon 118: 350, 2012.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiophores cylindrical, $360 \times 490 \times 5-8.5 \mu m$, 4–6-septate. Conidiogenous cells polyblastic, proliferating sympodially without progression and giving rise to a cluster of conidia, brown, thick- and smooth-walled. Conidia ellipsoid, thick-walled, 1-distoseptate, very pale brown, base truncate, $14-16 \times 9-11 \mu m$ (Adapted from Ren et al. 2012).

Material examined: **China**, Guangdong Province, subtropical forest of Nanling, on dead branches of *Manglietia chingii*, 10 December 2010, Sh. C. Ren (HMAS146154, isotype).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China (Ren et al. 2012).

Description and illustration: Ren et al. (2012).

Notes: *Exserticlava manglietiae* S was examined by us, *E. uniseptata* and *E. yunnanensis* are three closely related species with 1-septate and smaller conidia in the genus (Bhat and Sutton 1985a; Cai and Hyde 2007; Rei et al. 2012). They can be distinguished from each other by conidial septation and size. In *E. manglietiae*, the conidia are very pale brown, ellipsoidal, with one central septum, and measuring of $14-16 \times 9-11 \mu m$. Both *E. uniseptata* and *E. yunnanensis* produce dark brown and larger conidia in size than those in *E. manglietiae*. In addition, in *E. yunnanensis* the conidia are pyriform and versicolorous, with a larger dark basal cell and a smaller paler apical cell; in *E. uniseptate*, the conidia are with a shorter basal cell than the apical cell.

Exserticlava triseptata (Matsush.) S. Hughes, N. Z. J. Bot. 16: 311, 1978.

 \equiv Cordana triseptata Matsush., Microfungi of the Solomon Island and Papua-New Guinea (Kobe): 40, 1975.

= Chaetosphaeria chlorotunicata F.A. Fernández & Huhndorf, Fungal Divers. 18: 18, 2005.

Description on the natural substrate: Colonies hairy, brown or blackish brown. Mycelium partly superficial, partly immersed, composed of branched, septate, smooth, pale brown to brown hyphae. Teleomorph: Not observed. Anamorph: Conidiophores solitary, erect, straight, or slightly curved, cylindrical, smooth, 4–8-septate, thick-walled, brown to dark brown, blackish at lower part, $130-250\times5-8$ µm. Conidiogenous cells clavate, subcylindrical, brown, thick- and smooth-walled, 20–30 µm long, 7–10 µm wide at distal end, 6–7 µm wide at the base, polyblastic, multiple conidiogenous loci active within the collarette. Conidia acrogenous, solitary, brown, 3-distoseptate, smooth, ellipsoidal, broad clavate, oblong-cylindrical, 25–28×15–16 µm, both base and apex rounded.

Materials examined: **China**, Guangxi Province, Shiwandashan, on dead culms of bamboo, 29 December 1997, W.P. Wu (Wu1527f).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China, Japan, Kenya, Malaysia, Micronesia, Puerto Rico, Ponape and Seychelles.

Description and illustration: Hino and Katumoto (1961); Matsushima (1975, 1985); Hughes (1978); Kirk (1985); Kuthubutheen and Nawawi (1994a, b, c); Hyde and Goh (1998); Tsui et al. (2001a, b, c); Réblová and Seifert (2003); Fernández and Huhndorf (2005).

Notes: *Exserticlava vasiformis* and *E. triseptata* are two most closely related species on morphology, and can be distinguished by relatively larger conidia in the latter species. *Exserticlava vasiformis* is by far the most common species seen in China. Only one scare collection of *E. triseptata* was made from China by us. No living strain was obtained with several attempts. Its occurrence on dead culm of *Dendrocalamus* sp. and the submerged wood in Hong Kong was also reported (Lu et al. 2000).

The anamorphic state, obtained from the single ascospore isolate of *Chaetosphaeria chlorotuicata* F.A. Fernández & Huhndorf, was described as *Exserticlava* sp. (conidiophores cylindrical, 223–288 × 11–13 µm on natural substrate, 235–382 µm (up to 650) long on PCA, bearing a terminal monophialidic and funnel-shaped phialides; conidia cylindrical, brown, 3-distoseptate, $31–38 \times 16–19$ µm on the substrate, $22–30 \times 10–15$ µm on CMA, with a distinctive basal hilum, centric or slightly eccentric) and it is highly possible this is *E. triseptata* (Fernández & Huhndorf 2005).

Exserticlava uniseptata Bhat & B. Sutton, Trans. Br. Mycol. Soc. 85: 116, 1985.

Teleomorph: Unknown. Anamorph: Conidiophores cylindrical, septate, up to 290 μ m long, 5–7.5 μ m wide. Conidiogenous cells terminal, integrated, clavate, polyblastic with several indistinct, unthicken conidiogenous loci. Conidia clavate, broadly rounded at the base, 1-distoseptate, the septum in the lower half of the conidium, medium brown, 14.5–21 × 9.5–15 μ m (Adapted from Chang 1995). Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Chang 1995) and Ethiopia (Bhat and Sutton 1985a).

Description and illustration: Bhat and Sutton (1985a); Chang (1995).

Notes: No specimen was examined by the author. The description is based on description by Chang (1995).

Exserticlava vasiformis (Matsush.) S. Hughes, N. Z. J. Bot. 16: 311, 1978.

 \equiv Cordana vasiformis Matsush., Microfungi of the Solomon Islands and Papua-New Guinea (Kobe): 40, 1975.

= Chaetosphaeria capitata Sivan. & H.C. Chang, Mycol. Res. 99: 715, 1995.

Description on the natural substrate: Colonies hairy, brown or blackish brown. Mycelium partly superficial, partly immersed, composed of branched, septate, smooth, pale brown to brown hyphae. Teleomorph: Not observed. Anamorph: Conidiophores solitary, arising from superficial mycelium, erect, straight, or slightly curved, cylindrical, smooth, 2-4-septate, thick-walled, brown to dark brown, $100-110 \times 5-7$ µm. Conidiogenous cells cupulate, pale brown to brown, thick- and smooth-walled, 12-15 µm long, 13–14 µm wide at distal end, 5–6 µm wide at the base, with a funnel-shaped collarette, and multiple conidiogenous loci active within the collarette, occasionally with overgrowing to form subhyaline, septate, obclavate structure of up to $20 \,\mu\text{m}$ wide at the widest part and $6\text{--}7 \,\mu\text{m}$ wide at distal end. Conidia acrogenous, solitary, brown, 3-distoseptate, smooth, ellipsoidal, oblong-cylindrical, $20-24 \times 11-12 \,\mu\text{m}$, both base and apex rounded.

Materials examined: China, Guangdong Province, Lufushan, on dead leaves, 15 October 1998, W.P. Wu (Wu1997b); Guangdong Province, Dinghushan, on dead material of palm, 9 October 1998, W.P. Wu (Wu1859f); Guangdong Province, Dinghushan, on wood of unidentified plant, 9 October 1998, W.P. Wu (Wu1862b); Guangdong Province, Dinghushan, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (Wu1863a); Guangdong Province, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (Wu2070d); Guangdong Province, Guangzhou, South China Botanical Garden, on dead culm of grass, 4 March 2012, W.P. Wu (Wu12336); Guangdong Province, Guangzhou, Baiyunshan, on dead culm of grass, 5 March 2012, W.P. Wu (Wu12018); Guangdong Province, Zhaoqing, Dinghuashan, on dead bark of unidentified tree, 3 March 2012, W.P. Wu (Wu12127); Guangdong Province, Guangzhou, Yuexiu Garden, on dead culm of bamboo, 2 March 2012, W.P. Wu (Wu12224); Guangdong Province, Shaoguan, Danxiashan, on dead leaves of grass, 25 Dec 2012, W.P. Wu (Wu12424); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead branch of unidentified plant, 2 January 1997, W.P. Wu (Wu1265a, Wu1326d); Guangxi Province, Shiwandashan, on dead culms of bamboo, 30 December 1997, W.P. Wu (Wu1542c); Guangxi Province, Shiwandashan, on dead culms of bamboo, 31 December 1997, W.P. Wu (Wu1605f); Guangxi Province, Nangning, on dead leaves of *Eucalyptus* sp., 3 January 1998, W.P. Wu (Wu1612a); China: Guangxi Province, Nangning, on dead branches of unidentified plant, 3 January 1998, W.P. Wu (Wu1653j); Hainan Province, on rotten wood, December 1999, W.P. Wu (Wu5552c); Hunan Province, Zhangjiajie, on dead leaves of unidentified tree, 15 October 2010, W.P. Wu (Wu11032b). Sichuan Province, Ya An, Yucheng, Wanguan, Bifengxia, on dead leaf sheath of bamboo, 15 December 2013, W.P. Wu (Wu13207, 13,217). Living strain: 42905 (from Wu1265a).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Australia, Brazil, China, Costa Rica, Puerto Rico, India, Japan, Malaysia, New Zealand and North America.

Description and illustration: Matsushima (1975); Hughes (1978); Crane and Schoknecht (1982); Kuthubutheen and Nawawi (1994a, b, c); Tsui et al. (2001a, b, c); Fernández and Huhndorf (2005); Xia (2017).

Notes: Exserticlava vasiformis is the most commonly found species in the genus and has been well documented (Matsushima 1975; Hughes 1978; Kuthubutheen and Nawawi, 1994a, b, c). It is characteristic that the fungus produces with a terminal funnel-shaped collarette, and multiple conidiogenous loci active within the collarette, from which occasionally with overgrowing to form subhyaline, septate, obclavate structure of up to 20 µm wide at the widest part and 6-7 µm wide at distal end. Exserticlava vasiformis (conidia $20-24 \times 11-12 \mu m$) and E. triseptata (conidia $25-28 \times 15-16 \,\mu\text{m}$) are closely related species in producing 3-septate and ellipsoidal conidia, but in E. triseptata the conidia are significant larger in size and no overgrowing of conidiogenous cells (Hughes 1978). The anamorph and teleomorph connection between E. vasiformis and Chaetosphaeria capitata has been established from the single ascospore culture and the molecular phylogenetic analysis (Fernández and Huhndorf 2005). In the phylogenetic analysis, E. vasiformis was clustered together with other Chaetosphaeria with dark brown conidia and it is not closely related to the type species of Chaetosphaeria. Its occurrence on many different plants incl. Arenga engleri, Bambusa tuldoides, Miscanthus floridulus, Pandanus frucatus and Phoenix hanceana from Hong Kong was reported by Lu et al. (2000). It is also reported from Taiwan (Matsushima 1980).

Exserticlava yunnanensis L. Cai & K.D. Hyde, Mycoscience 48: 292, 2007.



Fig. 168 *Monosporoschisma elegans* (Wu5520, holotype). **a, b, g, i, j** Capitate hyphae. **c–f, h** Capitate hyphae, conidiophores and conidiogenous cells. Scale bar: **a–g** 10 μm, **h** 100 μm, **k** 5 μm



Fig. 169 *Monosporoschisma elegans* (Wu5520, holotype). **a–b** Upper part of capitate hyphae with percurrent proliferations. **c–e** Upper part of conidiophores bearing developing conidia. **e–k** Conidia. Scale bar: $5 \,\mu\text{m}$

Typification: China: Yunnan Province, on submerged wood in a small forest stream, 14 July 2003, L. Cai, CAI–7FB30.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Cai and Hyde 2007). Description and illustration: Cai and Hyde (2007).

Notes: *Exserticlava yunnanensis* differs from other known species in the genus by its 1-septate, pyriform and versicolorous conidium, with a darker basal cell in relatively larger size and a paler apical cell in smaller size. It is mostly similar to *E. globosa* V. Rao & de Hoog and *E. uniseptata* Bhat & B. Sutton, both species also produce 1-septate conidia. However, conidia of *E. globosa* are globose and concolorous; while conidia of *E. uniseptata* are concolorous with a smaller basal cell than apical cell (Bhat and Sutton 1985a; Rao and de Hoog1986; Tui et al. 2001).

Monosporoschisma W.P. Wu & Y.Z. Diao, gen. nov., Myco-Bank MB841545.

Etymoloty: Refers to its similarity to *Sporoschisma* in brown, cylindrical and multiseptate conidia.

Diagnosis: Conidiophores cylindrical, septate. Conidigenous cells monophialidic, terminal, cylindrical; collarette broadly funnel-shaped. Conidia cylindrical, septate, brown.

Type species: *Monosporoschisma elegans* W.P. Wu & Y.Z. Diao.

Colonies superficial, effuse, black, hairy to setose, composed of conidiophores and capitate hyphae arising from small stromata. Teleomorph: Unknown. Anamorph: Capitate hyphae present, erect, simple, sterile, brown, septate, with an apical swelling and percurrent proliferations. Conidiophores subcylindrical, erect, single or in small cluster together with capitate hyphae, septate, dark brown to blackish, terminating in a conidiogenous cell. Conidiogenous cells integrated, terminate, monophialidic, brown to dark brown, cylindrical, with short collarettes with wider opening at the apex. Conidia ellipsoidal, oblong, ends rounded, 3-septate, central cells brown to dark brown, end cells pale brown to brown, base with a distinct scar.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China.

Monosporoschisma elegans W.P. Wu & Y.Z. Diao, sp. nov., Figs. 168–169, MycoBank MB841615.

Etymology: Refers to it beautiful conidia.

Typification: **China**, Hainan Province, on dead material of unidentified palm, 12 December 2000, W.P. Wu & Yan Huang, Holotype HMAS 352,025 (= Wu5520).

Description on the natural substrate: Colonies superficial, effuse, black, hairy to setose, composed of conidiophores and capitate hyphae arising from small stromata. Mycelium

partial superficial and partly immersed into substratum, consisting of pale brown to brown, septate, branched hyphae of 2-3 µm wide. Teleomorph: Unknown. Anamorph: Capitate hyphae erect, simple, sterile, brown to dark brown, becoming pale brown towards the apex, 5-8-septate, smooth, $180-230 \times 4-5 \ \mu\text{m}$, apex distinctly swollen and $6-7 \ \mu\text{m}$ wide, with 1-4 percurrent proliferations. Conidiophores subcylindrical, erect, single or in small cluster together with capitate hyphae, multiseptate but hardly seen due to almost blackish wall, blackish, become paler towards the apex, smooth, $270-325 \times 11-13 \mu m$, terminating in a conidiogenous cell. Conidiogenous cells integrated, terminate, monophialidic, brown to dark brown, cylindrical, 7.5-8 µm wide, apex truncate, collarettes 2-3 µm deep, 6.5-8 µm wide, slightly narrower at the base, with 1-4 percurrent proliferations. Conidia ellipsoidal, oblong, 3-septate, rounded at both ends, central cells brown to dark brown, end cells pale brown to brown, $30-34 \times 13.5-16 \,\mu\text{m}$, base with distinct scars of 3.5-4 µm wide.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China.

Notes: This unique fungus on decaying leaves of palm resembles *Fusichalara* S. Hughes & Nag Raj, *Sporoschisma* Berk. & Broome and *Sporoschismopsis* Hol.-Jech., but differs from them by the conidiogenesis. In *Fusichalara*, *Sporoschisma* and *Sporoschismopsis*, the conidiogenous cells are composed of distinctly differentiated venter and collarette, where the conidiogenous loci deeply sitting at the base of long collarettes. In *Monosporoschisma elegans*, the conidiogenous cells have typical phialides with inconspicuous collarettes and only very small part of the conidia sitting within the collarettes. In addition, *Fusichalara* and *Sporoschismopsis* are lacking capitate hyphae (Holubová-Jechová and Hennebert 1972; Holubová-Jechová 1973a, b; Hughes and Kendrick 1963; Nag Raj and Kendrick 1975; Seifert et al. 2011).

On conidiogenesis and conidial morphology, *Monosporoschisma elegans* also shows some similarity to *Paradischloridium ychaffrei* and *Endophragmia microaquatica*. However, no capitate hyphae are formed in the last two species (Matsushima 1975; Bhat and Sutton 1985b). The conidial morphology in this species also brings the comparison with *Duosporium cyperi*. However, in the latter species the conidiogenous cells are with sympodial proliferations and the conidiogenous loci are very narrower hole surrounded with a distinct scar (Ellis 1971; Mecardo Sierra et al. 1997). No living strain was obtained for molecular study, its placement in Chaetosphaeriaceae is based on morphological characters such as presence of capitate hyphae, phialidic conidiogenous cells and conidiogenous.



Fig. 170 *Phaeodischloridium inaequiseptatum* (Wu5523). **a-k** Conidiophores and conidiogenous cells. **i-t** Conidia. Scale bar: **a-h** 10 μ m, **i-t** 5 μ m

Phaeodischloridium W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB841541.

Etymology: Refers to its similarity to *Dischloridium* in monophialidic conidiogenous cells with mbroad opening and cylindrical conidia.

Dioagnosis: Similar to *Dischloridium* but differs in producing coloted and septate conidia.

Type species: *Phaeodischloridium inaequiseptum* (Matsush.) W.P. Wu & Y.Z. Diao (\equiv *Endophragmia inaequisepta* Matsush.).

Colonies effuse, hairy, velvety, dark brown. Stroma absent. Teleomorph: Unknown. Anamorph: Conidiophores solitary, erect, unbranched, straight, or slightly flexuous, septate, smooth or verruculose, dark brown, percurrently regenerating, paler towards the apex, with a swollen base. Conidiogenous cells integrated, terminal, cylindrical, lageniform, collarette inconspicuous. Conidia holoblastic, solitary, accumulating in slimy brown masses at the apices or sometimes sliding down along the sides of conidiogenous cells after secession, cylindrical to cylindric-clavate, obtuse at both ends, medium to dark brown except the pale brown basal cells, 3-septate, apical cell longer than others, thinwalled, smooth.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China and Japan.

Phaeodischloridium inaequiseptatum (Matsush.) W.P. Wu & Y.Z. Diao, comb. nov. Figure 170, MycoBank MB841734.

 \equiv Endophragmia inaequisepta Matsush., Icones Microungorum a Matsushima Lectorum: 69, 1975.

≡ Dischloridium inaequiseptum (Matsush.) Hol.-Jech., Česká Mykol. 41: 111, 1987.

= Chaetosphaeria aquatica Z.L. Luo, K.D. Hyde & H.Y. Su, Fungal Divers. 99: 582, 2019.

Colonies effuse, hairy, velvety, dark brown. Teleomorph: Unknown. Anamorph: Conidiophores solitary, erect, unbranched, straight, or slightly flexuous, 4–7-septate, smooth or verruculose, dark brown, percurrently regenerating, paler towards the apex, 100–130 μ m long, 5–6 μ m wide, with a swollen base of up to 10 μ m wide. Conidiogenous cells integrated, terminal, cylindrical, lageniform, 6–10×4–5.5 μ m wide, 3–3.5 μ m wide at the conidiogenous loci, lacking a conspicuous collarette. Conidia holoblastic, solitary, accumulating in slimy brown masses at the apices or sometimes sliding down along the sides of conidiogenous cells after secession, cylindrical to cylindric-clavate, obtuse at both ends, medium to dark brown except the pale brown basal cells, 3-septate (rarely 1-septate), apical cell longer than others, thin-walled, smooth, 16–30×5–7 μ m.

Materials examined: **China**, Hainan Province, Haikou, on rotten wood of unidentified plant, 20 December 2000, W.P. Wu (Wu5523); Guangdong Province, Guangzhou, South China Botanical Garden, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (Wu2221).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China and Japan (Matsushima 1975; Luo et al. 2019).

Description and illustration: Matsushima (1975); Luo et al. (2019).

Notes: This unique fungus was originally described as Endophragmia inaequiseptata (Matsushima 1975). Since Endophragmia is not used as the generic name after Hughes's relocation of its species and its inclusion in Endophragmiella was not accepted by Hughes (1979), Holubová-Jechová (1987a, b) transferred it to Dischloridium, which was highly questioned due to its brown and 3-septate conidia. Morphologically it is identical to the recently described Chaetosphaeria aquatica on conidiophores $(181-271 \times 5-7 \mu m)$, conidiogenous cells and conidia $(1-3-\text{septate}, 20-24 \times 6-8 \,\mu\text{m})$. Phylogenetically this fungus belongs to Chaetosphaeriaceae, but is clearly separated from other known Chaetosphaeria species including the type species. Thus, a new genus is created to accommodate this fungus. On the phylogenetic tree, it is clustered together with Catenularia and Cacumisporium, both with dark colored conidia.

Endophragmia. inaequiseptata is an earlier name for Chaetosphaeria aquatica, the new combination Phaeodischloridium inaequiseptatum (Matsush.) W.P. Wu & Y.Z. Diao is made here and C. aquatica becomes to be a synonym.

This fungus shows some similarity with *Paradischloridium ychaffrei* (=*Dischloridium triseptata*) on terminal monophialidic conidiogenous cells, lacking conspicuous collarettes, and brown, 3-septate conidia, but they clearly differ from each other. In *P. ychaffrei*, the young and hyaline conidia are formed within the venter of the conidiogenous cells, and the conidia are pseudoseptate (Bhat and Sutton 1985a; Reblová et al. 2011a, b).

Sporoschisma Berk. & Broome, Gardener's Chronicle: 540, 1847.

=*Pithospermum* Mont., Sylloge Generum Specierumque Plantarum Cryptogamarum: 306, 1856.

= Melanochaeta E. Müll., Harr & Sulmont, Rev. Mycol. 33: 377, 1969.

Colonies effuse, black, hairy, composed of ascomata with mixed tufts of conidiophores. Teleomorph: Ascomata solitary, scattered, superficial, anchored to substrate by an indistinct basal stroma, broadly pyriform; wall smooth and shining, covered with stiff, erect, dark brown to black setae each with a slightly swollen, light brown to colorless cap. Paraphyses filiform, septate, longer than asci, hyaline. Asci unitunicate, cylindrical to narrow clavate, apex with a refractive, non-amyloid ring, eight-spored. Ascospores partially biseriate, fusiform with transverse septa, curved, central four cells darker brown and larger than the lighter brown end cells. Anamorph: Colonies discrete, superficial, effuse, black, hairy to setose, composed of conidiophores and capitate hyphae arising from small stromata. Capitate hyphae present or absent, erect, simple, sterile, brown, septate, with an apical swelling surrounded by a blob of mucilage. Conidiophores subcylindrical to clavate, erect, single or in small cluster together with capitate hyphae, septate in the basal part, brown to dark brown, terminating in a conidiogenous cell. Conidiogenous cells integrated, terminate, phialidic, brown to dark brown, subcylindrical to urceolate with long collarettes. Conidia more or less cylindrical to subcylindrical, ends flattened or rounded, septate, pale brown to dark brown, formed in false chain.

Type species: S. mirabile Berk. & Broome.

Ecology/Substrate/Host: Saprobe on dead material of plants, especially rotten wood.

Geographical distribution: Commonly known, especially in subtropical and tropical area.

Description and illustration: Hughes (1949, 1966); Nag Raj and Kendrick (1975); Ellis (1971); Holubová-Jechová (1978); Goh et al. (1997); Seifert et al. (2011); Zelski et al. (2014); Luo et al. (2016).

Notes: Sporoschisma was created to accommodate lignicolous hyphomycetous fungi that form chains of dematiaceous conidia endogenously from flask-shaped or cylindrical, dark brown conidiophores, often with sterile capitate setae (Hughes 1949, 1966; Nag Raj and Kendrick 1975; Ellis 1971; Holubová-Jechová 1978; Goh et al. 1997; Seifert et al. 2011; Zelski et al. 2014; Luo et al. 2016). Morphologically, the most closely related genera to Sporoschisma are Chalara (Corda) Rabenh. and Sporoschismopsis. Sporoschisma differs from them by producing capitate setae, colored and cylindrical conidia with truncated ends (Seifert et al. 2011). In addition to this, the conidia in Sporoschisma are dark-colored, while they are hyaline in Chalara. In Sporoschismopsis, the percurrently proliferated conidiophores are cylindrical and without distinct swollen venter, and the conidia are clavate. The conidial anatomy and conidiogenesis in Sporoschisma was studied by Ho et al. (1998).

A revision for all species known in the genus was given Hughes (1949) and most of the described taxa were excluded from the genus (9 species and 1 variety) or regarded as synonym (1 variety). The four species accepted by Hughes were *S. insigne, S. juventile, S. mirabile* and *S. saccardoi*. Including of *S. insigne* into the genus was questioned by Hughes due to its hyaline conidia and this was later excluded from the genus and replaced into *Chalara* (Hughes 1958; Nag Raj and Kendrick 1975). Several additional species have been described since then (Rao and Rao 1964; Bhat and Kendrick 1993; Goh et al. 1997; Luo et al. 2016). Goh et al. (1997) provided the latest revision for the genus and 7 species (including 2 new species) were accepted in the genus. Yang et al. (2016a, b) introduced two new species, *S. lon-gicatenatum* and *S. palauense* from submerged wood from freshwater in Thailand. Réblová et al. (2016) made two new combinations *Sporoschisma daemonoropis* (and *S. taitense*.

The teleomorphs of the genus *Sporoschisma* were known in 4 species, *S. daemonoropsis* (=*Melanochaeta daemonoropsis*), *S. hemipsilum* (=*Melanochaeta hemipsila*), *S. mirabile* (=*M. aotearoae* and *S. taitense* (=*Melanochaeta taitensis*). All of them belong to *Melanochaeta* in Chaetosphaeriaceae (Hughes 1966; Müller et al. 1969; Samuels and Müller 1978; Müller and Samuels 1982; Goh et al. 1997).

With the combined morphological and phylogenetic study, 13 species are accepted in the genus (Supplementary Fig. 5), including *S. australiense*, *S. chiangraiense*, *S. daemonoropsis*, *S. hemipsilum*, *S. juvenile*, *S. longicatenatum*, *S. mirabile*, *S. nigroseptatum*, *S. palauense*, *S. parcicuneatum*, *S. phaeocentron*, *S. taitense*, and *S. uniseptatum* (Berkeley 1847; Boudier 1911; Rao and Rao 1964; Bhat and Kendrick 1993; Goh et al. 1997; Zhao and Zhao 2012; Réblová 2014; Zelski et al. 2014; Luo et al. 2016; Yang et al. 2016a, b; Réblová et al. 2016; Bao et al. 2021). Phylogenetically these species are monophyletic. Identification of species in the genus is mainly based on conidial morphology such as shape, size and septation, but other characters including morphology of conidiophores and capitate setae can also be used together.

The genus *Sporoschisma* is widely distributed and has worldwide distribution (Hughes 1949, 1966, 1953, 1979; Rao and Rao 1946; Holubová-Jechová 1973a, b, 1982; Matsushima 1975, 1980; Bhat and Sutton 1985a; Bhat and Kendrick 1993; Goh et al. 1997). The genus was recently studied in submerged wood in China, with 5 species reported from Yunnan Province of mainland China (Luo et al. 2016), 5 species (*S. juvenile, S. mirabile, S. nigrseptatum, S. hemipsilum* and *S. uniseptatum*) from Hong Kong (Goh et al. 1997; Lu et al. 2000) and 2 species (*S. mirabile* and *S. saccardoi*) from Taiwan (Matsushima 1980).

Key to species of Sporoschisma with anamorphs*

1. Conidia 1-septate......2 1. Conidia more than 1-septate.....4 2. Conidia $24-35 \times 13-15 \ \mu m$ wide, capitate setae absent.....S. parcicuneatum Conidia less than 12 µm wide, capitate setae pre-2. 3. Conidia 27–32×11–12.5 µm wide.....S. uniseptatum 3. Conidia 15.3–30×8.5–12.5 µmS. chiangraiense 4. Conidia mostly 3-septate......5 4.



Fig. 171 *Sporoschisma hemipsilum* (Wu17512). **a**, **b**Capitate hyphae and conidiophores. **c**, **g**, **h** Conidiophores with vector and long collarette. **d**, **e**, **i**, **h** Conidia. **f** Capitate hyphae. Scale bar: **a**, **b**a, b 40 μm, **c**–**e**, **h** 20 μm, **f**, **g** 10 μm, **i**, **j** 5 μm

5.	Conidia versicolorous with end cells paler than middle
	cells6
5.	Conidia uniformly pigmented7
6.	Conidia $27-37.5 \times 9.5-10.5 \mu m$, ends cell very short,
	smooth-walledS. australiense
6.	Conidia 24–52×11–14.5 μ m, end cells same sized as
	other cells, verruculoseS. phaeocentron
7.	Conidia uniformly 3-septate, $32-38 \times 11-12 \ \mu m$,
	smooth-walledS. mirabile
7.	Conidia 1–3-septate
8.	Conidia $34-44 \times 10.5-14.5 \ \mu\text{m}$, verruculose, ends
	rounded S. juvenile
8.	Conidia $36-58 \times 10-14 \ \mu\text{m}$, smooth, ends truncated
	S. palauense
9.	The two central cells of conidia distinctly longer than
	the penultimate onesS. nigroseptatum
9.	The four inner cells of the conidia almost of equal
	length10
10.	Conidia $35-45.5 \times 9-11 \mu m$, both ends rounded
	S. longicatenatum
10.	Conidia more than 11 µm wide, both ends trun-
	cated11
11.	Conidia 42–47×12.5–13.5 µmS. hemipsilum
11.	Conidia 37–42×11.5–12.5 µmS. taitense

(**S. daemonoropsis* is known with only teleomorph and not included in the key).

Sporoschisma hemipsilum (Berk. & Broome) Zelski, A.N. Mill. & Shearer, IMA Fungus 5: 433. 2014. Figure 171

≡ Sphaeria hemipsila Berk. & Broome, Bot. J. Linn. Soc. 14: 126, 1873.

≡ Lasiosphaeria hemipsila (Berk. & Broome) Sacc., Syll. Fung. 2: 198, 1883.

 \equiv Chaetosphaeria hemipsila (Berk. & Broome) Petch., Ann. Roy. Bot. Gard. (Peradenija) 6: 336, 1917.

 \equiv *Melanochaeta hemipsila* (Berk. & Broome) E. Müll. et al., Rev. Mycol. 33: 377, 1969.

= Chaetosphaeria coelestina Höhn., Sitzungsber. Akad. Wiss. Wein, Math.-Naturwiss. Kl, 1 Abt. 118: 324, 1909.

= *Sporoschisma saccardoi* E.W. Mason & S. Hughes, Mycol. Pap. 31: 20, 1949.

Description on the natural substrate: Colonies effuse, black, hairy. Mycelium partially immersed and partly superficial, composed of pale brown to brown, septate and branched hyphae. Teleomorph: Not observed. Anamorph: Capitate setae present, erect, straight, smooth, in tufts mixed with conidiophores, 3–5-septate, pale brown to medium brown, paler towards the apex, up to 300 μ m long, 5–6.5 μ m wide, with a swollen apex of 5–10 μ m wide, proliferation absent or up to 5 times, often together with conidiophores arising from a stroma. Teleomorph: Not observed. Anamorph: Conidiophores solitary or rarely in small group of 2-3, associated with 1-3 capitate setae, erect, straight or slightly flexuous, cylindrical, 1-septate at the base but hardly seen due to nearly blackish wall, dark brown to blackish, paler towards the apex, smooth, thickwalled, consists of a stalk with 1 cell and a terminated conidiogenous cell, 200-280 µm long, stalk 10-15 µm wide. Conidiogenous cells monophialidic, terminated, integrated, dark brown to blackish, smooth, consist of a swollen venter and a tubular collarette, transition from venter to collarette gradually, venter subcylindrical, 17.5-20 µm wide; collarette cylindrical, 15–17.5 µm wide, frayed at the apex. Conidia borne in false chain, doliiform to cylindrical, both ends truncated or flattened and thick-walled, medium cells dark brown, end cells lighter but with darker colored and thick wall, smooth, uniformly 5-septate, septa dark brown and $3-5 \ \mu m$ thick, $46-53 \times 13-14 \ \mu m$.

Materials examined: **China**, Beijing, Huairou, Hongluosi, on rotten wood, 29 July 2020, W.P. Wu (17,331); China: Guangdong Province, on submerged rotten wood, 9 October 1998, W.P. Wu (W2081b); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead wood of unidentified plant, 2 January 1997, W.P. Wu (1273b); China, Jilin Province, Changbaishan, on wood of ?*Pinus* sp., 5 September 1998, W.P. Wu (W1739). Living strains: 78,101 and 78,100 (from Wu17331).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: Australia, Brunei Darussalam, Canada, China, Ecuador, Indonesia, Italy, Kenya, Malaysia, Peru, South Africa, Thailand and Europe (Luo et al. (2016).

Description and illustration: Hughes (1949, 1966); Nag Raj and Kendrick (1975); Goh et al. (1997); Zelski et al. (2014); Yang et al. (2016a, b); Luo et al. (2016).

Notes: Sporoschisma hemipsilum is a commonly found species in the genus and was fully described and illustrated by Hughes (1949, 1966), Nag Raj and Kendrick (1975), Goh et al. (1997), Zelski et al. (2014), Luo et al. (2016) and Yang et al. (2016a, b). It can be distinguished from the most closely related species S. nigroseptatum by its four inner cells of the conidia equal in length, while in S. nigroseptatum the two central cells are longer than the penultimate cells (Nag Raj and Kendrick 1975; Goh et al. 1997). The Chinese collection of S. hemipsilum is agreeable with those described from other geographical localities as given by different authors. However, we have seen that the capitate hyphae proliferating up to 5 times in one of the Chinese collections (W1739) and this was not reported earlier. There is a big variation on conidial size among the several examined collections, the specimen Wu1739 has biggest conidia with size of $46-53 \times 13-16 \,\mu\text{m}$, while in specimen Wu2081b the conidia are measured $32-43 \times 11-11.5$ µm. This has also been reported in the different publication, for example,



Fig. 172 Sporoschisma juvenile (Wu1306b). a-e Conidiophores and conidiogenous cells. f-h Conidia. Scale bar: 20 µm

48–60×11–13.5 μ m from Perú by Zelski et al. (2014); 36.5–53×10–13 μ m from Thailand by Yang et al. (2016a, b), 42–47×12.5–13.5 μ m from China by Luo et al. (2016). It might be a species complex that needs to be solved with help of DNA sequence data.

The teleomorph of *Sporoschisma hemipsilum* was known as *Chaetosphaeria hemipsilum*, but this was not found from the Chinese specimens examined here (Hughes 1966; Müller et al. 1969; Nag Raj and Kendrick 1975;

Goh et al. 1997). The ITS sequences obtained from the Chinese collections are 99–100% identical to several sequences from materials collected in other countries. Goh et al. (1997) reported it on submerged wood from Hong Kong. Matsushima (1981) reported it from Taiwan. Recently the species was also reported on the decaying wood submerged in water from mainland China (Luo et al. 2004, 2016, 2020).

Sporoschisma juvenile Boud., Icones Mycologicae 3: 589, 1904. Figure 172

= Sporoschisma aquaticum Z.L. Luo, H.Y. Su & K.D. Hyde, Mycol. Prog. 15: 1148, 2016.

Description on the natural substrate: Colonies effuse, black, hairy. Mycelium partially immersed and partly superficial, composed of pale brown to brown, septate and branched hyphae. Teleomorph: Not observed. Anamorph: Capitate setae present, erect, straight, smooth, in tufts mixed with conidiophores, 2-4-septate, pale brown to medium brown, paler towards the apex, 100–125 µm long, 5-7 µm wide, with a swollen apex of 7-10 µm wide. Conidiophores solitary or in small group of 2-3, associated with 1-3 capitate setae, erect, straight or slightly flexuous, cylindrical, septate but hardly seen due to nearly blackish wall, dark brown to blackish, paler towards the apex, smooth, thick-walled, 175-225 µm long, consists of a stalk with 2 cells and a terminated conidiogenous cell, stalk up to 8 µm wide with a swollen basal cell of 12-15 µm wide. Conidiogenous cells monophialidic, terminated, integrated, dark brown to blackish, smooth, 100-125 µm long, consist of a swollen venter and a tubular collarette, transition from venter to collarette abrupt, venter ellipsoidal to subcylindrical, 17-20 µm wide; collarette cylindrical, 12.5-13 µm wide, frayed at the apex. Conidia borne in false chain, cylindrical, both ends rounded or subtruncated or flattened, pale brown to brown, verruculose, concolorous, 1-3-septate but mostly 3-septate, $30-38 \times 10-12 \,\mu m$.

Material examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead wood of unidentified plant, 2 January 1997, W.P. Wu (Wu1306b).

Ecology/Substrate/Host: Saprobe on dead material of plants including *Alnus*, *Angelica*, *Fagus*, *Fraxinus*, *Hedera*, *Quercus*, *Sorbus* and other plants.

Geographical distribution: Australia, China, Czechoslovakia, France, Hong Kong, Perú, Seychelles and UK (Luo et al. (2016).

Description and illustration: Hughes (1949); Nag Raj and Kendrick (1975); Goh et al. (1997); Zelski et al. (2014); Luo et al. (2016).

Notes: *Sporoschisma juvenile* differs from other species in the genus by its abrupt transition from venter to collarette in conidiogenous cells, and 3-septate conidia with verruculose wall (Hughes 1949; Goh et al. 1997; Zelski et al. 2014; Luo et al. 2016). In a recent study, Luo et al. (2016, 2019) reported the occurrence of *S. juvenile* on submerged wood with smaller conidia size $(25-31 \times 9-10 \ \mu\text{m})$. *Sporoschisma aquaticum*, morphologically similar to *S. juvenile*, was treated as a synonym of *S. juvenile* (Luo et al. 2016, 2019). It is a common species and has been recorded on various plant species. The species was reported in Hong Kong (Lu et al. 2000) and mainland China (Lupo et al. 2016, 2019). *Sporoschisma longicatenatum* J. Yang, J.K. Liu & K.D. Hyde, Phytotaxa 289: 152, 2016. Figure 173

Description on the natural substrate: Colonies effuse, black, hairy, with long chains of conidia. Mycelium immersed, composed of pale to dark brown hyphae. Teleomorph: Unknown. Anamorph: Capitate hyphae scattered or in groups mixed with conidiophores, capitate, usually surrounded by hyaline mucilage at the swollen apex, smooth, pale to medium brown, paler towards the subhyaline apex, straight or flexuous, 2-septate, $80-120 \times 4-5 \mu m$, $6-8 \mu m$ wide at the swollen apex. Conidiophores smooth, dark brown to black, straight or slightly flexuous, solitary or in groups of 2-3, arising from dark brown to black bulbous base, composed of a cylindrical stipe and a swollen venter with a long cylindrical neck, erect, sometimes proliferating percurrently, 180–242 μ m long; basal part 45–60 \times 5–6.5 μ m; phialides 152-174 µm long. Conidiogenous cells monophialidic, integrated, terminal, brown, lageniform, frayed at the apex, 150–174 μ m long; venter 34–27 \times 14–18 μ m; collarette $110-125 \times 10-12 \mu m$. Conidia cylindrical to doliiform, (25-) $30-39 \times 8.5-10 \mu m$, (4–)5-euseptate, hyaline when young, olivaceous to brown at maturity, with hyaline to pale brown end cells, which are much shorter than the four inner cells, conspicuously darkened at the septa, rounded at both ends.

Materials examined: **China**, Guangdong Province, Guangzhou, Baiyunshan, on rotten seed pod of unidentified *Leguminosae*, 5 February 2012, W.P. Wu (Wu12046); Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead stem of unidentified plant, 2 January 1997, W.P. Wu (Wu1306k). Living strains: 42822 (from Wu1306k), 54250 and 54415 (from Wu12046).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China and Thailand (Yang et al. 2016a, b).

Description and illustration: Yang et al. (2016a, b).

Notes: *Sporoschisma longicatenatum* is a recently described species on submerged wood in freshwater from Thailand (Yang et al. 2016a, b). Morphologically *S. logicatenatum* and *S. hemipsilum* are very similar and can be distinguished by the conidia with rounded ends in *S. longicatenatum* and more or less truncated ends in *S. hemipsilum*. The ITS sequences obtained from the Chinese collections are 100% identical to those ones from the type specimen.

Sporoschisma mirabile Berk. & Broome, Gard. Chron.: 540, 1847. Figure 174

 \equiv *Chaetosphaeria aotearoae* S. Hughes, N. Z. J. Bot. 4: 78, 1966.

≡ *Melanochaeta aotearoae* (S. Hughes) E. Müll., Harr & Sulmont, Rev. Mycol. (Paris) 33: 378, 1969.

Description on the natural substrate: Colonies effuse, black, hairy. Mycelium partially immersed and partly



Fig. 173 Sporoschisma longicatenatum (Wu12064). **a–d, f–h** Capitate hyphae, conidiophores, conidiogenous cells and conidia. e Conidia. Scale bar: **a–d** 20 μm, **e–h** 10 μm



Fig. 174 Sporoschisma mirabile (Wu7273). a, b, d Setae and conidiophores. e-g Setae. c, hl Conidia. Scale bar: a-g 20 µm, h-l 10 µm

superficial, composed of pale brown to brown, septate and branched hyphae. Teleomorph: Not observed. Anamorph: Capitate setae present, erect, straight, smooth, in tufts mixed with conidiophores, 3–4-septate, pale brown to medium brown, paler towards the apex, 100–125 μ m long, 5–7 μ m wide, with a swollen apex of 7–9 μ m wide. Conidiophores solitary or in small group of 3–4, associated with 1–6 capitate setae, erect, straight or slightly flexuous, cylindrical, septate but hardly seen due to nearly black-ish wall, dark brown to blackish, paler towards the apex,

smooth, thick-walled, consists of a stalk with 2–3 cells and a terminated conidiogenous cell, 150–200 μ m long, stalk up to 10 μ m wide with a swollen basal cell of 15–18 μ m wide. Conidiogenous cells monophialidic, terminated, integrated, dark brown to blackish, smooth, consist of a swollen venter and a tubular collarette, transition from venter to collarette gradually, venter ellipsoidal, 15–20 μ m wide; collarette cylindrical, 11–14 μ m wide, frayed at the apex. Conidia borne in false chain, cylindrical, both ends truncated or flattened and thick–walled, medium brown to dark brown,



Fig. 175 Sporoschisma nigroseptatum (2074c). **a–c, f, g** Conidiophores and conidiogenous cells. **d** Capitate hyphae. **e, h–m** Conidia. Scale bar: 20 μm

smooth, concolorous, uniformly 3-septate, septa dark brown and $3-5 \mu m$ thick, $32-38 \times 11-12 \mu m$.

Materials examined: **China**, Hubei Province, Shennongjia, on dead branches, Sept 2004, W.P. Wu (Wu8098a, Wu8161a, Wu8174a, Wu8174b, Wu8273, Wu8276b, Wu8307d); Yunnan Province, Xishuangbanna, on dead branches, 16 October 1999, W.P. Wu & Yan Huang (Wu2930b). Living strain: 50702 (from Wu8273).

Ecology/Substrate/Host: Saprobe on dead material of plants including Alnus, Bambusa, Beilschmiedia, Corynocarpus, Dysoxylum, Epilobium, Fagus, Fraxinus, Freycinetia, Knightia, Melicytus, Neopanax, Quercus, Rhipogonum, Rhapalostylis, Salix, Sorbus, Ulmus and many other plants.

Geographical distribution: China, Belgium, Canada, France, Germany, New Zealand, UK and USA.

Description and illustration: Hughes (1949, 1966); Nag Raj and Kendrick (1975); Goh et al. (1997); Luo et al. (2016).

Notes: *Sporoschisma mirabile* Berk. & Broome was fully described and illustrated by Hughes (1949), Nag Raj and Kendrick (1975), Goh et al. (1997) and Luo et al. (2016). It differs from the most closely related species *S. juvenile* by its smooth-walled, darker and wider conidia with truncated or flattened ends and gradual transition from venter to collarette. The teleomorph of *S. mirabile* was described as *Melanochaeta aotearoae* (*= Chaetosphaeria aotearoae*), and it was also found from one of the Chinese specimens (Wu8273) examined here (Hughes 1966; Müller et al. 1969).

Sporoschisma mirabile is another commonly found species on many different plant species and with broad distribution, Goh et al. (1997) reported it on dead culms of *Bambusa* sp. from Hong Kong and Matsushima (1980) reported its occurrence in Taiwan. More recently the species was also reported on submerged decaying wood in Yunnan, mainland China (Luo et al. 2016).

Sporoschisma nigroseptatum D. Rao & R. Rao, Mycopath. Mycol. Appl. 24: 82, 1964. Figure 175

Description on the natural substrate: Colonies effuse, black, hairy. Mycelium partially immersed and partly superficial, composed of pale brown to brown, septate and branched hyphae. Teleomorph: Not observed. Anamorph: Capitate setae present, erect, straight, smooth, in tufts mixed with conidiophores, 3–4-septate, pale brown to medium brown, paler towards the apex, up to 200 μ m long, 4–5 μ m wide, with a swollen apex of 7–9 μ m wide, proliferation absent or up to 3 times, often together with conidiophores arising from a stroma. Conidiophores solitary or rarely in small group of 2–3, associated with 0–3 capitate setae, erect, straight or slightly flexuous, cylindrical, 2-septate at the base but hardly seen due to nearly blackish wall, dark brown to blackish, paler towards the apex, smooth, thick-walled, consists of a stalk with 1–2 cell and a terminated conidiogenous cell, 250–300 μ m long, stalk 10–14 μ m wide. Conidiogenous cells monophialidic, terminated, integrated, dark brown to blackish, smooth, consist of a swollen venter and a tubular collarette, transition from venter to collarette gradually, venter subcylindrical, 17–22.5 μ m wide; collarette cylindrical, 17–20 μ m wide, truncated at the apex. Conidia borne in false chain, doliiform to cylindrical, both ends truncated or flattened and thick-walled, medium cells dark brown, end cells lighter but with darker colored and thick wall, smooth, uniformly 5-septate, septa dark brown and 2–3.5 μ m thick, 30–38 × 13.5–14 μ m; the two central cells (7–12 μ m long) are distinctly longer than the penultimate cells (5–6 μ m long).

Materials examined: **China**, Guangdong Province, on submerged rotten wood, 9 October 1998, W.P. Wu (Wu1976a, Wu2074a).

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China, Australia, India, Japan and New Zealand (Luo et al. (2016).

Description and illustration: Rao and Rao (1964); Hughes (1966); Nag Raj and Kendrick (1975); Bhat and Sutton (1985a); Morgan-Jones et al. (1992); Goh et al. (1997); Luo et al. (2016).

Notes: *Sporoschisma hemipsilum* (= *S. saccardoi*) also produce 5-septate, versicolored, smooth-walled conidia, but in this species the four inner cells of the conidia are equal in length (Hughes 1966; Goh et al. 1997). *Sporoschisma nigroseptatum* seems to be a tropical species, and less commonly found than *S. hemipsilum*. The species was fully described and illustrated by Hughes (1949, 1966), Nag Raj and Kendrick (1975), Goh et al. (1997) and Luo et al. (2016). Goh et al. (1997) reported it on submerged wood from Hong Kong. Luo et al. (2016) reported its occurrence on decaying wood submerged in a stream in Yunnan, mainland China. Its occurrence in Taiwan was also reported (Chen 1994). No living strain and DNA sequence are available for comparison with *S. hemipsilum* and other related species.

Sporoschisma parcicuneatum Goh & K.D. Hyde, Mycol. Res. 101: 1298, 1997. Figure 176

Description on the natural substrate: Teleomorph: Not observed. Anamorph: Capitate setae absent. Conidiophores solitary or in small group of 2–5, erect, straight or slightly flexuous, subcylindrical, 2-septate but hardly seen due to nearly blackish wall, dark brown to blackish, paler towards the apex, smooth, thick-walled, consists of a stalk with 2 cells and a terminated conidiogenous cell, up to 200 μ m long, stalk up to 5–10 μ m wide, arising from dark brown to blackish bulbous basal stromata 10–18 μ m wide. Conidiogenous cells monophialidic, terminated, integrated, dark brown to blackish, smooth, 100–125 μ m long, consist of a swollen venter and a tubular collarette, transition from



Fig. 176 Sporoschisma parcicuneatum (Wu2209). a–e, g, h, j, l, m Conidiophores and conidiogenous cells. f Hyaline and young conidia. i, k, o–r Conidia. Scale bar: 20 μm

venter to collarette abrupt, venter ellipsoidal to subcylindrical, 13–15 μ m wide; collarette cylindrical, 12–13 μ m wide, frayed at the apex. Conidia borne in false chain, slightly cuneate, subcylindrical, slightly rounded or flattened at both ends, pale brown to medium brown, finely spinulose, concolorous, 1-septate, rarely 2-septate, 20–27×10–13.5 μ m.

Material examined: **China**, Guangdong Province, on submerged rotten wood, 9 October 1998, W.P. Wu (Wu2209). Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China and Philippines (Goh et al. 1997).

Description and illustration: Goh et al. (1997).

Notes: *Sporoschisma parcicuneatum* was originally described on submerged wood from Philippines by Goh et al. (1997). The species is characterized by absence of capitate setae, abrupt transition from venter to collarette in

conidiogenous cells, and 1-septate, cuneate conidia. No living strain and DNA sequence are available for comparison.

Sporoschisma phaeocentron W.H. Ho, K.D. Hyde & Goh, Mycol. Res. 101: 1299, 1997.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Luo et al. 2016) and Malaysia (Goh et al. 1997).

Description and illustration: Goh et al. (1997); Luo et al. (2016).

Notes: *Sporoschisma phaeocentron* was originated described from Malaysia (Goh et al. 1997). Its occurrence in China was recently reported from the submerged decaying wood collected in a stream in Cangshan Mountain, Yunnan, China (Luo et al. 2016). No living strain and DNA sequence are available for comparison.

Sporoschisma taitense (Mugambi & Huhndorf) A.N. Mill., IMA Fungus 7: 133, 2016.

 \equiv Melanochaeta taitensis Mugambi & Huhndorf, Sydowia 60: 263, 2008.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Luo et al. 2016) and Kenya (Mugambi and Huhndorf 2008).

Description and illustration: Mugambi and Huhndorf (2008); Luo et al. (2016); Réblová et al. (2016).

Notes: *Sporoschisma taitense* was originally described from Kenya and recently also recorded from China (Mugambi and Huhndorf 2008; Luo et al. 2016). *Sporoschisma taitense* is morphologically similar to *S. nigroseptatum* in having cylindrical to doliiform, 5-septate, smooth conidia with four inner cells dark brown and the two end cells hyaline to pale brown, but differs from it in the conidia without conspicuous, spherical guttulate. Furthermore, the phylogenetic analysis based on combined ITS and LSU sequence data also showed they belong to two different species.

Sporoschisma uniseptatum Bhat & W.B. Kendr., Mycotaxon 49: 71, 1993.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China (Lu et al. 2000), India (Bhat and Kendrick 1993) and Seychelles (Goh et al. 1997).

Illustration: Bhat and Kendrick (1993); Goh et al. (1997).

Notes: No specimen of this species was seen by us. *Sporoschisma uniseptatum* is characterized by presence of capitate setae, gradually transition from venter to collarette in conidiogenous cells, and 1-septate, cylindrical conidia. The species was originally described on decaying twigs from India, and later reported by Goh et al. (1997) on submerged

wood from Philippines. Lu et al. (2002) recorded its occurrence in Hong Kong.

Stephembruneria Castañeda, Fungi Cubenese III: 14, 1988. Colonies effuse, hairy, dark brown. Teleomorph: Unknown. Anamorph: Conidiophores solitary, erect, dark brown, proliferation percurrently or occasionally sympodially. Conidiogenous cells integrated, terminal, monophialidic or polyphialidic, cylindrical to clavate; collarettes cylindrical, with narrower sporulating loci. Conidia holoblastic, acrogenous, solitary, ellipsoidal, obtuse at apex, base with a distinct scar, septate, dark brown, smooth.

Type species: Stephembruneria elegans Castañeda.

Ecology/Substrate/Host: Saprobe on dead material of plants.

Geographical distribution: China and Cuba Castañeda-Ruiz (1988).

Description and illustration: Castañeda-Ruiz (1988).

Notes: The genus *Stephembruneria* was originally described for a dematiaceous hyphomycetes found on dead culms of unidentified Gramineae species from Cuba. It is characterized by solitary and cylindrical conidiophores, mono- or polyphialidic conidiogenesis cells with cylindrical collarettes and narrow sporulating loci, and brown multiseptate conidia (Castañeda-Ruiz 1988). *Kylindria, Xenokylindria* and *Paradischloridium* are the related genera with similar conidiogenesis. However, in *Kylindria* and *Xenokylindria* the conidia are hyaline; and in *Paradischloridium* the collarettes in conidiogenous cells are cup-shaped and as broad as conidiogenous cell body (DiCosmo et al. 1983; Bhat and Sutton 1985a; Castañeda-Ruiz 1988).

Stephembruneria microsperma W.P. Wu & Y.Z. Diao, sp. nov., Fig. 177, MycoBank MB841616.

Etymology: Refers to it small conidia.

Diagnosis: Similar to the type species of the genus, but differs in producing smaller conidia.

Typification: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead branches of unidentified plant, 2 January 1997, W.P. Wu, Holotype HMAS 352,055 (=Wu1318a), ex-type strain NN 43126.

Description on the natural substrate: Colonies effuse, hairy, dark brown. Teleomorph: Unknown. Anamorph: Conidiophores solitary, erect, straight or slightly flexuous, unbranched, cylindrical, 3–5-septate, smooth at the lower part, verruculose at the upper part, dark brown, blackish at the base, percurrently or sympodially proliferating, paler towards the apex, 250–270 μ m long, 7–8 μ m wide, with a swollen base up to 30 μ m wide. Conidiogenous cells integrated, terminal, mono- or poly-phialidic, cylindrical or slightly clavate, brown, becoming paler towards the apex, smooth or verruculose, 30–45 μ m long, 8–10 μ m wide at the widest distal end; collarettes cylindrical, 2–2.5 μ m long and



Fig. 177 *Stephembruneria microsperma* (Wu1318a, holotype). **a–e** Conidia. **f**, **g** Conidiophores. **h–m** Part of conidiophores and terminal condiogenous cells. Scale bar: **a**, **b** 20 μm, **c–g**, **h–m** 10 μm

2.5–3 µm wide. Conidia holoblastic, solitary, accumulating in dry masses at the apices or sometimes sliding down along the sides of conidiogenous cells after secession, ellipsoidal, obtuse at apex, base with a distinct scar of 1.5 µm wide, (6–)7-septate, medium to dark brown, apical and basal cells subhyaline, thin-walled, smooth, $27-31 \times 11-12 \mu m$.

Otrher materials examined: China, Guangdong Province, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (Wu2217); Guangxi Province, Shiwandashan, on dead culms of bamboo, 29 December 1997, W.P. Wu (Wu1515); Guangxi Province, Damingshan, on dead stem of grass, 19 December 1997, W.P. Wu (Wu1444); Guangxi Province, Shiwandashan, on dead culms of bamboo, 31 December 1997, W.P. Wu (Wu1605e).

Ecology/Substrate/Host: Saprobe on dead culm of bamboo.

Geographical distribution: China.

Notes: Stephembruneria microspora is very similar to the type species S. elegans, but has smaller conidia than those in S. elegans (30-43×10-13 µm, by Castañeda-Ruiz 1988; Li 2016). The smaller conidia were constantly found from all examined collections from China. In addition, the conidiophores in the S. elegans are also longer. The similar fungus was reported from China under S. elegans R.F. Castañeda by Ma et al. (2012), where the author also reported the smaller conidia $(26.5-33.5 \times 10-11.5 \ \mu\text{m})$ from their material on dead branches of Ficus benjamina, collected in Hainan Province.

Phylogenetically, Stephembruneria microspora is closely related to members of Chaetosphaeriaceae. On a megablast search using the ITS sequences from the strain obtained from the ex-type strain, the closest matches in NCBI's GenBank nucleotide database were members of Phialocephala, Chaetosphaeria, Nawawia and Phialophora in Chaetosphaeriaceae, including *Phialocephala* sp. (GenBank AB671500, 85% identity), Chaetosphaeria dilabens (Gen-Bank MH861683, 84% identity.

Genera with synnematous conidioma

Five genera among the 89 accepted chaetosphaeriaceous fungal genera form synnematous conidiomata. These genera are Arcuatospora, Menisporopsis, Phialoarthrobotryum, Phialosporostilbe, Polynema, and some species of Thozetella (Nag Raj 1978; Seifert et al. 2011).

Phylogenetically all these genera are well-defined monophyletic genera, but polyphyletic in the phylogenetic trees generated by using the combined data set of ITS and LSU (Fig. 3). Morphologically most of these genera are also welldelimited by a combination of morphological characters of setae, conidiophores, conidiogenous cells and conidia. Living strains of many studied species were also studied on PDA, some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Key to synnematous genera of anamorphic chaetosphaeriaceous fungi:

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Arcuatospora Réblová & Hern.-Restr., J. Fungi 7 (6. No 438): 8, 2021.

Colonies on the natural substrate effuse, hairy. Teleomorph: Unknown. Anamorph: Conidiomata synnematous. Setae erect, straight, arise singly from a discoid, pseudoparenchymatous subiculum, dark brown to black, opaque, thick-walled, paler and thinner-walled at the apex, apex sterile, broadly rounded, occasionally terminating into a phialide. Conidiophores macronematous, synnematous, closely bound, parallel, unbranched, brown, synnemata arise around the base of the seta, surrounds the seta, diverge from it towards their apices and become unilateral. Conidiogenous cells integrated, terminal, mono- or polyphialidic, extending percurrently and sympodially, paler than the conidiophores; collarettes subhyaline, cup-shaped or funnel-shaped. Conidia falcate, slightly truncate at the base with a basal scar, 1-septate, hyaline, with a straight or gently curved setula at each end, inserted terminally at the apex, subterminally at the base, conidia accumulate in slimy fascicles (Adapted from Réblová et al. 2021b).

Type species: Arcuatospora novae-zelandiae (S. Hughes & W.B. Kendr.) Réblová & Hern.-Restr.

Ecology/Substrate/Host: Saprobe on dead leaves of plant. Geographical distribution: Widely distributed in subtropi-

cal and tropical areas, including Australia, Brazil, China,


Fig. 178 Maximum likelihood (ML) tree based on ITS sequence data for the genus *Arcuatospora*. Bootstrap support values \geq 60%, Bayesian posterior probability values \geq 0.95 are shown at the nodes. *Chaetosphaeria ciliate* CBS122131 was chosen as the outgroup. Ex-type

Costa Rica, Cuba, Ecuador, Japan, Mexico, Nepal, New Zealand, Kenya and Venezuela.

Description and illustration: Réblová et al. (2021b).

Note: The genus *Arcuatospora* was established for *Menisporopsis novae-zelandiae* and three other species which are morphologically similar to *Menisporopsis*, but phylogenetically unrelated to the lineage containing *M. theobromae* and other species of *Menisporopsis* (Réblová et al. 2021b). The transversely 1-septate conidia with simple setulae and synnemata surrounding the seta becoming unilateral towards their apices are the main diagnostic characteristics of the genus to distinguish it from *Menisporopsis*. Our phylogenetic analysis based on the Chinese materials supports the above separation (Figs. 3, 178). In total seven species of *Arcuatospora* were discovered from China.

Members of the genus are saprobes on decaying leaves, petioles and fruits of various host plants. They have been reported worldwide from freshwater and terrestrial biotopes in subtropical and tropical geographical areas (Hughes 1952; Pirozynski and Hodges 1973; Varghese and Rao 1978; Rao and de Hoog 1986; Seifert et al. 2011). The living strains were also studied on PDA (Fig. 179), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

strains are indicated with "T" in the end of the taxa labels. Latin names and ex-type strain numbers of the new species described in the current study are shown in font

Arcuatospora ellisii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 180, MB841617.

Etymology: Named after the former IMI mycologist M.B. Ellis for his contribution to anamorphic fungi.

Diagnosis: Similar to *Arcuatospora hughesii* in smaller conidia but differs in not curved collarettes; Similar to *A. sinensis* but differs in ITS sequences.

Typification: **China**, Guangdong Province, Shenzhen, Lianhuashan Park, on dead leaves of *Cinnamomum* sp., 15 November 2019, W.P. Wu, Holotype HMAS 351957 (= Wu17147), ex-type strain CGMCC 3.20745 (= NN77699).

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnematous, solitary, erect, straight or flexuous, basal stroma 20–25 μ m diam. Setae cylindrical, erect, straight, unbranched, dark brown to blackish, becoming paler toward the apex, up to 16 septa, smooth- and thick-walled, 160–295 μ m long, 4.5–6 μ m wide, apex 3–4 μ m, sterile and terminated with a rounded apex, sitting not in the middle of conidiophores. Conidiophores closely compacted into synnemata; synnemata brown, 75–87 μ m high, 8–13 μ m wide in the lower part, 15–20 μ m wide in the upper fertile



Fig. 179 Colony of Arcuatospora species on PDA after 20 days at 25 °C. **a**, **b** Arcuatospora ellisii (ex-type strain 77541). **c**, **d** A. hughesii (ex-type strain 54242). **e**, **f** A. lunata (ex-type strain 77700).

region; conidiophores cylindrical, erect, straight of flexuous, unbranched or branched, pale to medium brown, septate, smooth- and thick-walled, 70–90 µm high, 1.2–1.5 µm wide,

yunnanensis (47742)

terminating in a conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, lageniform, erect, straight, thin-walled, $20-25 \times 2.5-3 \mu m$, periclinal thickening obvious, collarette funnel-shaped and conspicuous, $1.5-2.5 \mu m$ wide, up to $1.5 \mu m$ deep. Conidia holoblastic,

aggregated in white slimy heads around the conidiogenous cells, hyaline, 1-setptate, smooth- and thin-walled, lunate, fusiform, straight or slightly curved, $13-14.5 \times 2-2.3 \mu m$, base slightly truncated, apex rounded or obtuse, appendiculate with one setula of 5–6.5 µm long at each end.

g-j A. septata (g-h ex-type strain 47512. i-j 50638). k, l A. sinensis

(ex-type strain 57331). m, n A. suttonii (ex-type strain 78459). o, p A.

Culture characteristics: Colonies on PDA effuse, colonies 1.2–1.6 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, soil brown, with



Fig. 180 Arcuatospora ellisii (Wu17244). a-c Conidiomata with setae and synnemata. d Synnemata, conidiophores and conidiogenous cells with funnel-shaped collarette. e-l Conidia. Scale bar: a-c 20 μ m, d 10 μ m, e-l 5 μ m



Fig. 181 Arcuatospora hughesii (Wu12237, holotype). **a–c** Synnematous conidiomata with setae. **d** Upper part of the synnemata with conidiogenous cells. **e–i** Conidiophores and conidiogenous cells. **j–s** Conidia. Scale bar: **a–c** 40 µm, **d** 20 µm, **e–s** 10 µm

pale colored margin, reverse pale brown to soil brown (Fig. 179a, b).

Other materials examined: **China**, Guangdong Province, Shaoguan, Danxiashan, on dead leaves of unidentified tree, 25 December 2012, W.P. Wu (12,497); Guangdong Province, Shenzhen, Lianhuashan Park, on dead leaves of unidentified tree, 11 November 2019, W.P. Wu (Wu17244). Living strains: 55,346 (from Wu12497), 77,699 (from Wu17244).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Arcuatospora ellisii* is phylogenetically closely related to other species in the genus. Morphologically it resembles other species on appearance of conidiomata, but differs from them by monophialidic conidiogenous cells, lunate or fusiform conidia in smaller size (Hughes and Kendrick 1968; Réblová et al. 2021b). Variations on conidial size were observed among different collections.

Arcuatospora hughesii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 181, MycoBank MB841619.

Etymology: Named after the Canadian mycologist S.J. Hughes.

Diagnosis: Similar to other species in the genus, but differs in curved collarettes, and smaller conidia $(14-15.5 \times 2-2.5 \ \mu\text{m})$ with shorter setulae (6–8 $\mu\text{m})$.

Typification: **China**, Guangdong Province, Guangzhou, Yuexiu Park, on dead leaves of unidentified tree, 2 March 2012, W.P. Wu, Holotype HMAS 351958 (=Wu12237), extype strain CGMCC 3.20646 (=NN54242).

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight or flexuous, basal stroma 30-35 µm diam. Setae cylindrical, erect, straight, unbranched, dark brown to blackish, becoming paler toward the apex, septate, smooth- and thick-walled, $250-300 \times 5-7 \mu m$, apex rounded and $2.5-3 \mu m$ wide, sitting not in the middle of conidiophores. Conidiophores closely compacted into synnemata; synnemata brown, 11-17 µm wide; conidiophores cylindrical, erect, straight or flexuous, unbranched, or branched, pale to medium brown, septate, smooth- and thick-walled, $130-150 \times 2-3.5 \mu m$, terminating in a conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, lageniform, erect, straight, thin-walled, 18-25 µm long, 2.5-3.5 µm wide, periclinal thickening obvious, collarette funnel-shaped and conspicuous, 1–2 µm wide, 1–1.5 µm long. Conidia holoblastic, aggregated in white slimy heads around the conidiogenous cells, hyaline, 1-setptate, smooth- and thin-walled, falcate, fusiform, curved, $14-15.5 \times 2.0-2.5 \mu m$, base slightly

truncated, apex acute, appendiculate with one setula of $6-8 \ \mu m$ long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 0.7–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse pale brown to brown (Fig. 179c, d).

Ecology/Substrate/Host: Saprobe on dead leaves of plant. Geographical distribution: China.

Notes: Arcuatospora hughesii is similar to A. novaezelandiae in having 1-septate conidia with a single setulae at each end. However, in A. novae-zealandiae, the conidiophores are closely packed together, the conidiogenous cells are monoblastic, and the conidia are much bigger (17–20 μ m long) and with longer setulae (9–12 μ m) (Hughes and Kendrick, 1968; Réblová et al. 2021b). In addition, the ITS sequences for those two species are significantly different.

Arcuatospora lunata W.P. Wu & Y.Z. Diao, sp. nov., Fig. 182, MycoBank MB841620.

Etymology: Refers to its lunate conidia.

Diagnosis: Similar to *Arcuatospora suttonii*, but differs in a combination of cylindrical conidiogenous cell with funnel-shaped collarette, lunate conidia with tapering ends and unique ITS sequence.

Typification: **China**, Guangdong Province, Shenzhen, Lianhuashan Park, on dead leaves of unidentified tree, 11 November 2019, W.P. Wu, Holotype HMAS 351959 (=Wu17248), ex-type culture CGMCC 3.20750 (=NN77700).

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight or flexuous, basal stroma 25-30 µm diam. Setae cylindrical, erect, straight, unbranched, dark brown to blackish, becoming paler toward the apex, 8-13-septate, smooth- and thick-walled, 150–300 µm long, 6–8 µm, apex rounded and 4–5 µm, sitting not in the middle of conidiophores. Conidiophores closely compacted into synnemata; synnemata brown, 10-12 µm wide in the lower part, 17-22 µm wide in the upper fertile region; conidiophores cylindrical, erect, straight of flexuous, unbranched or branched, pale to medium brown, septate, smooth- and thick-walled, 60-120 µm high, 1.2-1.5 µm wide, terminating in a conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, cylindrical, clavate, erect, straight, thin-walled, $13-18 \times 3-3.5 \,\mu m$ long, periclinal thickening obvious, collarette funnel-shaped and conspicuous, 1.5-3 µm wide, up to 1.5 µm deep. Conidia holoblastic, aggregated in white slimy heads around the conidiogenous cells, hyaline, 1-septate, smooth- and thinwalled, lunate, fusiform, curved, $14-17 \times 2-2.3 \mu m$, base



Fig. 182 Arcuatospora lunata (Wu17248, holotype). **a–c** Synnematous conidiomata with setae. **d–i** Conidia. **j–l** Upper part of the synnemata with conidiophores and conidiogenous cells. Scale bar: **a–c** 20 μ m, **d–l** 10 μ m



Fig. 183 Arcuatospora novae-zelandiae (Wu7249). **a–e** Synnamatous conidiomata with setae. **f** Upper part of setae. **g** Upper part of synnemata with phialidic conidiogenous cells. **h–o** Conidia. Scale bar: **a–c** 40 µm, **d, e** 20 µm, **f–o** 5 µm

slightly truncated, apex acute, appendiculate with one setula of $5-7 \mu m$ long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 1-1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, with pale colored margin, reverse pale brown to yellow brown (Fig. 179e, f).

Other material examined: **China**, Guanxi Province, Nanning, Subtropical Botanical Garden, on dead leaves of unidentified tree, 15 November 2013, W.P. Wu (Wu13145). Living strain: 57,467 (from Wu13145).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Arcuatospora lunata resembles A. suttonii, A. novae-zelandiae and A. hughesii in having 1-septate conidia with a single setula at each end. In A. hughesii, the conidiophores in the fertile region of the synnemata are not closely packed, the conidiogenous cells are usually polyphialidic, and the conidia are smaller $(14-15.5 \times 2.0-2.5 \ \mu\text{m})$. In A. novae-zealandiae, the conidia are slightly larger $(17-20 \ \mu\text{m})$ long) and with longer setulae $(9-12 \ \mu\text{m})$ (Hughes and Kendrick 1968; Réblová et al. 2021b). The conidia in A. suttonii are slightly longer and wider than those in A. lunata. In addition, the ITS sequences for those four species are significantly different.

Arcuatospora novae-zelandiae (S. Hughes & W.B. Kendr.) Réblová & Hern.-Restr., J. Fungi 7: 8, 2021. Figure 183

 \equiv Menisporopsis novae-zelandiae S. Hughes & W.B. Kendr. N. Z. J. Bot. 6: 369, 1968.

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight, or flexuous. Setae cylindrical, erect, straight, unbranched, dark brown to blackish, becoming paler towards the apex, septate but hardly seen due to heavy pigmentation, smooth- and thick-walled, apex acute, $180-300 \times 8-9 \mu m$, normally not sitting in the middle of conidiophores. Conidiophores closely compacted into synnemata, cylindrical, erect, straight of flexuous, unbranched, pale to medium brown, septate, smooth- and thick–walled, $80–150 \times 1.5–2 \,\mu m$, terminating in a conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, lageniform, single, erect, straight or curved, thin-walled, periclinal thickening obvious, collarette inconspicuous, 3-3.5 µm wide, collarette up to 1.5 µm wide. Conidia holoblastic, aggregated in white slimy heads around the conidiogenous cells, hyaline, uniseptate, smooth- and thin-walled, falcate, fusiform, curved, $17-20 \times 1.8-2.5 \mu m$, base truncated, apex acute, appendiculate with one setula of $9-12 \ \mu m$ long at each end.

Materials examined: **China**, Hubei Province, Shennongjia, on dead leave of unidentified tree, 19 September 2004, W.P. Wu (Wu7050); Yunnan Province, Simao, On dead leaves, 13 October 1999, W.P. Wu & Yan Huang (WU2814b); Yunnan Province, Baoshan, Lujiang, Bawan, Gaoligongshan, on dead fruit of *Quercus* sp., 15 October 2013, W.P. Wu (Wu7249).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Australia, Brazil, China, Costa Rica, Cuba, Ecuador, Japan, Mexico, Nepal, New Zealand, Kenya, and Venezuela. Probably widely distributed in tropical and subtropical area Réblová et al. (2021b).

Description and illustration: Hughes and Kendrick (1968); Cruz et al. (2014); Réblová et al. (2021b).

Notes: As already known in literatures, Arcuatospora novae-zelandiae exhibits distinctive characteristics, such as conidiophores forming lateral to the seta near the apex, and 1-septate conidia with one setula at each end (Hughes & Kendrick 1968; Réblová et al. 2021b); but also showed some minor variation on setae, conidiophore and conidial morphology among specimens collected from different sites, for example, Arias et al. (2010) collected specimens with polyphialidic conidiogenous cells and larger conidia. Matsushima (1975) also reported the presence of larger conidia. The dimensions of the morphological structures of A. novae-zelandiae from Chinese material agree with the original description, variations on size of setae and conidiophores, conidial shape and size are also seen among different specimens from China. The fungus was described from dead leaves of Sycopsis sinensis from China (Li et al. 2012). Its occurrence in Taiwan was also reported (Matsushima 1980). The species has been recorded from many countries, but their identity to the type specimen needs to be confirmed by comparative study on morphology and phylogeny (Hughes and Kendrick 1968; Matsushima 1975, 1980, 1989, 1993; Mercado Sierra et al. 1997a, b; Castañeda-Ruiz et al. 2001; Delgado et al. 2002; Arias et al. 2010; Almeida et al. 2011; Cruz et al. 2014).

Arcuatospora septata W.P. Wu & Y.Z. Diao, sp. nov., Fig. 184, MycoBank841622.

Etymology: Refers to the septate conidia.

Diagnosis: Similar to other species in the genus, but differs in producing short conidiogenous cells with inconspicuous collarette, and relatively large conidia $(16.5-19(-21) \times 2.4-2.6 \ \mu\text{m})$ with longer setulae at both ends $(7-10 \ \mu\text{m} \ \text{long})$.

Typification: **China**, Hunan Province, Chen Zhou, Yizhang County, Mangshan, on dead leaves of unidentified tree, 10 April 2002, W.P. Wu, Holotype HMAS 351960 (= Wu6039c), ex-type strain CGMCC 3.20644 (= NN47512).



Fig. 184 *Arcuatospora septata* (Wu6039c, holotype). **a** Synnamatous conidiomata with setae, **b–f** Synnemata, conidiophores and conidiogenous cells with inconspicuous collarette. **g–p** Conidia. Scale bar: **a** 20 μ m, **b–f** 10 μ m, **g–p** 5 μ m



Fig. 185 Arcuatospora sinensis (Wu12528). a–d Synnemata with setae. e Basal part of synnemata with stroma and conidiophores. f Basal part of synnemata showing basal stroma and hyphae. g–l Con-

idiophores and conidiogenous cells. m–t Conidia. Scale bar: a–d 40 $\mu m,\,e$ 20 $\mu m,\,f\text{--}t$ 5 μm



Fig. 186 *Arcuatospora sinensis* (Wu13025, holotype). **a–d** Synnemata with setae. **f–h** Conidiophores with terminal and phialidic conidiogenous cells. **i–m** Conidia. Scale bar: **a–c** 40 µm, **d** 10 µm, **e–m** 5 µm

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight or flexuous, basal stroma 40-50 µm diam. Setae cylindrical, erect, straight, unbranched, dark brown to blackish, becoming paler toward the apex, multiseptate, smooth- and thickwalled, $260-360 \times 6-8 \mu m$, apex rounded and $4-5 \mu m$ wide, sitting not in the middle of conidiophores. Conidiophores closely compacted into synnemata; synnemata brown, 100–175 µm high, 10–15 µm wide, 25–30 µm wide in the sporulating region; conidiophores cylindrical, erect, straight of flexuous, unbranched, or branched in the top part, pale to medium brown, septate, smooth- and thick-walled, $100-160 \times 1.5-2 \mu m$, terminating in a conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, cylindrical, erect, straight, thin-walled, pale brown to brown, 10-18 µm long, 2.5-4 µm wide, periclinal thickening not obvious, collarette inconspicuous, 1-1.5 µm wide, up to 1 µm long. Conidia holoblastic, aggregated in white slimy heads around the conidiogenous cells, hyaline, 1-setptate, smooth- and thin-walled, falcate, fusiform, curved, $16.5-19(-21) \times 2.4-2.6 \mu m$, base slightly truncated, apex acute, appendiculate with one setula of 7-10 µm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 1.2–1.7 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, grey to greybrown, with brown colored margin, reverse pale brown to dark brown (Fig. 179g–j).

Other saterials examined: **China**, Hubei Province, Shennongjia, on dead leave of unidentified tree, 19 September 2004, W.P. Wu (Wu8279c); Sichuan Province, Ya An, Yucheng, Bifengxia, on dead leaves of *Cinnamomum* sp., 15 December 2013, W.P. Wu (Wu13192). Living strains: 50638 (from Wu8279c), 57,705 (from Wu13192).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China, Japan (Réblová et al. (2021b).

Description and illustration: Réblová et al. (2021b).

Notes: Arcuatospora septata is phylogenetically closely related to other species in the genus. Morphologically it differs from other species by shorter conidiogenous cells with inconspicuous collarettes and larger conidia with longer setulae. Réblová et al. (2021b) described a similar fungus from a pure culture CBS694.74 as a distinct species, but without giving it a name due to lacking morphological characters on natural substrate.

Arcuatospora sinensis W.P. Wu & Y.Z. Diao, sp. nov., Figs. 185, 186, MycoBank MB841623.

Etymology: refers to the country China where this fungus was first discovered.

Typification: **China**, Zhejiang Province, Hangzhou, Longjing, on dead leaves of *Cinnamomum* sp., 30 September 2013, W.P. Wu, Holotype HMAS 351961 (=Wu13025), ex-type strain CGMCC 3.20653 (=NN57332).

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight or flexuous, basal stroma 25-37 µm diam. Setae cylindrical, erect, straight, unbranched, dark brown to blackish, becoming paler toward the apex, up to 7-12-septate, smooth- and thick-walled, 170-270 µm long, 5-7 µm wide, apex 2.5-3 µm, sterile and terminated with a rounded apex, or fertile and terminated with a conidiogenous cells, sitting not in the middle of conidiophores. Conidiophores closely compacted into synnemata; synnemata brown, 120–150 µm high, 11–15 µm wide in the lower part, 20-25 µm wide in the upper fertile region; conidiophores cylindrical, erect, straight or flexuous, unbranched or branched, pale to medium brown, septate, smooth- and thick-walled, 120-159 µm high, 1.2-1.5 µm wide, terminating in a conidiogenous cell. Conidiogenous cells monophialidic or polyphialidic, integrated, terminal, cylindrical, lageniform, erect, straight, thin-walled, 15-25 µm long, 2.5-3 µm wide, periclinal thickening obvious, collarette funnel-shaped and conspicuous, 1-1.5 µm wide, up to 1 µm deep. Conidia holoblastic, aggregated in white slimy heads around the conidiogenous cells, hyaline, 1-setptate, smoothand thin-walled, lunate, fusiform, curved, 10-13(-15) µm, base slightly truncated, apex rounded or obtuse, appendiculate with one setula of 5–7.5 µm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 0.6–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, brown, with pale colored margin, reverse pale brown to brown (Fig. 179k, l).

Other materials examined: **China**, Guangdong Province, Shaoguan, Danxiashan, on dead leaves of unidentified tree, 25 Dec 2012, W.P. Wu (Wu12497, Wu12528); Guangdong Province, Shenzhen, Lianhuashan Park, on dead leaf of *Cinnamomum* sp., 11 November 2019, W.P. Wu (Wu17244). Living strains: 55,333 (from Wu12528), 55,346 (from Wu12497), 57,331 (from Wu13025a) and 77,699 (from Wu17244).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Arcuatospora sinensis is phylogenetically closely related to other species in the genus. Morphologically it resembles other species on appearance of conidiomata, but differs from them by monophialidic or polyphialidic conidiogenous cells, lunate conidia in smaller size (Hughes



Fig. 187 Arcuatospora suttonii (Wu17630, holotype). **a–c** Synnamatous conidiomata with setae. **d–f** Upper part of the synnemata with conidiophores and conidiogenous cells. **g** Apex of setae. **h–k** Conidia. Scale bar: **a–c** 20 μm, **d–k** 5 μm

and Kendrick 1968; Réblová et al. 2021b). Slightly longer conidia (up to 16 μ m) was observed in the specimen Wu12528.

Arcuatospora suttonii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 187, MB841624.

Etymology: Named after the former IMI mycologist Brian C. Sutton.

Diagnosis: Similar to *Arcuatospora novae-zelandiae* and *A. hughesii* in monophialidic conidiogenous cells and 1-septate conidia with a single setula at each end, but differs from them by curved collarettes and size of conidia and setulae.

Typification: **China** Hainan Province, Sanya, Yalongwan Park, on dead leaves of unidentified tree, 29 December 2020, W.P. Wu, Holotype HMAS351962 (= Wu17630), ex-type strain CGMCC 3.20764 (= NN78459).

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight or flexuous, basal stroma 25–35 µm diam. Setae cylindrical, erect, straight, unbranched, dark brown to blackish, becoming paler toward the apex, up to 15-septate, smooth- and thick-walled, 150–330 μm long, 3.5–5 μm, apex rounded and 2.5–3 μm, sitting not in the middle of conidiophores. Conidiophores closely compacted into synnemata; synnemata brown, 11–16 µm wide in the lower part, 17–23 µm wide in the upper fertile region; conidiophores cylindrical, erect, straight or flexuous, unbranched or branched, pale to medium brown, septate, smooth- and thick-walled, (50-)90-140 µm high, 1.2–1.5 µm wide, terminating in a conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, lageniform, erect, straight, thin-walled, 13-32 µm long, 2.8–3.5 µm wide, periclinal thickening obvious, collarette funnel-shaped and conspicuous, curved, 1.5-3.5 µm wide, up to 1 µm deep. Conidia holoblastic, aggregated in white slimy heads around the conidiogenous cells, hyaline, 1-setptate, smooth- and thin-walled, falcate, fusiform, curved, $13-17.5 \times 2.5-3 \mu m$, base slightly truncated, apex acute, appendiculate with one setula of 5-8 µm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, light brown to dark brown, reverse of the same color, or darker (Fig. 179m, n).

Other living strain: 78,459 (from Wu17630).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Arcuatospora suttonii is similar to A. novaezelandiae and A. hughesii in having uniseptate conidia with a single setula at each end. In *A. hughesii*, the conidiophores in the fertile region of the synnemata are not closely packed, the conidiogenous cells are usually monophialidic, the collarettes are not curved, and the conidia are smaller $(14-15.5 \times 2.0-2.5 \,\mu\text{m})$. In *A. novae-zealandiae*, the conidia are slightly larger $(17-20 \,\mu\text{m} \log)$ and with longer setulae $(9-12 \,\mu\text{m})$. In addition, the ITS sequences for those three species are significantly different. Some variation on the ITS sequences was observed from different strains of this species, same as found in *A. novae-zelandiae*.

Arcuatospora yunnanensis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 188, MycoBank MB841626.

Etymology: Refers to the Yunnan province in China where this fungus was first discovered.

Diagnosis: Resembles *Arcuatospora novae-zelandiae* on conidial shape, but differs from it by the setae somewhat centrally in synnemata, and smaller conidia.

Typification: **China**, Yunnan Province, Baoshan, Lujiang, Bawan, Gaoligongshan, on dead fruit of *Quercus* sp., 15 October 2013, W.P. Wu, Holotype HMAS 351963 (= Wu7244b), ex-type strain CGMCC 3.20642 (=NN47742).

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight or flexuous, basal stroma 30-40 µm diam. Setae cylindrical, erect, straight, unbranched, dark brown, becoming paler toward the apex, 8-12-septate, smooth- and thick-walled, $250-280 \times 6-9 \mu m$, $3.5-4 \mu m$ wide at the rounded apex, sitting in the middle of conidiophores. Conidiophores closely compacted into synnemata; synnemata brown, 90-120 µm high, 15-17 µm wide in the lower part, 18–25 µm wide in the upper fertile region; conidiophores cylindrical, erect, straight of flexuous, unbranched or branched, pale to medium brown, septate, smooth- and thick-walled, 90-100 µm high, 1.5-2 µm wide, terminating in a conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, lageniform, cylindrical, erect, straight, thin-walled, 15-20 µm long, 2-2.5 µm wide, periclinal thickening obvious, collarette inconspicuous or conspicuous, funnel-shaped, and not curved, 1-1.2 µm wide, up to 1 µm deep. Conidia holoblastic, aggregated in slimy heads around the conidiogenous cells, hyaline, 1-setptate, smooth- and thin-walled, falcate, fusiform, curved, $13-17 \times 2-2.5$ µm, base slightly truncated, apex acute, appendiculate with one setula of 6-7 µm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 1.5–2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to grey-brown, reverse pale brown (Fig. 1790, p).



Fig. 188 *Arcuatospora yunnanensis* (Wu7255a, holotype). **a–e** Synnematous conidiomata with setae. **f** Synnemata with basal stroma. **g** Conidiophores in the synnemata. **h** Upper part of the synnemata with conidiogenous cells. **i–r** Conidia. Scale bar: **a–d** 40 μ m, **e–g** 20 μ m, **h–q** 10 μ m

Other materials examined: **China**. Hunan Province, Chenzhou, Yizhang County, Mangshan, on dead leaves of unidentified tree, 12 April 2002, W.P. Wu (Wu6026); Yunnan Province, Baoshan, Lujiang, Bawan, Gaoligongshan, on dead leaves of *Quercus* sp., 15 October 2001, W.P. Wu (Wu7255a). Living strains: 47,471 (from Wu6026) and 47757 (from Wu7255a).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China, Nepal.

Notes: Arcuatospora yunnanensis is phylogenetically closely related to other species in the genus. Morphologically it resembles A. novae-zelandiae on conidial shape, but differs from it by the setae somewhat centrally in synnemata, and smaller conidia. Réblová et al. (2021b) described a similar fungus from a pure culture MUCL43189 as a distinct species, but without giving it a name due to lacking morphological characters on natural substrate. The ITS sequence from this fungus is almost identical to those obtained from living strains of A. yunnanensis. Variations on conidial size were observed among different collections, for example: $13-14.5 \times 1.5-2$ µm from the type specimen, $14-17 \times 2-2.5$ µm from Wu7255a.

Menisporopsis S. Hughes, Mycol. Pap. 48: 59 1952.

=*Menisporopascus* Matsush., Matsush. Mycol. Mem. 10: 141, 2003.

Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnematous, solitary, erect, straight, or flexuous, composed of a number of parallel, thinor thick-walled, septate, brown, smooth conidiophores and dark brown, septate setae. Conidiophores closely compacted into synnemata, cylindrical, unbranched, medium brown to dark brown, septate, smooth- and thick-walled. Conidiogenous cells monophialidic or polyphialidic, integrated, terminal, cylindrical or clavate, single, erect, straight, thickwalled but becoming thin-walled towards the apex, periclinal thickening obvious, collarette conspicuous or inconspicuous, funnel-shaped. Conidia holoblastic, aggregated in slimy heads, hyaline, aseptate or septate, thin-walled, smooth, falcate, fusiform, subcylindrical, curved, appendiculate.

Type species: Menisporopsis theobromae S. Hughes.

Ecology/Substrate/Host: Saprobe on decaying plant material, especially decaying leaves and fruit.

Geographical distribution: Broadly distributed, and commonly found in subtropical and tropical area.

Description and illustration: Hughes (1952); Pirozynski and Hodges (1973); Varghese and Rao (1978); Rao and de Hoog (1986); Seifert et al. (2011).

Notes: The genus *Menisporopsis* was first introduced for *Menisporopsis theobromae*, a microfungus from decaying

leaves of *Theobroma cacao* in Ghana (Hughes 1952). This genus is characterized by synnematous conidiomata that surround a central, simple, dark brown seta, phialidic conidiogenous cells and lunate to falcate 0- to 1-septate conidia with terminal setulae (Hughes 1952; Pirozynski and Hodges 1973; Varghese and Rao 1978; Rao and de Hoog 1986). On conidial morphology, the genus *Menisporopsis* is similar to *Dictyochaeta* and *Menispora*, but can be distinguished from them by its synnematous conidiomata with setae (Hughes 1952; Ellis 1971, 1976).

Fourteen species are known in the genus Menisporopsis and they are distinguished primarily by conidial morphology and dimensions. These species are M. anisospora, M. breviseta, M. dushanensis, M. heterosetulosa, M. kobensis, M. ludoviciana, M. multisetulata, M. novae-zealandiae, M. pandanicola, M. pirozynskii, M. pleiosetosa, M. profusa, M. theobromae and M. trisetulosa (Hughes and Kendrick 1968; Ellis 1971; Matsushima 1971, 1975; Pirozynski and Hodges 1973; Rao 1978; Kirk and Sutton 1985; Rao and de Hoog 1986; Castañeda-Ruiz et al. 1997; Siboe et al. 1999; Tsui et al. 1999; Castañeda-Ruíz et al. 2001; Matsushima 2003; Seifert et al. 2011; Tibpromma et al. 2018; Lin et al. 2019). However, Menisporopsis ludoviciana (= Chaetopsina ludoviciana) was excluded from the genus and transferred into Vermiculariopsiella as V. ludoviciana (Castañeda-Ruíz et al. 2001;). Key to the eight accepted species was provided by Siboe et al. (1999), Castañeda-Ruíz et al. (2001) and Cruz et al. (2014).

Matsushima (2003) first described the teleomorph of the genus *Menisporopsis* with the new genus, *Menisporopascus* Matsush, typified by *Menisporopascus kobensis* and was later placed in Sordariomycetidae *incertae sedis* by Lumbsch and Huhndorf (2007a, b, 2010). Based on preliminary studies, *Menisporopsis* was included in a clade within Chaetosphaeriaceae (Réblová et al. 2006; Reblová and Seifert 2008).

Our phylogenetic analysis shows that the synnematous genus Menisporopsis is polyphyletic, and the species are resolved with two very distinct phylogenetic groups (Figs. 3 and 189). The first group includes *M. theobromae* (the type species of the genus), M. anisospora, M. breviseta, M. dushanensis, M. pandanicola, M. pirozynskii and several new species; morphologically these species produce synnematous conidiomata with 1 (rarely 2) centralized setae, monophialidic or polyphialidic conidiogenous cells, and setulate, hyaline and aseptate conidia formed in droplet; phylogenetically they are closely related to Phialosporostilbe with similar structure on conidiomata, but differs by tetrahedral conidia with three protuberant corners and a slightly truncate base bearing a single setulae in the latter genus (Mercado Sierra and Mena Portales 1985; Hyde et al. 1996; Shirouzu and Harada 2004; Seifert et al. 2011). The second group is with two known species, A. novae-zealandiae



Fig. 189 Maximum likelihood (ML) tree based on ITS sequence data for the genus *Menisporopsis*. Bootstrap support values $\ge 60\%$, Bayesian posterior probability values ≥ 0.95 are shown at the nodes. *Nawawia filiformis* MFLU 18–1500 was chosen as the outgroup. Ex-

and *Arcuatospora seorsa*, and several new species, differs from the members in the first group by producing synnemata with one setae not sitting in the center of the synnemata and 1-septate conidia; and phylogenetically they are closely related to *Menispora* species. In a very recent publication by Réblová et al. (2021b), the new genus, *Arcuatospora* Réblová & Hern.-Restr, was created to accommodate the second group. This separation is supported from our phylogenetic analysis with additional species.

In nature the *Menisporopsis* species occur as saprobes on decaying leaves and submerged decomposing wood in pantropical areas (Tsui et al. 1999; Seifert et al. 2011). Several species are discovered from China and reported here. Living strains of many studied species were also studied on PDA (Fig. 190), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Key to all known species of *Menisporopsis* (Revised from Siboe et al. 1999; Castañeda-Ruíz et al. 2001 and Cruz et al. 2014)

type strains are indicated with "T" in the end of the taxa labels. Latin names and ex-type strain numbers of the new species described in the current study are shown in font

1.	Conidiogenous cells unilocal2
1.	Conidiogenous cells multilocal
	M. profusa
2.	Conidia truncated at the base
2.	Conidia not truncated at the base4
3.	Conidia ellipsoid, $12-18 \times 4-5$ µm, $2-4$ basal and 1
	apical setula up to 6 um long
3.	Conidia heterosporous, $17-30 \times 2-6$ µm, 1 setulae at
	each end and 1–2 lateral setula arising more or less at
	the center on the concave side
	M anisospora
4	Conidia with one setulae at both ands
4.	
4.	Conidia with more than one setula at both
_	ends
5.	Conidia $22-24 \times 3-3.5 \mu\text{m}$, setulae 4.5-6.5 μm long;
	microconidia cylindrical $7-8 \times 1 \ \mu m$
	M. biformis
5.	No microconidia produced6
6.	Conidia $22-30 \times 4.5 \ \mu\text{m}$; setulae 6-10 μm
	M. kobensis
6.	Conidia 15–22 µm long



Fig. 190 Colony of *Menisporopsis*, *Eucalyptostroma*, *Eucalyptostromiella and Pseudothozetella* species on PDA after 20 days at 25 °C. a, b *Menisporopsis biformis* (ex-type strain 78233). c, d *M. dinemasporioides* (ex-type strain 54208). e, f *M. dushanensis* (54228). g, h *M. macrospora* (ex-type strain 77554). i, j *Eucalyptostroma hon-*

- Conidia 14–20×2.0–3.5 μm, aseptate, setula 6–10 μm long......M. theobromae

Conidia, allantoid, with 3 setulae, 10 μm long, one setulae at both ends and one setula near the base at the convex side, 12–20×2 μm......*M. trisetulosa* Conidia with more than 3 setulae......9
Conidia 11–14.5×2.0–3.0 μm, with 4 setulae*M. elegans* Conidia more than 15 μm......0.10
Conidia with 1–2 setulae at each end......

- 11
- 10. Conidia with 2–3 setulae at each end......14
- 11. Setae $97-189 \times 2.7-5.4 \ \mu\text{m}$; synnemata $6.5-12 \ \mu\text{m}$ wide; conidia cylindrical or fusiform, 14.2-

gluosiense (**a**, **b** ex-type strain 77220; **c**, **d** 77221). **k** Eucalyptostroma oxenbolliae (ex-type strain 76600). **l** Eucalyptostromiella beijingensis (ex-type strain 78012). **m** Pseudothozetella lunata (ex-type strain 76055)

	24.3×2.4 -3.6 µm; setulae 1-2 at each end, 4-9 µm
11.	Setae longer than 200 μ m; synnemata wider
12.	12 Setae 207–405 μm long; synnemata 8–22.5 μm wide;
	setulae 1–2 at each end, 3–11 μ m long
12.	
	wide; conidia lunate, $17-22 \times 2-3 \mu m$; setulae (1-)2 at each end, $4-12 \mu m \log$
10	
13.	Conidia $15-20 \times 2-3 \mu m$, cylindrical to allantoid, with 4–5 setulae, 1–3 basal setulae of the differ-
	ent length and one subapical setulae at the convex side
13.	Conidia $12-19 \times 2.5-4 \mu m$, allantoid, with 5-6 setulae,
	3–4 basal, 1 subapical and 1apical



Fig. 191 *Menisporopsis biformis* (Wu17473, holotype). **a–c** Synnemata with setae. **d** Upper part of the synnemata with conidiophores and conidiogenous cells. **e** Apical part of setae with mucilaginous cap. **f**, **g** Microconidia. **h–l** Conidia. Scale bar: **a** 50 µm. **b**, **c** 20 µm, **d–l** 5 µm

Menisporopsis biformis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 191, MycoBank MB841627.

Etymology: Refers to its two types of conidia produced from the same synnemata.

Diagnosis: Similar to *Menisporopsis theobromae* in conidial morphology but differs in producing two types of conidia (macroconidia and microconidia) and macroconidia in larger size.

Typification: **China**, Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead leaf petiole of palm, 17 October 2020, W.P. Wu, Holotype HMAS 352,019 (=Wu17473), ex-type strains CGMCC 3.20805 (=NN78233).

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight, or flexuous, consisting of 1-centralized setae and closely packed conidiophores, 11-14 µm wide in the lower part, up to 40 µm wide in the upper fertile region. Setae cylindrical, erect, straight, unbranched, medium brown to dark brown, up to 12-septate, smooth- and thick-walled, $190-227 \times 3-4.5 \,\mu\text{m}$, apex rounded, slightly swollen and with a mucilaginous cap. Conidiophores closely compacted into synnemata, cylindrical, erect, straight of flexuous, unbranched, pale to medium brown, septate, smooth- and thick-walled, 110-150 µm high, 1.5–2.5 µm wide, terminating in a conidiogenous cell. Conidiogenous cells mono- or poly-phialidic, integrated, terminal, cylindrical or clavate, erect, straight or curved, thinwalled, smooth, dark brown, $25-28 \times 2.5-3 \mu m$, with up to 4 inconspicuous collarettes. Conidia holoblastic, aggregated slimy heads around the conidiogenous cells, both microconidia and macroconidia are produced; microconidia hyaline, aseptate, cylindrical to fusiform, thin- and smooth-walled, with rounded ends, as etulate, $7-8 \times 1 \mu m$; macroconidia hyaline, aseptate, smooth- and thin-walled, cylindrical, falcate, curved, $22-24 \times 3-3.5 \mu m$, appendiculate with a setula at each end and 4.5–6.5 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 8–14 mm diameter in 14 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, brown to dark brown, reverse of the same color (Fig. 190a, b).

Other materials examined: **China** Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead leaf petiole of palm, 17 October 2020, W.P. Wu (Wu17474, Wu17475). Living strains: 78,234 (from Wu17474), 78,235 and 78,236 (from Wu17475).

Ecology/Substrate/Host: Saprobe on dead leaf of palm. Geographical distribution: China.

Notes: *Menisporopsis biformis* is characterized by centrally located setae among conidiophores, forming both microconidia and macroconidia, and larger macroconidia with one setula at each end. It can be easily distinguished from other known species by the two types of conidia. Morphologically it is mostly similar to *Menisporopsis theobromae* in morphology of synnemata and conidia, but differs in producing two types of conidia (macroconidia and microconidia) and larger macroconidia (Tsui et al. 1999; Cruz et al. 2014; Lin et al. 2019).

Menisporopsis breviseta C.G. Lin & K.D. Hyde, Myco-sphere 10: 678, 2019.

Ecology/Substrate/Host: Saprobe on decaying leaves of plant.

Geographical distribution: China (Lin et al. 2019).

Description and illustration: Lin et al. (2019).

Notes: *Menisporopsis breviseta* is a recently described species from China. It is similar to *M. pandanicola* in lunate conidia with 1–2 setula at each end, but differs from *it* by shorter setae and conidia with 1–2 setula at each end (Lin et al. 2019).

Menisporopsis dinemasporioides W.P. Wu & Y.Z. Diao, sp. nov., Fig. 192, MycoBank MB841628.

Etymology: Refers to its similarity to the genus *Dine-masporium* on cupulate conidiomata.

Diagnosis: Similar to *Menisporopsis theobromae* but differs in producing cup-shaped conidiomata with excipulum-like structure and 1–2 setae arising centrally, and slightly smaller conidia.

Typification: **China**, Guangdong Province, Zhaoqing, Dinghushan, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu, Holotype HMAS 352,020 (=Wu12102), ex-type strain CGMCC 3.20711 (=NN54208).

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight or flexuous, cup-shaped, with a basal stroma and a cup-shaped sporulating part with excipulum-like structure and 1-2 setae arising centrally, basal stroma 40-50 µm diam. Setae 1-2 in each conidiomata, cylindrical, erect, straight, unbranched, dark brown to blackish, becoming paler toward the apex, septate, smooth- and thick-walled, $220-285 \times 4-5.5 \mu m$, apex rounded and 2-2.5. Conidiophores closely compacted into synnemata; synnemata dark brown to black, 150-180 µm long, 40-60 µm wide, lower part blackish, 40-50 µm high, upper part loosely packaged with excipulum-like



Fig. 192 *Menisporopsis dinemasporium* (Wu12102, holotype). **a–c** Synnematous conidiomata with setae. **d–f, i–m, o, p** Conidia. **g, h, n** Excipulum and conidiophores. Scale bar: **a–c** 50 μm, **g, h, I, n** 10 μm, **d–f, j–m, o, p** 5 μm



Fig. 193 *Menisporopsis dushanensis* (Wu12183). **a**, **b** Synnematous conidiomata with single setae. **c**, **d** Fertile regions of synnemata with phialidic conidiogenous cells. **e**, **f** Phialidic conidiogenous cells with inconspicuous collarettes. **g**-**k** Conidia

structure, 80–110 µm high; conidiophores cylindrical, erect, straight of flexuous, unbranched or branched, pale to medium brown, septate, smooth- and thin-walled, $60-100 \times 2-3$ µm, terminating in a conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, lageniform, erect, straight, thin-walled, 15–20 µm long, 2–3.5 µm wide, periclinal thickening obvious, collarette inconspicuous. Conidia holoblastic, aggregated in white slimy heads around the conidiogenous cells, hyaline, aseptate, smooth- and thinwalled, falcate, fusiform, curved, $19-22 \times 3.5-4.2$ µm, both ends rounded, appendiculate with one setula of 5–8 µm long at each end.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, then grey to yellow brown, with pale colored margin, reverse yellow brown and with dark brown in the center (Fig. 190c, d).

Other materials examined: **China**, Sichuan Province, Dujiangyan, Qingchengshan, on dead leaves of unidentified tree, 9 November 2019, W.P. Wu (Wu17232a, b, c, d, r). Living strains: 77,694, 77,695, 77,696, 77,618 and 77,745 (all from Wu17232).

Ecology/Substrate/Host: Saprobe on dead leaf of palm. Geographical distribution: China.

Notes: *Menisporopsis dinemasporioides* can be easily distinguished from all other species by its conidiomata with excipulum-like structure with 1–2 setae arising centrally from the basal stroma of the conidiomata, falcate to fusiform conidia in smaller size and with one setulae at each end (Tsui et al. 1999; Castañeda-Ruiz et al. 1997, 2001; Cruz et al. 2014; Heredia et al. 2000, 2018). Similar conidiomata with excipulum-like structure was illustrated in *M. multisetulata* by Heredia et al. (2018).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 54208 include *Menisporopsis* anisospora (GenBank MH862827, 97% identity), *M. theobromae* (GenBank KX609957, 93% identity), *M. dushanensis* (GenBank NR166299, 92% identity).

Menisporopsis dushanensis C.G. Lin & K.D. Hyde, Mycosphere 10: 681, 2019. Figure 193

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight or flexuous, basal stroma 30-40 µm diam. Setae cylindrical, erect, straight, unbranched, dark brown to blackish, becoming paler toward the apex, up to 15 septa, smooth- and thick-walled, $370-450 \times 5-9 \mu m$, apex rounded and $3.5-4 \mu m$, sitting in the middle of conidiophores. Conidiophores closely compacted into synnemata; synnemata brown, lower part closely packed and 20-25 µm wide, upper part diverged, 50-60 µm wide; conidiophores cylindrical, erect, straight of flexuous, unbranched or branched, pale to medium brown, septate, smooth- and thick-walled, $130-160 \times 2-3 \mu m$, terminating in a conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, lageniform, erect, straight, thin-walled, 20-25 µm long, 2.5-3.2 µm wide, periclinal thickening obvious, collarette inconspicuous or conspicuous, cylindrical, straight or slightly curved. Conidia holoblastic, aggregated in slimy heads at the apex of synnemata, hyaline, aseptate, smooth- and thin-walled, falcate, fusiform, curved, $11.5-14.5 \times 2.0-3.0 \mu m$, both ends rounded, appendiculate with one terminal setula of 7-9 µm long at each end and one subterminal setula of 3-6.5 µm at each end.

Culture characteristics: Colonies on PDA effuse, colonies 3–3.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, to slightly grey with pale colored margin, reverse pale–yellow brown, with a dark center (Fig. 190e, f).

Material examined: **China**, Guangdong Province, Zhaoqing, Dinghuashan, on dead leaves of *Fagus* sp., 3 March 2012, W.P. Wu (HMAS 352,021 (= Wu12183)). Living strain: 54,228.

Ecology/Substrate/Host: Saprobe on dead leaves of different plants including *Fagus* sp.

Geographical distribution: China (Lin et al. 2019).

Description and illustration: Lin et al. (2019).

Notes: Morphologically *Menisporopsis dushanensis* is similar to a few species such as *M. breviseta* (setae 97–189 µm long; conidiophores up to 182 µm long; conidia cylindrical or fusiform, aseptate, $14-24 \times 2.4-3.6$ µm; 1-2setulae at each end, 4-9 µm long), *M. dushanensis* (setae 207–455 µm long; conidiophores up to 147 µm long; conidia cylindrical or fusiform, aseptate, $14-20.5 \times 2.7-4.2$ µm; 1-2 setulae at each end, 3-11 µm long), *M. pandanicola* (setae 344-375 µm long; conidia lunate, aseptate, $17-22 \times 2-3$ µm; (1-)2 setulae at each end, 4-12 µm long) and *M. pirozynskii* (setae 300-500 µm long; conidiophores up to 75-80 µm long; conidia cylindrical or fusiform, aseptate, $16-20.5 \times 2-3.5$ µm; 2 setulae at each end, terminal setulae 7-10 µm long, subterminal setulae 2.5-8 µm long) in producing fusiform to subcylindrical conidia with both terminal and lateral appendages (Varghese and Rao 1978; Castañeda-Ruiz et al. 1997; Tibpromma et al. 2018; Lin et al. 2019). *Menisporopsis dushanensis* differs from them by shorter but wider conidia with longer setulae.

Menisporopsis macrospora W.P. Wu & Y.Z. Diao, sp. nov., Fig. 194, MycoBank MB841630.

Etymology: Refers its large conidia.

Diagnosis: *Menisporopsis macrospora* resembles *M. breviseta*, *M. dushanensis*, *M. pandanicola* and *M. pirozynskii* in producing conidia bearing both terminal and lateral appendages, but differs from these species by slightly larger conidia with obtuse ends.

Typification: **China**: Sichuan Province, Dujiangyan, Qingchengshan, on dead leaves of unidentified tree, 9 November 2019, W.P. Wu, Holotype HMAS 352,022 (=Wu17184), ex-type strain CGMCC 3.20673 (=NN77554).

Description on the natural substrate: Mycelium superficial, consisting of yellow-brown, septate, 1.5-2 µm thick hyphae. Teleomorph: Unknown. Anamorph: Seta central, solitary, erect, straight, subulate, thick-walled, smooth, brown, 10-12-septate, up to 300 µm long, 5-8 µm wide at the base, and $3-4 \mu m$ wide at the apex. Synnemata brown, 150-180 µm high, 22-25 µm wide, spreading at the head. Conidiophores unbranched, pale brown, 1.5-2 µm wide with swollen phialides $(2.5-3.5 \,\mu\text{m})$. Conidiogenous cells monophialidic, terminal, pale brown, straight, brown, smooth, thin-walled, $20-25 \times 2.5-3.5 \mu m$, collarette inconspicuous. Conidia allantoid, smooth, aseptate, hyaline, aggregated into slimy masses at the apex of the synnemata, $17.5-21 \times 3-3.5 \mu m$, with 2 setulae at each end, usually 1 at the terminal 5-7 µm long and 1 on the subterminal convex side 3-5 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 0.8–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, purple-brown, reverse pale brown to soil brown (Fig. 190g, h).

Other living strain: 77,555 (from the holotype specimen). Ecology/Substrate/Host: Saprobe on dead leaves of plant. Geographical distribution: China.

Notes: *Menisporopsis macrospora* resembles *M. dushanensis*, *M. pirozynskii* and *P. pandanicola* in producing aseptate conidia bearing 1–2 setulae at each end, usually one at the terminal and one on the subterminal convex side (Varghese and Rao 1978; Castañeda-Ruíz et al. 2001; Tibpromma et al. 2018; Lin et al. 2019). Apart from the slightly larger conidia with obtuse ends in *M. macrospora*, these species are hardly distinguished from each other by morphology, and the ITS barcoding is useful for species delimitation.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,554 include *Menisporopsis dushanensis* (GenBank NR_16699, 98% identity), *M.*



Fig. 194 *Menisporopsis macrospora* (Wu17184, holotype). **a** Synnemata with setae. **b**, **c** Upper part of the synnemata with conidiophores and conidiogenous cells. **d–j** Conidia. All from the holotype specimen. Scale bar: **a** 40 μ m, **h** 20 μ m, **b–g**, **i**, **j** 5 μ m,



Fig. 195 Menisporopsis pandanicola (Wu13119). a-f Synnematous conidiomata with setae. g Low part of synnematous conidiomata showing conidiophores, conidiogenous cells and central setae. h Api-

cal part of setae. i–n Conidia. Scale bar: a–d 40 µm, e, f 20 µm, l 30 µm, g, i–k, m, n 5 µm

breviseta (GenBank NR_166296, 96% identity), *M. pandanicola* (GenBank MH388353, 95% identity), and *M. theobromae* (GenBank MN999923, 95% identity).

Menisporopsis multisetulata K. M. Tsui, T. K. Goh, K.D. Hyde & I. J. Hodgkiss, Mycol. Res. 103: 150, 1999.

Typification: **China**, Hong Kong, New Territories, Tai Po, Lam Tsuen River, on submerged wood, 27 November 1996, K. M. Tsui, KM117 (HKU(M) 4662).

Ecology/Substrate/Host: Saprobe on dead leaves of plant. Geographical distribution: China (Tsui et al. 1999) and Mexico (Heredia et al. 2018).

Description and illustration: Tsui et al. (1999); Heredia et al. (2018).

Notes: *Menisporopsis multisetulata* is unique in having conidia which have in total 5(6)-setulae (Tsui et al. 1999). It is similar to *M. pirozynskii* in its conidial size and shape. However, the conidia in *M. multisetulata* are slightly wider than those in *M. pirozynskii*.

Menisporopsis pandanicola Tibpromma & K.D. Hyde, Fungal Divers. 93: 128, 2018. Figure 195

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight, or flexuous. Setae cylindrical, erect, straight, unbranched, medium brown to dark brown, up to 10 septa, smooth- and thick-walled, $250-450 \times 7-8$ µm. Conidiophores closely compacted into synnemata; synnemata brown, lower part closely packed, 25-35 wide at the base, $15-20 \mu m$ wide in the middle part, 100-130 µm high; conidiophores cylindrical, erect, straight of flexuous, unbranched or branched, pale to medium brown, septate, smooth- and thick-walled, $100-130 \times 1.5-2.5 \mu m$, terminating in a conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, lageniform, erect, straight, thin-walled, 12-18 µm long, 2-2.5 µm wide, periclinal thickening obvious, collarette inconspicuous, curved, and 1-1.5 µm wide/high. Conidia holoblastic, aggregated in white slimy heads around the conidiogenous cells, hyaline, aseptate, smooth- and thin-walled, lunate, curved, $15.5-18 \times 2-3 \mu m$, both ends rounded, appendiculate with 4 setulae, always with a single and 6–8 µm long apical setula, 1-2 basal setulae of the different length, usually 1 at the terminal 6-8 µm long and 1 on the subterminal convex side 4.5-6 µm long.

Typification: **China**, Hong Kong, Lantau Island, Pui O Beach, on *Pandanus* sp., 20 September 2016, S. Tibpromma HK011 (HKAS 100,862, holotype); ex-type living culture, KUMCC 17–0271 = MFLUCC 17–0638).

Materials examined: China, Guangdong Province, on dead stem of unidentified plant, 9 October 1998, W.P.

Wu (2046b); Guangdong Province, Guangzhou, on dead leaves of unidentified tree, 10 December 2013, W.P. Wu (WU12658a, b, c, d, Wu12679); December Guangxi Province, Nanning, Qingxiushan, on dead leaves of unidentified tree, 12 November 2013, W.P. Wu (Wu13119a, b, c); Yunnan Province, Xishuangbanna, on dead leaves of unidentified plant, 6 October 1999, W.P. Wu & Yan Huang (2737a). Living strains: NN57673 (from Wu12658b), 57,674 (from Wu12658c), 57,670 (from Wu12658d), 57,454 (from Wu13119b), 57,466 (from Wu13119a), 57,449 (from Wu13119c) and 57,712 (from Wu12679).

Ecology/Substrate/Host: Saprobe on dead leaves of plant. Geographical distribution: China (Tibpromma et al. 2018).

Description and illustration: Tibpromma et al. (2018).

Notes: *Menisporopsis pandanicola* has slightly larger conidia $(17-22 \times 2-3 \ \mu\text{m})$ with 1–2 longer setulae at each end (4–12 μm) than the closely related species *M. theobromae* (conidia 12–14×1.8–2 μm) with 1 setula at each end (6–8 μm long) (Liu et al. 2016; Tibpromma et al. 2018).

Menisporopsis pirozynskii Varghese & Rao, Bot. Notiser 131: 215, 1978.

Ecology/Substrate/Host: Saprobe on dead leaves of plant.

Geographical distribution: Argentina, Brazil, Brunei Caledonia, China, Congo, Cuba, India, Malaysia, Mexico, Nigeria and Thailand. Probably widely distributed in tropical and subtropical area.

Description and illustration: Varghese and Rao (1978); Mouchacca (1990); Cabello et al. (1993); Matsushima and Matsushima (1996); Castañeda-Ruiz et al. (1997); Begerow et al. (2000); Heredia et al. (2000); Somrithipol et al. (2008); Gusmão et al. (2001); Calduch et al. (2002a); Whitton et al. (2012); Cruz et al. (2014).

Notes: *Menisporopsis pirozynskii* differs from other known species of the genus by its monophialidic conidiogenous cells and aseptate conidia with 4 setulae, including a single apical, 1–2 basal of the different length, and one subapical (Varghese and Rao 1978; Castañeda-Ruiz et al. 1997). Variation on number and position of setulae was reported in this species (Mouchacca 1990; Cabello et al. 1993; Castañeda-Ruiz et al. 1997; Cruz et al. 2014). The dimensions and morphology of the reproductive structures of these specimens collected in China agrees with the original description (Varghese and Rao 1978).

Menisporopsis theobromae S. Hughes, Mycol. Pap. 48: 59 1952. Figure 196

Description on the natural substrate: Colonies hypophyllous, effuse, thick, inconspicuous. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnemata, solitary, erect, straight, or flexuous,



Fig. 196 *Menisporopsis theobromae* (Wu17182). **a, b** Synnematous conidiomata with setae. **c** Part of a synnemata with conidiophores and setae. **d, e** Conidiophores and conidiogenous cells. **f–k** Conidia. Scale bar: **a, b** 40 μm, **c** 10 μm, **d–k** 5 μm

consisting of a central setae and closely packed conidiophores, 10-15 µm wide at the lower part, 20-25 µm wide in the upper sporulating region. Setae cylindrical, erect, straight, unbranched, medium brown to dark brown, up to 15-septate, smooth- and thick-walled, $180-500 \times 5-8 \mu m$, with a rounded or truncated apex, sometimes with a mucilaginous cap. Conidiophores closely compacted into synnemata, cylindrical, erect, straight of flexuous, unbranched, pale to medium brown, septate, smooth- and thick-walled, $80-130 \times 1-1.5 \mu m$, terminating in a conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, cylindrical or clavate, single, erect, straight or curved, thinwalled, periclinal thickening obvious, $11-16 \times 3-3.5 \mu m$, collarette inconspicuous or funnel-shaped. Conidia holoblastic, aggregated in white slimy heads around the conidiogenous cells, hyaline, aseptate, smooth- and thin-walled, falcate, fusiform, curved, $12-16 \times 2-2.5 \,\mu$ m, with a setula at each end and 5-8 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 8–16 mm diameter in 14 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, grey-brown, soil brown to dark brown, reverse brown to dark brown.

Materials examined: China Guangdong, Guangzhou, South China Agriculture University, on dead leaves of unidentified tree, 30 December 2018, W.P. Wu (Wu16362); Guangxi Province, Nanning, Qingxiushan, on dead leave of unidentified tree, 12 November 2013, W.P. Wu (Wu13127); Hainan Province, Sanya, on dead leaves of unidentified tree, 27 December 2020, W.P. Wu (Wu17617); Sichuan Province, Dujiangyan, Qingchengshan, on dead leaves of unidentified tree, 9 November 2019, W.P. Wu (Wu17182); Yunnan Province, Xishuangbanna, on dead leaves of unidentified plant, 16 October 1999, W.P. Wu & Yan Huang (Wu2738b, Wu2841); Zhejiang Province, Huaian County, Qiandaohu, on dead leaf of fern, 15 October 2018, W.P. Wu (Wu16135); Zhejiang Province, Deqing, Moganshan, on dead leaves of Osmanthus fragrans, 16 October 2019, W.P. Wu (Wu17002). Living strains: 57,433 and 53,437 (from Wu13127), 76,330 and 76,331 (from Wu16135), 77,333 and 77,371 (from Wu17002), 76,660 and 76,661 (from Wu16362), 77,596 and 77,597 (from Wu17182), 78,417 and 78,418 (from Wu17617).

Ecology/Substrate/Host: Saprobe on dead leaves of plant. Geographical distribution: Australia, Brazil, China, Congo, Cuba, French Guiana, French Polynesia, Japan, Ghana, Ivory Coast, Malaysia, Mexico, Papua New Guinea, Peru, Philippines, Puerto Rico, Sri Lanka and Venezuela. Probably widely distributed in tropical and subtropical area.

Description and illustration: Hughes (1952); Ellis (1961); Matsushima (1971); Cruz et al. (2014); Liu et al. (2016); Luo et al. (2018).

Notes: Menisporopsis theobromae differs from other known species of the genus by central setae in the synnemata, monophialidic conidiogenous cells and aseptate conidia with one setula at each end (Hughes 1952; Tsui et al. 1999; Liu et al. 2016). This species is probably the most widespread member of the genus, in consequence there is a remarkable morphological variability as reported and also from our own observation, for example the unusual presence of 0-1-septate conidia described by Heredia-Abarca (1994) and smaller conidial size reported by Cruz et al. (2014) (Hughes 1952; Meyer 1959; Batista et al. 1965; Matsushima 1971, 1980, 1989, 1993; Kiffer et al. 1981; Heredia-Abarca 1994; Mercado Sierra et al. 1997a, b; Castañeda-Ruíz et al. 2001; Whitton et al. 2012; Cruz et al. 2014). Among the material we studied, variation on shape and size of synnemata, setae, conidia and setulae were observed. In the specimen Wu17617, the setae are with a truncated apex covered by a mucilaginous cap. The conidia from the Chinese specimens are somewhat smaller than those from original description given by Hughes (1952). Its occurrence in Taiwan was reported by Matsushima (1980).

Phialoarthrobotryum Matsush., Icones Microfungorum A Matsushima Lectorum: 111, 1975.

Teleomorph: Unknown. Anamorph: Conidiomata synnemata, cylindrical, rigid, brown, capitulate at the apex; synnematous hyphae closely packed in parallel, septate, branched at the top part, terminated with phialides. Conidia brown, septate, formed in wet spore mass.

Type species: *Phialoarthrobotryum triseptatum* Matsush. Ecology/Substrate/Host: Saprobe on dead material of *Bambusa multiplicis*.

Geographical distribution: Japan. Description and illustration: Matsushima (1975).

Phialoarthrobotryum triseptatum Matsush., Icones Microfungorum A Matsushima Lectorum: 112, 1975.

Description on the natural substrate: Colonies effuse, black. Teleomorph: Unknown. Anamorph: Synnemata solitary or 2–3 in cluster, erect, straight, 1200–1700 μ m high, 20–45 μ m wide at the middle part, basal part inflated, dark brown, capitulate at the apex; synnematous hyphae arranged in parallel to form the synnemata, septate, brown, 1.5–2.5 μ m wide, apex with 2–3 branches and terminated with 2–3 phialides. Phialides cylindrical, hyaline, 1.2–1.8 μ m wide, 2–2.5 μ m wide below the apex, collarette funnel-shaped. Conidia elongate obovoid, slightly curved, 14–25×4–6 μ m, (1–)3(–6)-septate, medium brown, formed in brown to black spore mass (From Matsushima 1975).

Typification: On branches of *Bambusa multiplicis*, Japan: Yaku Island, Kagoshima, July 1971, T. Matsushima (2183, typus). Ecology/Substrate/Host: Saprobe on dead material of *Bambusa multiplicis*.

Geographical distribution: Japan (Matsushima 1975).

Description and illustration: Matsushima (1975).

Notes: *Phialoarthrobotryum* was established for *P. triseptatum*, a microfungus on bamboo. It is similar to *Arthrobotryum* in forming synnemata, and brown and septate conidia, but with phialidic conidiogenesis (Matsushima 1975). Recently the LSU and ITS sequences were produced from the ex-type material preserved in CBS (CBS120.84 = MFC2183 from Japan, identified by Matsushima, 1971). The phylogenetic analysis together with other Chaetosphaeriaceous fungi clearly shows its affinity to Chaetosphaeriaceae. The second species, *P. brasiliense* H.P. Upadhyay described from Brazil, differs from *P. triseptata* by hyaline, 0-7(-9)-septate and fusiform conidia (Upadgyay 1981). Its phylogenetic relationship with the type species of the genus remains to be studied for the strain (ATCC46169) from the type specimen.

Phialosporostilbe Mercado & J. Meno, Revista Jard. Bot. Nac. Univ. Habana 6: 58, 1985.

Colonies effuse, hairy, greyish brown. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata synnematal, solitary, erect, unbranched, straight, or flexuous, composed of parallel, thick-walled, septate, brown, smooth conidiophores, which are usually form individual conidiophores, except for one in the center which sometimes remains sterile. Conidiophores unbranched, medium brown to dark brown, smooth, septate, thick-walled. Conidiogenous cells monophialidic, integrated, terminal, single, cylindrical to clavate, straight, thick-walled but becoming thin-walled towards the apex, periclinal thickening obvious, collarette inconspicuous. Conidia hyaline, aseptate, thin-walled, smooth, round-tetrahedral to pyramidal, with 3 protuberant corners each corner furnished with one setula, base slightly truncate to rounded with one setula. Microconidia occasionally seen, hyaline, aseptate, ellipsoidal, smooth, formed in drop from conidiogenous cells in the lower part of the synnemata.

Type species: *Phialosporostilbe trubinata* Mercado & J. Meno.

Ecology/Substrate/Host: Saprobe on dead plant material. Geographical distribution: Widely distributed, including Brazil, China, Cuba, Japan and Thailand.

Description and illustration: Mercado Sierra and Mena Portales (1985); Mercado Sierra et al. (1997a, b).

Notes: The genus *Phialosporostilbe* was introduced for a synnematous hyphomycetes with phialidic conidiogenous cells and round-tetrahedral to pyramidal conidia with a few appendages (Mercado Sierra and Mena Portales 1985). Subsequently six additional species have been added into the genus, such as *Phialosporostilbe catenata*, *P. dendroidea*, *P. gregariclava*, *P. setosa*, *P. scutiformis*, *P. yadongensis*, (Bhat and Kendrick 1993; Hyde et al. 1996; Shirouzu and Harada 2004; Sureshkumar et al. 2005; Wu and Zhang 2009; Yang et al. 2018a). Phylogenetically, *Phialosporostilbe* is closely related to other members of Chaetosphaeriaceae (Yang et al. 2018a).

Its distinction with *Nawawia* is somewhat confused, as discussed by Bhat and Kendrick (1993) and Hyde et al. (1996). The conidiogenesis and conidial morphology are almost identical among the members of described species in these two genera, the only difference is that *Phialosporostilbe* produces synnematous conidiomata with setae, while most species in *Nawawia* produce solitary conidiophore and do not have setae. However, the recent molecular study showed these two genera are phylogenetically distinct, which also leads to transfer the synnematous species *Nawawia dendroidea* into *Phialosporostilbe* (Yang et al. 2018a).

Four species have been reported from China, including *P. setosa*, *T. scutiformis*, *P. turbinata* and *P. yadongensis* (Chang 1989; Wu and Zhang 2009; Yang et al. 2018a). Here we added another species *P. gregariclava* as new record for China.

Key to known species of Phialosporostilbe.

1.	Conidia with 4–10 apical appendages
	P. yadongensis
1.	Conidia with 2-4 apical and 0-1 basal appendages2
2.	Conidia of two types, 5–7.5 µm longP. setosa
2.	Conidia 8–15 µm long
3.	Conidia without basal appendage4
3.	Conidia with both apical and basal appendages6
4.	Conidia 12–15×7.4–10 µmP. catenata
4.	Conidia < 12 µm long
5.	Conidia 10-12 µm long, 8-10 µm wide, appendage
	4–8 μm longP. dendroidea
5.	Conidia 7.5-11.6 µm long, 6-8.2 µm wide, appendage
	3.5–7.5 μm long
6.	Conidia 8.5–11.5×7–8 μm <i>P. trubinata</i>
6.	Conidia 8-13 × 8-12.5 µm
	P. gregariclava

Phialosporostilbe gregariclava Shirouzu & Y. Harada, Mycoscience 45: 390, 2004. Figure 197

Description on the natural substrate: Colonies effuse, hairy, greyish brown. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae 2–4 μ m wide. Teleomorph: Unknown. Anamorph: Conidiomata synnematal, formed from basal stroma, solitary, erect, unbranched, straight, or flexuous, up to 300 μ m tall, 15–20 μ m wide, composed of single setae and 4–7 parallel and closely compacted conidiophores. Setae cylindrical,



Fig. 197 *Phialosporostilbe gregariclava* (Wu2259). **a** Conidia. **b** Synnemata with setae. **c** Conidiophores and conidiogenous cells. **d** Fertile setae. Scale bar: **a**, **c**, **d** 20 μ m, **b** 40 μ m

dark brown, multiseptate, thick- and smooth-walled, up to 200-300 µm tall, 8-10 µm wide, terminating in a clavate to subcylindrical conidiogenous cell. Conidiophores macronematous, mononematous, cylindrical, pale brown to medium brown, 3-5-septate, smooth- and thick-walled, $60-130 \times 6-8$ µm, terminating in a clavate to subcylindrical conidiogenous cell. Conidiogenous cells monophialidic, integrated, terminal, single, clavate to subcylindrical, straight, thick-walled but becoming thin-walled towards the apex, 25-30 µm long, 8-12 µm wide at its widest part, apical collarette 3-4 µm wide, periclinal thickening obvious, collarette inconspicuous. Conidia hyaline, aseptate, thinwalled, smooth, round-tetrahedral to pyramidal, 13-15 µm across the widest points, 10-15 µm long, with 3 protuberant corners, each corner furnished with one setula, 5–6 um long, base truncate or rounded and with one setula of 4-6 µm long.

Material examined: **China**, Yunnan Province, Xishuangbanna, On rotten wood, 16 October 1999, W.P. Wu & Yan Huang (Wu2259).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Japan (Shirouzu and Harada 2004).

Description and illustration: Shirouzu and Harada (2004).

Notes: *Phialosporostilbe gregariclava* differs from the other known species in the genus by its setiform synnematous conidiomata with relatively a fewer (4–7) conidiophores, and obclavate to subcylindrical, broader conidiogenous cells, and slightly larger conidia with appendages at both ends (Mercado Sierra and Mena Portales 1985; Bhat and Kendrick 1993; Hyde et al. 1996; Shirouzu and Harada 2004).

Phialosporostilbe scutiformis N.G. Liu, J. Yang & K.D. Hyde, Mycosphere 9: 1144, 2018.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Setae $380-500 \times 4.2-5.2 \mu m$. Synnemata 14–22 µm wide. Conidiophores $245-415 \times 3.3-4.8 \mu m$. Conidiogenous cells monophialidic, cylindrical to cylindric-clavate, $35-45 \mu m$ long, $3.5-4.7 \mu m$ wide at the base, $1.9-3.0 \mu m$ wide at the tip, with an inconspicuous apical collarette. Conidia round-tetrahedral, pyramidal, smooth, aseptate, thin–walled, guttulate, viewed from above triangular, $6-8.2 \mu m$ long of each above edge, $7.5-11.6 \mu m$ long of the side, with an appendage $3.5-7.5 \mu m$ long at each corner (Yang et al. 2018a).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Thailand (Yang et al. 2018a; Zhang et al. 2022).

Description and illustration: Yang et al. (2018a); Zhang et al. (2022).

Notes: No specimen was examined by us and the above description is based on the original description (Yang et al. 2018a). *Phialosporostilbe scutiformis* is morphologically similar to *P. turbinata* and *P. dendroidea* in having tree-like structures of conidiophores and turbinate or cordiform conidia (Hyde et al. 1996; Mercado Sierra et al. 1997a, b; Shirouzu and Harada 2004; Wu and Zhang 2009). However, *P. scutiformis* is distinguished from the other species by its conspicuous seta which is erect in the center of the lower conidiophores, and size of conidia and conidial setulae.

Phialosporostilbe setosa Bhat & W.B. Kendr., Mycotaxon 49: 57, 1993.

Description on the natural substrate: Colonies effuse, hairy, greyish brown. Mycelium partly immersed and partly superficial, composed of pale brown, septate hyphae 2-3.5 µm wide. Teleomorph: Unknown. Anamorph: Conidiomata synnematal, solitary, erect, unbranched, straight or flexuous, up to 380 µm tall, 10-15 µm wide, composed of 5-20 parallel, thick-walled, septate, brown, smooth hyphae 3-4.5 µm wide, usually diverging ³/₄ distance from base to apex to form individual conidiophores, except for one in the center which remains sterile. Conidiophores unbranched, medium brown to dark brown, smooth, 1-2-septate, thick-walled, up to 380 µm long, 3-4.5 µm wide. Conidiogenous cells phialidic, integrated, terminal, single, cylindrical, straight, thick-walled but becoming thin-walled towards the apex, up to 50 µm long, 4–5 µm wide, slightly narrowing at the apex to 2-3 µm wide, periclinal thickening obvious, collarette inconspicuous. Conidia hyaline, aseptate, thin-walled, smooth, round-tetrahedral to pyramidal, 8-10 µm across the widest points, 10-12.5 µm long, with 3 protuberant corners and a slightly truncate to rounded base, each corner furnished with one setula, 4-6 µm long. Microconidia hyaline, aseptate, ellipsoidal, smooth, 2–3 µm diam, formed in drop from conidiogenous cells in the lower part of the synnemata.

Materials examined: **China** Guangdong Province, Dinghushan, on dead leaves of unidentified bamboo, 9 October 1998, W.P. Wu (Wu1993); Guangdong Province, Shaoguan, Danxiashan, on dead leaves of *?Miscanthus* sp., 25 December 2012, W.P. Wu (Wu12420). Living strains: 55,255 (from Wu12430), 55,256 (from Wu12420) and 44,663 (from Wu1903).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China, Cuba (Mercado Sierra and Mena Portales 1985) and India (Bhat and Kendrick 1993).

Description and illustration: Mercado Sierra and Mena Portales (1985); Bhat and Kendrick (1993); Hyde et al. (1996).

Notes: The fungus from the Chinese collections agrees well with the original description of *P. setosa* given by

Bhat & Kendrick, especially with the development of basal conidial setulae and a microconidia state (Mercado Sierra and Mena Portales 1985; Bhat and Kendrick 1993; Hyde et al. 1996; Shirouzu and Harada 2004).

Phialosporostilbe turbinata Mercado & Mena, Revista Jard. Bot. Nac. Univ. Habana 6:56, 1985.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Synnemata 300–620 μ m high, 13–19 μ m thick near the base, loosed up and separated into individual conidiophores, septate. Conidiogenous cells monophialidic, integrate, determinate, subulate, cylindrical, brown to pale brown at the apex. Conidia solitary, single, cuboid, hyaline, thin-walled, smooth, with semispherical base part to sit on the phialidic conidiogenous cells, 11–14 μ m length, 10–11.5 μ m wide, with 3 fine appendages, one at the apex, two at the side ridge and one at the basal part (Chang 1989).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Cuba (Chang 1989; Mercado Sierra and Mena Portales 1985).

Description and illustration: Chang (1989); Mercado Sierra and Mena Portales (1985).

Notes: No specimen was examined, and the above description is based on report on *Miscanthus* sp. and decaying twig from Taiwan by Chang (1989). Compared with the type specimen, the synnemata from the Taiwan collection is much longer and the conidia are more as cubic instead of turbinate conidia (Chang 1989).

Phialosporostilbe yadongensis Y.M. Wu & T.Y. Zhang, Mycotaxon 110:1, 2009.

Teleomorph: Unknown. Anamorph: Conidiomata synnematal 200–720 μ m tall, 10–25 μ m wide at base, 8–18 μ m wide at the apex, composed of one dark brown, central seta and 10–20 parallel, thick-walled, septate, brown conidiophores diverging at their fertile apices; setae220–720 μ m long, 6–9 μ m wide. Conidiogenous cells monophialidic, cylindrical, 20–50 μ m long, 3–5 μ m wide at the apex, with an inconspicuous apical collarette. Conidia catenate, up to 10 in a chain, cuneiform, with 4–10 radiating subapical appendages and a slightly truncate to rounded narrow base, aseptate, thick-walled, smooth, base truncate, pale brown, 6–8.5 μ m long, 6–8 μ m wide at the widest region, appendages 4–7 μ m long (Adapted from Wu and Zhang 2009).

Materials examined: **China**, Tibet, Yadong altitude 3400 m, isolated from a grassland soil, 11 September 2007, Y.M. Wu (HMAS196250, isotype).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China (Wu and Zhang 2009).

Description and illustration: Wu and Zhang (2009); Zhang and Wu (2019).

Notes: *Phialosporostilbe yadongensis* was described from a soil fungus isolated from Tibet, China and differs from other species by producing conidia with 4–10 radiating subapical appendage (Mercado Sierra and Mena Portales 1985; Wu and Zhang, 2009; Bhat and Kendrick 1993; Hyde et al. 1996; Shirouzu and Harada 2004). The isotype HMAS196250 was examined by us and it clearly shows a difference species from other known species in the genus.

Genera with sporodochial conidiomata

Among the 89 accepted chaetosphaeriaceous genera, nine genera form sporodochial conidiomata. These genera are *Adautomilanezia*, *Eucalyptostroma*, *Eucalyptostromiella*, *Minimidochium*, *Neonawawia*, *Pseudothozetella*, *Thozetella* and *Verhulstia*. Phylogenetically all these genera are well-defined monophyletic genera, but polyphyletic in the phylogenetic trees generated by using the combined data set of ITS and LSU (Fig. 3). Morphologically most of these genera are also well-delimited by a combination of setae, conidiophores, conidiogenous cells and conidia. The living strains of many studied species were also studied on PDA, some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Key to all sporodochial genera in anamorphic chaetosphaeriaceous fungi:

1.	Sporodochia without sterile setae or microawn2
1.	Sporodochia or synnemata with sterile setae or micro-
	awn
2.	Conidia ellipsoidal, fusiformEucalyptostroma
2.	Conidia lunate or falcate
3.	Conidiogenous cells cylindrical, lageniform; conidia fal-
	catePseudothozetella
3.	Conidiogenous cells with bulbous base and cylindrical
	upper part; conidia lunatEucalyptostromiella
4.	Conidiomata sporodochia or synnemata; setae absent;
	microawns presentThozetella
4.	Conidiomata sporodochia; setae present; microawns
	absent
5.	Conidia dark brown, 3-septate, ellipsoid
	Adautomilanezia
5.	Conidia hyaline, 0–1-septate6
6.	Conidia without appendagesVerhulstia
6.	Conidia bearing appendages7
7.	Conidia star-shaped, 5-lobed, bearing 4-6 filiform
	appendagesNeonawawia
7.	Conidia fusiform, falcate, with 1 filiform appendage at
	each end
8.	Conidia 1-septateRattania



Fig. 198 Eucalyptostroma hongluosiensis (a-c Wu16890, holotype; c-e Wu17318). a, f-i Conidiophores and conidiogenous cells. b-e Conidia. f Sporodochial conidiomata. Scale bar: a-e, g-i 5 µm, f 10 µm

8. Conidia aseptate......Minimidochium

Eucalyptostroma Crous & M.J. Wingf., Persoonia 37: 311, 2016.

Teleomorph: Unknown. Anamorph: Conidiomata scattered to gregarious, superficial, sporodochial, cupulate, orange-yellow; basal stroma of textura intricata. Setae absent. Conidiophores arising from a stroma, septate, branched, pale orange-brown; forming a penicillate conidiogenous apparatus. Conidiogenous cells integrated, terminal, lageniform to cylindrical, in whorls, orange-brown, finely roughened to warty, thin-walled, with apical percurrent proliferations. Conidia aseptate, hyaline, smooth, thinwalled, ellipsoid, fusiform, cylindrical, apex sub-obtuse, base truncate, widest in upper third, lacking appendages.

Type species: *Eucalyptostroma eucalypti* Crous & M.J. Wingf.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China, Colombia and Malaysia.

Description and illustration: Crous et al. (2016, 2018a, b).

Notes: The genus Eucalyptostroma was originally created for a hyphomycete occurring on Eucalyptus pellita leaves in Malaysia (Crous et al. 2016). The type species Eucalyptostroma eucalypti is characterized by stromatic conidiomata with orange-yellow spore mass, closely packed and pigmented conidiophores in a penicillate arrangement, monophialidic conidiogenous cells, and hyaline, aseptate and ellipsoid conidia. In nature, Eucalyptostroma is recognized on leaves by forming slimy, yellow-orange conidial mass on either synnemata or sporodochia (Crous et al. 2016, 2018a, b). Apart from the type species, the second species, Eucalyptostroma eucalyptorum also occurring on Eucalyptus leaves in Colombia was added into the genus and is distinguished by forming more synnematal conidiomata, and having slightly larger conidia than those in E. eucalypti $(3-4.5 \times 2 \ \mu m \ vs. 4-6 \times 1.5-2.5 \ \mu m)$ (Crous et al.

2016, 2018a, b). Phylogenetically both species are allied to Chaetosphaeriaceae (Hashimoto et al. 2015a, b; Crous et al. 2016, 2018a, b).

In our phylogenetic analysis, two known species of Eucalyptostroma (Fig. 3, Supplementary Fig. 6), E. eucalypti (the type species) and E. eucalyptorum, and two undescribed species from China, are clustered together and formed a distinct group with strong support. In addition, several isolates from decaying fruit of Quercus sp., collected around Beijing area, produce very similar conidiomata, conidiogenous cells and conidia as *Eucalyptostroma*, but they are phylogenetically very distinct and the new genus Eucalyptostromiella is created to accommodate this fungus. On the phylogenetic tree, the genus Paliphora, with setiform conidiophores, intercalary or terminal conidiogenous cells, polytretic sporulating loci on the conidiogenous cells, and hyaline, aseptate or septate, cylindrical to subfusiform or subacerose conidia in slimy masses, is clustered together with the genus Eucalyptostroma with strong support (Sivanesan and Sutton 1985; Malosso et al. 2017). Living strains of many studied species were also studied on PDA (Fig. 190), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Key to the accepted species of Eucalyptostroma.

1.	Conidiomata synnematous; conidia fusoid-ellipsoid in
	upper third, apex subobtuse, base truncate, $4-6 \times 1.5$ -
	2.5 μm <i>E. eucalyptorum</i>
1.	Conidiomata sporodochial0.2
2.	Conidia cylindrical, fusiform, $4-6 \times 1-1.5 \mu m$
	E. hongluosiense
2.	Conidia fusoid-ellipsoid, widest in the upper
	third
3.	Conidia 3–4.5×2 µmE. eucalypti
3.	Conidia $3-4 \times 1-1.2$ µmE. oxenbolliae

Eucalyptostroma hongluosiense W.P. Wu & Y.Z. Diao, sp. nov., Fig. 198, MycoBank MB841631.

Etymology: Refers to one of the localities, the Hongluo Temple, Beijing, where this fungus was collected.

Diagnosis: Similar to *Eucalyptostroma eucalypti* but differs in producing cylindrical, longer but narrower conidia.

Typification: **China**, Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead fruit of *Cyclobalanopsis* sp., 25 August 2019, W.P. Wu, Holotype HMAS 352,006 (=Wu16890), ex-type strain CGMCC 3.20669 (=NN77221).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata scattered to gregarious, superficial, sporodochial, cupulate, orange-yellow, up to 400 µm diam; basal stroma of textura intricate, composed of brown, thick-walled and irregularly shaped cells, 15–40 µm thick. Setae absent. Conidiophores arising from upper layer of the basal stroma, septate, branched, pale orange-brown, 20–28×2–2.5 μ m. Conidiogenous cells integrated, terminal, lageniform to subcylindrical, single or in whorls, orangebrown, thin-walled, 12–16×2–2.5 μ m, apex up to 1.5 μ m wide, with cylindrical or funnel-shaped collarettes. Conidia 4–6×1–1.5 μ m, aseptate, hyaline, smooth, thin-walled, cylindrical, fusiform, subcylindrical, slightly tapering towards both ends, apex subobtuse, base truncate or subobtuse, 1 μ m diam.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.3 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, white to soil brown, with pale colored margin, reverse pale brown to brown, with yellow brown pigment diffused into agar (Fig. 190i, j).

Materials examined: China, Beijing, Huairou, Hongluosi, on dead fruit of Quercus sp., 12 June 2020, W.P. Wu (WuBJ11, WuBJ12); Beijing, Huairou, Hongluosi, on dead fruit of Quercus sp., 29 July 2020, W.P. Wu (Wu17297, Wu17318, Wu17372, Wu17350, Wu17369, Wu17381); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of Quercus sp., 2 December 2018, W.P. Wu (Wu16283). Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead fruit of Cyclobalanopsis sp., China 25 August 2019, W.P. Wu (Wu16870). Living strains: 76,613 (from Wu16283), 77,221 (from the holotype Wu16890), 77,206 (from Wu16870), 77,448 (from WuWuBJ11), 77,449 (from WuBJ12), 77,936 and 77,937 (from Wu17369a, b), 77,946 and 77,947 (from Wu17318a, b), 77,952 and 77,953 (from Wu17350a, b), 77,959 (from Wu17297) and 77,997 (from Wu17377).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Eucalyptostroma hongluosiense* differs from the two known species in the genus, *E. eucalypti* (conidia ellipsoid, (3-) 4 $(-4.5) \times 2 \mu m$) and *E. eucalyptorum* (conidia ellipsoid, $(4-)5(-6) \times (1.5)2(-2.5) \mu m$), by producing cylindrical to fusiform, longer but narrower conidia $(4-6 \times 1-1.5 \mu m)$ (Crous et al. 2016, 2018a, b). The species is found on leaves and fruit of *Fagaceae* in different part of China. The ITS sequences obtained from many strains in Chinese collections have little variation and are with 6 bp differences with the ITS sequence from the ex-type strain of *E. eucalypti*, a potential indication that a different bar code is needed for species identification in this genus. It is interesting to mention that this fungus was commonly found in the inside layer of the fruit nut holder of *Quercus* sp. in Beijing.

Eucalyptostroma oxenbolliae W.P. Wu & Y.Z. Diao, sp. nov., Fig. 199, MycoBank MB841632.



Fig. 199 *Eucalyptostroma oxenbolliae* (a Wu16273, b-h Wu16283). a Part of sporodochial conidiomata with conidiophores and conidiogenous cells. b-h Conidia. Scale bar: 5 µm

Etymology: Named after the former employee, Karen Oxenboll, from Novozymes, who strongly supported this work during last many years.

Diagnosis: Similar to *Eucalyptostroma eucalypti* and *E. eucalyptorum*, but differs in smaller conidia and unique ITS sequences.

Typification: **China**, Guangdong, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu, Holotype HMAS 352,007 (=Wu16273), ex-type strain CGMCC 3.20664 (=NN76600).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata scattered to gregarious, superficial, sporodochial, cupulate, orange-yellow, 70–300 μ m diam; basal stroma of textura intricate, composed of orange-yellow, thick-walled, and irregularly shaped cells, 50–73 μ m thick. Setae absent. Conidiophores arising from a stroma, septate, branched, pale orange-brown, 25–30 μ m long, 1.5–2 μ m wide. Conidiogenous cells integrated, terminal, lageniform to subcylindrical, single or in whorls, orange-brown, thin-walled, with apical percurrent proliferations, 10–15×1.5–2.5 μ m, apex 1–1.5 μ m wide. Conidia 3–4×1–1.2 μ m, aseptate, hyaline, smooth, thinwalled, ellipsoid, apex subobtuse, base truncate, widest in upper third. Culture characteristics: Colonies on PDA effuse, colonies 1.5–2.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white to pale brown, with pale colored margin, reverse pale brown and with light brown pigment diffused into agar (Fig. 190k).

Other materials examined: **China**, Guangdong, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (Wu16315, 16277b1). Living strains: 76,601 (from Wu16273),76,705 (from Wu16315) and 76,693 (from Wu16277b1).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Eucalyptostroma oxenbolliae* is morphologically similar to the three species under the genus, *E. eucalypti* (conidia ellipsoid, $(3-)4(-4.5) \times 2 \mu m$) and *E. eucalyptorum* (conidia ellipsoid, $(4-)5(-6) \times (1.5)2(-2.5) \mu m$) and *E. hongluosiensis*, but differs by producing smaller conidia $(3-4\times1-1.5 \mu m)$ (Crous et al. 2016, 2018a, b). Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 76,600 include *E. eucalypti* (GenBank NR_154027, 97% identity), *E. eucalyptorum* (GenBank NR159834, 96% identity) and *E. hongluosiensis* (GenBank OL628283, 96% identity).

Eucalyptostromiella W.P. Wu & Y.Z. Diao, gen. nov., Myco-Bank MB841543.

Etymology: Refers its similarity to the gnus *Eucalyptostroma*.

Diagnosis: Similar to *Eucalyptostroma* in orange-yellow sporodochial conidiomata, but morphologically differs in producing flask-shaped conidiogenous cells with a bulbous basal part and a tubular upper part, and lunate or falcate conidia with acute ends in morpho; and phylogenetically is also distinct.

Type species: *Eucalyptostromiella beijingensis* W.P. Wu & Y.Z. Diao.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata scattered to gregarious, superficial, sporodochial, cupulate, orange-yellow; basal stroma of textura intricata. Setae absent. Conidiophores arising from a stroma, septate, branched, orange-yellow to orange-brown, forming a penicillate conidiogenous apparatus. Conidiogenous cells integrated, terminal, flask-shaped, with a bulbous basal part and a tubular upper part, in whorls, orange-brown, thin-walled, with apical percurrent proliferations through collarettes; collarettes inconspicuous, slightly flaring. Conidia aseptate, hyaline, smooth, thin-walled, falcate or lunate, acute at both ends, produced in yellow-orange and slimy mass.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: The new genus *Eucalyptostromiella* is created for the sporodochial fungus on dead fruit of *Quercus* sp. and supported from both the phylogenetic analysis and morphological comparison with other relevant Chaetosphaeriaceous fungi, especially *Eucalyptostroma*. Morphologically the genus *Eucalyptostromiella* resembles *Eucalyptostroma* on producing sporodochial conidiomata with yellow-orange wet spore mass, yellow-orange conidiophores, terminal monophialidic conidiogenous cells, and hyaline, aseptate conidia (Crous et al. 2016, 2019). However, it differs from Eucalyptostroma in producing flask-shaped conidiogenous cells with a bulbous basal part and a tubular upper part, and falcate or lunate conidia with acute ends. In addition, they are phylogenetically distinct in the phylogenetic tree.

Eucalyptostromiella beijingensis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 200, MycoBank MB841633.

Etymology: Refers the locality Beijing, China, where this fungus was originally collected.

Diagnosis: Conidiomata sporodochial, fresh colored, yellow-orange to yellow-brown. Conidiophores cylindrical, yellow orange, $20-34 \times 1.5-2 \mu m$. Conidiogenous cells flask-shaped with a bulbous basal part and a tubular upper part, $12-15 \mu m \log$, $2-2.5 \mu m$ at the base, $1-1.2 \mu m$ in the upper part; collarettes inconspicuous, slightly flaring, with 0-3 percurrent proliferations through collarettes. Conidia falcate or lunate $9.5-12 \times 1.2-1.8 \mu m$, acute at both ends.

Typification: **China**, Beijing, Huairou, Hongluosi, on dead fruit of *Quercus* sp., 29 July 2020, W.P. Wu, Holotype HMAS 352,008 (=Wu17319), ex-type strain CGMCC3.20753 (=NN78017).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata scattered to gregarious, superficial, sporodochial, cupulate, orange-yellow or yellow-brown, up to 500 µm diam; basal stroma of textura intricate, composed of pale brown to dark brown, thick-walled, irregular shaped cells, up to 3 µm diam. Setae absent. Conidiophores arising from an upper layers of basal stroma, septate, branched, pale orange-yellow, slightly darker in the basal part, $20-34 \times 1.5-2 \mu m$, densely packed in a sporulating layer. Conidiogenous cells integrated, terminal, monophialidic, with a bulbous lower part and a narrow tubular upper part, single or a few in whorls, yellow-orange, thinwalled, 12–15 µm long, the low bulbous part 6–7 µm long and 2–2.5 μ m wide, the tubulous upper part 5–7 × 1–1.2 μ m; collarettes inconspicuous, slightly flaring, with 0-3 percurrent proliferation through collarettes. Conidia falcate, lunate, acute at both ends, $9.5-12 \times 1.2-1.8 \mu m$, aseptate, hyaline, smooth, thin-walled, produced in yellow-orange wet spore mass.


Fig. 200 *Eucalyptostromiella beijingensis.* **a**, **b** Sporodochial conidiomata. **c** Part of conidiomata with conidiophores and conidiogenous cells. **d**-**i** Conidiogenous cells. **j** Conidia. All from the holotype specimen Wu17319. Scale bar: **a**, **b** 10 μm, **c**-**i** 5 μm

Culture characteristics: Colonies on PDA effuse, colonies 1.0–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to brown in the central part, reverse brown to dark brown (Fig. 1901).

Other living strains: 78,016 and 78,012 (all from Wu17319).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Eucalyptostromiella beijingensis* resembles the four known species in *Eucalyptostroma*, but differs by flask-shaped conidiogenous cells with a bulbous lower part and a tubulous upper part, and falcate or lunate conidia with acute ends (Crous et al. 2016, 2018a, b).

Phylogenetically, *Eucalyptostromiella* is closely related to members in Chaetosphaeriaceae. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 78,012 include *Dictyochaeta fuegiana* (GenBank EF063574, 93% identity), *D. callimorpha* (GenBank AF466062, 93% identity) and *Exserticlava vasiformis* (GenBank AB753864, 92% identity).

Minimidochium B. Sutton, Can. J. Bot. 47: 2095, 1970.

Colonies effuse, brown, sparse. Mycelium immersed composed of pale brown, branched, smooth, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata sporodochia, scattered, punctiform, pulvinate, dark brown to black, setose. Setae sterile, arising from the lower cells of the stroma, subulate, acutely pointed, mid to dark brown, smooth, simple, erect, straight. Conidiophores macronematous, formed a close palisade over the surface of the stroma, straight or flexuous, hyaline to pale brown, smooth, septate. Conidiogenous cells integrated and terminal or discrete, monophialidic, cylindrical, clavate, lageniform, with a very small apical collarette. Conidia holoblastic, solitary, hyaline, aseptate or septate, curved, cylindrical, subcylindrical, fusiform, falcate, furnished with setulae appendages at each end (Adapted from Sutton 1970).

Type species: Minimidochium setosum B. Sutton.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Description and illustration: Sutton (1969); Seifert et al. (2011).

Notes: The genus *Minimidochium* was introduced by Sutton (1969) for a sporodochial hyphomycetes with falcate and appendaged conidia, *M. setosum*. Subsequently six species have been added into the genus so far, they are *Minimidochium crepuscolarae*, *M. eucalypti*, *M. indicum* Varghese & V.G. Rao, *M. indicum* Vittal & Doral (illegitimate), *M. microsporum*, *M. nipponicum* and *M. parvum* (Sutton 1969; Varghese and Rao 1978; Vittal and Dorai 1993; Matsushima 1995, 1996); Cabello et al. 1998; Pasqualetti et al. 2005; Zhao and Zhao 2012). No DNA sequence has been available for molecular phylogenic study, especially from the type species. Here we generated the ITS and LSU sequences from a new species, and assign the genus to Chaetosphaeriaceae. However, its taxonomic position might change according to the molecular phylogeny study with involvement of type species in future.

The genus was known from China with only one species, *M. monoseptatum*. Here we added another two species from China.

Key to known species of Minimidochium.

1.	Conidia 1–3 septate2
1.	Conidia aseptate
2.	Conidia 1-septate, 11–14×2–2.5 µm
	M. monoseptatum
2.	Conidia 3-septate, 35–42×5–6 µmM. triseptata
3.	Conidia with setulae at both ends, apical setulae
	branchedM. eucalypti
3.	Conidia with setulae at both ends, apical setulae unbra
	nched4
4.	Conidia less than 10 µm long5
4.	Conidia more than 10 µm long6
5.	Conidia $3.5-5 \times 1.5-2.7 \ \mu m$, setulae $0.5-2.5 \ \mu m$
	longM. microsporum
5.	Conidia 7.5–9.5 \times 2–2.5 µm, setulae 5–8 µm long
	M. setosum
6.	Conidia less than 2 µm wide7
6.	Conidia more than 2 µm wide8
7.	Conidia 8–12×1 µmM. parvum
7.	Conidia $12-15 \times 1.8-2 \mu m$; setulae $3-4 \mu m \log \dots$
	M. dictyochaetum
8.	Conidia more than 20 µm long9
8.	Conidia up to 17 µm long10
9.	Conidia $25-37 \times 4-5 \mu m$, setulae $3-7 \mu m \log \dots$
	M. falcata
9.	Conidia $20-23 \times 2-2.5 \ \mu\text{m}$, setulae 6–7 μm long
	M. elegans
10.	Conidia $10-13 \times 2.5-3.5 \mu\text{m}$, setulae $4-8 \mu\text{m}$
	M. nipponicum
10.	Conidia $11.5-16.5 \times 2-2.5 \ \mu m$, setulae up to
	10 μm <i>M. indicum</i>

Minimidochium dictyochaetum W.P. Wu, sp. nov., Fig. 201, MycoBank MB841634.

Etymology: Refers to its similarity to the genus *Dicty-ochaeta* in conidial morphology.

Typification: **China**, Yunnan Province, Xishuangbanna, on dead leaves of unidentified tree, 12 June 2018, Yu Zhang, Holotype HMAS 352,023 (= Wu15158), ex-type strain CGMCC 3.20660 (= NN75992).



Fig. 201 *Minimidochium dictyochaetum* (Wu18158, holotype). a Sporodochial conidiomata with setae and wet spore mass. b-k Conidia. l-m Setae. n Conidiogenous cell. Scale bar: a 20 μm, l-m 10 μm, b-k, n 5 μm

Description on the natural substrate: Mycelium immersed, composed of pale brown, branched, smooth, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata sporodochia, scattered, punctiform, pulvinate, dark brown to black, setose, 30-50 µm wide, 40-60 µm high, covered by white spore mass. Setae sterile, arising from the lower part of the stroma, subulate, acutely pointed, mid to dark brown, becoming paler towards the apex, smooth, simple, erect, straight or slightly curved, 5–8-septate, $200-420 \times 6-10 \,\mu\text{m}$. Conidiophores cylindrical, formed a close palisade over the surface of the stroma, straight or flexuous, pale brown to brown, becoming subhyaline towards the apex, smooth, 1–3-septate, $30-40 \times 2-3$ µm. Conidiogenous cells integrated and terminal, monophialidic, cylindrical, lageniform, $9-11 \times 2.5-3 \mu m$, with a very small apical collarette. Conidia holoblastic, solitary, hyaline, aseptate, curved, fusiform, apex acute, base slightly truncate, $13-15 \times 1.8-2$ µm, furnished with a setula at each end, 3-4 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 2.5–3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to pale brown, reverse pale brown to brown (Fig. 204a, b).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Minimidochium dictyochaetum* is characterized by sporodochial conidiomata, presence of setae among conidiophores, and hyaline, falcate, fusiform, aseptate conidia in large size ($20-23 \times 2-2.5 \mu m$) and bearing a short appendage ($3-4 \mu m$ long) at each end. Among the known species with aseptate conidia bearing unbranched setulae in the genus are *M. indicum*, *M. microsporum*, *M. nipponicum*, *M. parvum* and *M. setosum*, none of them has conidia longer than 20 μm , thus they can be easily distinguished from the new species described here (Sutton 1970; Ciccarone 1988; Vittal and Dorai 1991; Matsushima 1995, 1996; Cabello et al. 1998). *Rattania falcata* W.P. Wu described in this work also produces relatively larger conidia ($25-37 \times 4-5 \mu m$, with one setulae at each end and $4-7 \mu m$ long), but its conidia are much larger and with longer setulae.

Phylogenetically, *Minimidochium dictyochaetum* is closely related to some members in Chaetosphaeriaceae. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 75,992 include *Codinaea acaciae* (Gen-Bank KY965397, 89% identity), *Dictyochaeta aquatica* (GenBank MH476572, 90% identity), *D. curvispora* (Gen-Bank MH862954, 90% identity). 400



Fig. 202 Minimidochium triseptata (a-d Wu2083p, holotype) and Rattania intermedia (e-g Wu1998d, holotype). a Sporodochial conidiomata with setae and wet spore mass. b, e Setae. c, f Conidiophores and conidiogenous cells. d, g Conidia. Scale bar: a 100 µm, b-g 20 µm

Minimidochium triseptata W.P. Wu & Y.Z. Diao, sp. nov., Fig. 202a–d, MycoBank MB841635.

Etymology: Refers its 3-septate conidia.

Diagnosis: Differs from other species in the genus by 3-septate conidia in bigger size $(35-42 \times 5-6 \ \mu m)$ and bearing a longer setula $(7-10 \ \mu m)$ at each end.

Typification: **China**, Guangdong Province, on dead leaves of *?Smilax* sp., October 9 1998, W.P. Wu, Holotype HMAS 352,024 (=Wu2083p).

Description on the natural substrate: Mycelium immersed, composed of pale brown, branched, smooth, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata sporodochia, scattered, punctiform, pulvinate, dark brown to black, setose, up to 600 µm in diam. Setae sterile, arising from the lower cells of the stroma, subulate, acutely pointed, mid to dark brown, becoming paler towards the apex, smooth, simple, erect, straight or slightly curved, 8–12-septate, $250-375 \times 5-7 \mu m$, tapering toward a narrower upper part and acute apex. Conidiophores cylindrical, formed a close palisade over the surface of the stroma, straight or flexuous, pale brown to brown, becoming subhyaline towards the apex, smooth, 1–3-septate, $20-40 \times 4-5 \mu m$. Conidiogenous cells integrated and terminal, monophialidic, cylindrical, lageniform, $12-20 \times 4-5.5 \mu m$, with an apical collarette. Conidia holoblastic, solitary, hyaline, 3-septate, curved, fusiform, apex acute, base slightly truncate, $35-42 \times 5-6 \mu m$, furnished with a setula at each end, 7–10 μm long.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.



Fig. 203 *Pseudothozetella lunata* (Wu15207, holotype). **a, b** Sporodochial conidiomata. **c** Conidiophores and conidiogenous cells with collarette. **d–j** Conidia. Scale bar: **a** 40 μm, **b** 10 μm, **c–j** 5 μm



Fig. 204 Colony of *Minimidochium and Rattania* species on PDA after 20 days at 25 °C. **a**, **b** *Minimidochium dictyochaetum* (ex-type strain 75992). **c**, **d** *Rattania falcata* (ex-type strain 76627). **e**, **f** *R*. *intermedia* (ex-type strain 44906)

Notes: *Minimidochium triseptata* fits well into the genus *Minimidochium* in sporodochial conidiomata, presence of setae, monophialidic conidiogenous cells and hyaline conidia with appendages. It differs from all known species in the genus by producing 3-septate conidia in bigger size and bearing a longer setulae at each end (Sutton 1970; Ciccarone 1988; Vittal and Dorai 1991; Matsushima 1995, 1996; Cabello et al. 1998; Zhao 2012). No strain and DNA sequence data were obtained from the specimen for molecular phylogenetic analysis.

Pseudothozetella W.P. Wu & Y.Z. Diao, gen. nov., Myco-Bank MB841544.

Etymology: Refers its similarity to the genus *Thozetella* in sporodochial conidiomata.

Diagnosis: Similar to *Thozetella* in producing sporodochial conidiomata with slimy spore mass and hyaline, aseptate, falcate or fusiform to lunate conidia, but differs in no microawns and conidia without setulae.

Type species: *Pseudothozetella. lunata* W.P. Wu & Y.Z. Diao

Teleomorph: Unknown. Anamorph: Conidiomata sporodochia, scattered, punctiform, white, cream to light brown, topped by a moist spore mass. Conidiophores hyaline to pale brown, septate, smooth-walled, simple, or branched, cylindrical, terminating by one to several conidiogenous cells. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, hyaline to pale brown; collarettes inconspicuous, cylindrical, slightly flaring. Conidia holoblastic, falcate, fusiform, lunate, hyaline, aseptate, thin- and smooth-walled, with a truncated or obtuse base and a pointed apex, produced in slimy mass.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Pseudothozetella lunata W.P. Wu & Y.Z. Diao, sp. nov., Fig. 203, MycoBank MB841636

Etymology: Refers its lunate conidia.

Diagnosis: Conidiomata sporodochial, up to 80 μ m high. Conidiophores 70–120×2.5–4 μ m, 2–6-septate, branched, brown. Conidiogenous cells 14–19×2.5–3 μ m,

monophialidic; collarettes inconspicuous, cylindrical, slightly flaring. Conidia falcate, fusiform, lunate, hyaline, aseptate, $22-27 \times 1.2-1.6 \mu m$, with truncate or obtuse base and acute apex, produced in slimy mass.

Typification: **China**, Yunnan Province, Jinghong, Xishuangbanna, on dead leave of unidentified tree, 6 December 2018, Zhang Yu, Holotype HMAS 352,047 (= Wu15207), ex-type strain CGMCC 3.20661 (= NN76055).

Description on the natural substrate: Colonies creamcolored. Mycelium partly immersed and partly superficial, composed of dark brown, septate, and branched hyphae. Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears an ovoid to cylindrical, white mass of conidia. Basal stroma dark brown, composed of dark brown, irregularly shaped cells of 2-3.5 µm wide, up to 80 µm high. Conidiophores cylindrical, brown, irregularly branched, 2-6-septate, compact at base, more or less free toward of upper part of sporodochia, $70-120 \times 2.5-4$ µm. Conidiogenous cells monophialidic, integrated, terminal, light brown, cylindrical, $14-19 \times 2.5-3 \mu m$, periclinal wall thickened; collarettes inconspicuous, slightly flaring, 1-1.2 µm wide and 0.5–0.8 µm deep. Conidia falcate, fusiform, lunate, curved or straight, aseptate, hyaline, smooth, $22-27 \times 1.2-1.6 \mu m$, with a truncate or obtuse base, tapering towards a pointed apex, formed in slimy spore mass.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to dark brown, reverse brown to dark brown (Fig. 190m).

Other living strains: 76,056, 76,057, 76,058, 76,083, 76,084 and 76,103 (all from Wu15207).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: The new genus *Pseudothozetella* is characterized by sporodochial conidiomata, closely packed conidiophores terminating with monophialidic conidiogenous cells, and hyaline, aseptate, falcate, lunate, or fusiform conidia produced in slimy mass. Morphologically it is closely related to *Thozetella* but lacking microawn and conidial setulae, to *Menisporopsis* but without setae associated with conidiophores and asetulate conidia (Seifert et al. 2011).

The LSU and ITS sequences were also obtained from the single spore isolate of this species and its phylogenetic affinity to *Arthrobotryum*, *Thozetella* and *Chaetosphaeria* in Chaetosphaeriaceae was confirmed. Based on LSU blast in NCBI's GenBank, the closest matches to the extype strain 76,055 include *Chaetosphaeria fuegiana* (Gen-Bank EF063574, 93% identity), *C. callimorpha* (GenBank AF466062, 94% identity). Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 76,055 include Arthrobotryum hyalosporum (GenBank MH861926, 88% identity), C. dilabens (GenBank MH861683, 84% identity) and Phialocephala fusca (GenBank AB671500, 83% identity).

Rattania Prabhugaonkar & Bhat, Mycotaxon 108: 218, 2009.

Teleomorph: Unknown. Anamorph: Conidiomata sporodochia, superficial, gregarious, dark brown, setose, with a small stroma at the base. Setae erect, straight to flexuous, unbranched, rhizoidal at base, tapering to a pointed apex, septate, smooth, thick-walled, dark brown. Conidiophores distinct, branched, smooth, hyaline, arising in a palisade layer from a pseudoparenchymatous stroma. Conidiogenous cells terminal, integrated, usually monophialidic, sometimes extending sympodially once or twice to produce successive solitary holoblastic conidia, after secession leaving an inconspicuous, flat secession scar with no evident wall thickening. Conidia slimy, solitary, fusiform, curved, hyaline, smooth, aseptate or septate, thin-walled, truncate at the base, acuminate at the tip, setulate at both ends (Adapted from Prabhugaonkar and Bhat 2009).

Type species: *Rattania setulifera* Prabhugaonkar & Bhat. Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and India.

Description and illustration: Prabhugaonkar and Bhat (2009); Seifert et al. (2011); Calabon et al. 2021).

Notes: *Rattania* was introduced by Prabhugaonkar and Bhat (2009) to accommodates *Rattania setulifera*, a species isolated from fresh leaves of rattan in India. The genus is characterized by sporodochial conidiomata with setae, monoblastic conidiogenous cells, and slimy, fusiform, 0–5-septate conidia bearing one setula at each end (Ellis 1971, 1976; Prabhugaonkar and Bhat 2009; Bhat 2010; Seifert et al. 2011). The second species, *R. aquatica* M.S. Calabon & K.D. Hyde from submerged decaying wood in freshwater river in Thailand, was recently added into the genus (Calabon et al. 2021) (Fig. 204).

Shenoy et al. (2010) placed the genus in Chaetosphaeriaceae. It resembles *Brunneodinemasporium*, *Dinemasporium*, *Minimidochium*, *Neopseudolachnella*, *Pseudodinemasporium*, *Pseudolachnea* and *Pseudolachnella*, which morphologically also produce setose conidiomata, phialidic conidiogenous cells, and hyaline and falcate conidia with appendages. All these genera phylogenetically belong to the family Chaetosphaeriaceae (Ellis 1971, 1976; Sutton 1980a, b; Seifert et al. 2011; Lin et al. 2019; Fig. 3, Supplementary Fig. 7). Among these genera, all genera except for *Minimidochium* belong to coelomycetes producing cupulate to discoid conidiomata with lateral prosenchymatic wall (Sutton 1980a, b; Seifert et al. 2011; Hashimoto et al. 2015a, b), thus they can be easily distinguished from the genus *Rattania*.



Fig. 205 *Rattania falcata* (a-f, j-l Wu16324, holotype; f, g, h, I, m Wu16364). a-d Sporodochial conidiomata with setae. e, f Short setae-like structure. g Conidiophores and conidiogenous cells with

narrow sporulating channel and inconspicuous collarettes. h–m Conidia. Scale bar: a 10 $\mu m,$ b–m 5 μm

The genus *Minimidochium*, also a hyphomyces with superficial sporodochial conidiomata, can be distinguished from *Rattania* by its conidiogenous cells and conidia, furthermore phylogenetically they are clearly clustered into distinct clades in the phylogenetic tree. The living strains of studied species were also studied on PDA (Fig. 216).

Key to known species of Rattania.

1.	Conidia 1-septate, $25-50 \times 1.5-3.5 \mu m$; setulae 1–5 μm
	longR. setulifera
1.	Conidia aseptate2
2.	Conidia $12-17 \times 2.5-3 \mu m$; setulae 5-6.5 μm
	longR. falcata
2.	Conidia more than 20 µm long3
3.	Conidia $22-27 \times 3-5 \mu m$; setulae $3.6-8.3 \mu m$
	R. aquatica
3.	Conidia $25-37 \times 4-5 \mu m$; setulae $3-7 \mu m \log \dots$
	R. intermedia

Rattania falcata W.P. Wu & Y.Z. Diao, sp. nov., Fig. 205, MycoBank MB841637.

Etymology: Refers to its falcate conidia.

Diagnosis: Similar to the type species *Rattania setulifera*, but differs in producing phialidic conidiogenous cells and smaller conidia ($22-27 \times 3-5 \mu m$ in *R. aquatica* vs. $12-17 \times 2.5-3 \mu m$ in *R. falcata*). Also similar to *R. aquatica* but differs in smaller conidia ($22-27 \times 3-5 \mu m$ in *R. aquatica* vs. $12-17 \times 2.5-3 \mu m$ in *R. falcata*).

Typification: **China**, Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu, Holotype HMAS 352,048 (= Wu16324), ex-type strain CGMCC 3.20731 (= NN76627).

Description on the natural substrate: Mycelium immersed, composed of pale brown, branched, smooth, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata sporodochia, scattered, punctiform, pulvinate, dark brown to black, setose, 70–110 µm wide, 70–90 µm high, dark brown, basal stroma composed of dark brown, irregular cell. Setae sterile, arising from the lower part of the stroma, subulate, acutely pointed, mid to dark brown, becoming paler towards the apex, smooth, simple, straight or slightly curved, up to 3-13-septate, 150-520 µm long, the longer setae are $15-17 \,\mu m$ wide, and the short setae are 8–10 µm wide, with a long basal cells in 12–23 µm wide; hyphae in the outside layer of the basal stroma terminated with an obclavate setae with a wider base and tapering toward a pointed apex, $12-17 \times 3-3.5 \mu m$. Conidiophores formed a close palisade over the surface of the stroma, straight or flexuous, pale brown, becoming hyaline towards the apex, smooth, 1–3-septate, branched, $15-23 \times 2-3.5 \mu m$. Conidiogenous cells integrated, terminal, monophialidic,

cylindrical, lageniform, $9-11 \times 2.5-3.5 \mu m$, pale brown to brown, with a very small apical collarette. Conidia holoblastic, solitary, hyaline, aseptate, falcate, fusiform, curved, multiguttulate, $12-17 \times 2.5-3 \mu m$, apex attenuating into an acute apex, base truncate or rounded, furnished with a setula at each end, $5-6.5 \mu m$ long.

Culture characteristics: Colonies on PDA effuse, colonies 1.2–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, grey to slightly yellow, reverse dark brown in the center and becoming pale brown towards the margins (Figs. 204c, d).

Other materials examined: **China**, Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (Wu16314, 16,364, 16364a); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead fruit of unidentified broad leaf tree, 17 October 2020, W.P. Wu (Wu1774); Guangdong Province, on dead leaves of *?Smilax* sp., 9 October 1998, W.P. Wu (Wu2083a). Living strains: 76,663 (from Wu16364), 76,664 (from Wu16364a), 78,376 and 78,377 (from Wu17574).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Rattania falcata* differs from the known species in the genus *R. setulifera* by aseptate conidia in smaller size (aseptate and $12-17 \times 2.5-3 \mu m$ in *R. falcata*; 0–5-septate and $25-50 \times 1.5-3.5 \mu m$ in *R. setulifera*); from *R. aquatica* by small-sized conidia (aseptate, $22-27 \times 3-5 \mu m$ in *R. aquatica*) (Prabhugaonkar and Bhat 2009; Calabon et al. 2021).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 76,627 include *Rattania aquatica* (GenBank MW260331, 99% identity) and unidentified endophytic Sordariomycetes (GenBank AB847015, 95% identity). It is with surprise that the ITS sequences from *R. aquatica*, *R. falcata* and *R. intermedia* are almost identical (>99%), althgouth they can easily be distinguished by the conidial size.

Rattania intermedia W.P. Wu & Y.Z. Diao, sp. nov., Fig. 202e–g, MycoBank MB841638.

Etymology: Refers its conidial size between the other accepted species.

Diagnosis: Similar to *Rattania aquatica* and *R. falcata* in phialidic conidiogenous cells and falcate conidia, but differs in larger conidia.

Typification: **China**, Guangdong Province, Zhaoqing, Dinghushan, on dead branches of unidentified plant, 11 October 1998, W.P. Wu, Holotype HMAS 352,049 (=Wu1998d), ex-type strain CGMCC3.20638 (=NN44906).

Description on the natural substrate: Mycelium immersed, composed of pale brown, branched, smooth, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, scattered, punctiform, pulvinate, dark brown to black, setose, dark brown, basal stroma composed of dark brown, irregular cell. Setae sterile, arising from the lower part of the stroma, subulate, acutely pointed, mid to dark brown, becoming paler towards the apex, smooth, simple, straight or slightly curved, up to 10-septate, $160-320 \times 3-5 \mu m$, with a slightly swollen base up to 15 µm wide. Conidiophores cylindrical, formed a close palisade over the surface of the stroma, straight or flexuous, pale brown, becoming hyaline towards the apex, smooth, 2-4-septate, branched, 25-35×2.5-4 µm. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, lageniform, $10-15 \times 3-4.5 \mu m$, pale brown, with a very small apical collarette. Conidia holoblastic, solitary, hyaline, aseptate, falcate, fusiform, curved, multiguttulate, $25-37 \times 4-5$ µm, apex attenuating into an acute apex, base truncate or rounded, furnished with a setula at each end, $3-7 \mu m \log$.

Culture characteristics: Colonies on PDA effuse, colonies 2.8–3.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, grey, reverse dark brown in the center and becoming pale brown towards the margins (Figs. 204e, f).

Other material examined: China: Guangdong Province, Dinghushan, on dead branches of *Quercus* sp., 9 October 1998, W.P. Wu (1852e). Living strains: 44,665 (from Wu1852e) and 45,779 (from Wu1998d).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Rattania intermedia* differs the known species in the genus by conidial septation and size. The conidia in *R. setulifera* are septate and much larger (0–5 septate and $25-50 \times 1.5-3.5 \mu$ m) (Prabhugaonkar and Bhat 2009); the conidia in *R. falcata* is also aseptate but much smaller (12–17×2.5–3 µm). In addition, their ITS sequences are also significantly different from each other.

Phylogenetically, *Rattania intermedia* is closely related to some members in Chaetosphaeriaceae. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 44906 include *Rattania aquatica* (GenBank MW260331, 99% identity) and unidentified endophytic Sordariomycetes (GenBank AB847015, 95% identity).

Thozetella Kuntze, Revisio Generum Plantarum, A. Felix, Leipzig 2: 873, 1891.

Saprobic on decaying leaf, branches, and decaying wood. Teleomorph: Ascomata non-stromatic, semi-immersed, scattered to gregarious, often with confluent walls, subglobose to broadly conical, brown, glabrous, papillate, opening by a rounded pore. Ostiole central, periphysate. Peridium leathery to fragile, carbonaceous, two layered; outer wall composed of brown, brick-like cells of textura prismatica, cells opaque in the upper part, pale brown at the base, towards the interior grading into several rows of thin-walled, hyaline, flattened cells. Hamathecium composed of abundant, persistent, septate, hvaline paraphyses. Asci 8-spored, unitunicate, cylindrical-clavate, rounded, slightly tapering at the apex, short-pedicellate, with a distinct, non-amyloid apical annulus. Ascospores ellipsoid to narrowly fusiform, slightly curved, 1-septate, septum indistinct, not constricted at the septum, hyaline to yellowish grey, smooth-walled, arranged obliquely uniseriate, often two-seriate only in the upper fertile part, with a hardly defined mucilaginous sheath swelling and diffusing in water. Anamorph: Conidiomata sporodochia or synnemata-like, scattered, punctiform, white, cream to light brown, topped by a moist spore mass. Microawns absent or present, produced from conidiogenous cells, hyaline, thin or thick-walled, L-shaped, or hamate, sigmoid, or lunate or sickle-shaped, smooth, or rough-walled, aseptate or septate. Conidiophores hyaline to pale brown, septate, smooth-walled, simple, or branched, cylindrical. Conidiogenous cells integrated, terminal, monophialidic, cylindrical, hyaline to pale brown, with or without a minute apical collarette. Conidia holoblastic, lunate, aseptate, thin- and smooth-walled, with or without one filiform setula at each end.

Type species: *Thozetella nivea* (Berk. & Muell.) Kuntze. Ecology/Substrate/Host: Saprobe on dead plant material,

including leaves, seed, branches and rotten wood.

Geographical distribution: Broadly distributed, especially in subtropical and tropical area.

Description and illustration: Kuntze (1891); Pirozynski and Hodges (1973); Sutton and Cole (1983); Mercado Sierra et al. (1997a, b); Sliva and Grandi (2013).

Notes: The genus Thozetella is characterized by sporodochial or synnematous conidiomata, presence of microawns, cylindrical conidiophore, monophialidic conidiogenous cell with or without a minute collarette, and hyaline, aseptate, falcate, curved conidia with one setulae at each end (Seifert et al. 2011). Members of *Thozetella* also produce a second type of "conidium" from the conidiogenous cells, referred to as microawns, which are hyaline, aseptate or septate, often curved, variously shaped, smooth or verruculose especially towards the apex (Pirozynski and Hodges 1973; Nag Raj and Kendrick, 1975; Sutton and Cole 1983; Castañeda-Ruiz 1985a, b, 1985c; Sliva and Grandi 2013). These microawns are unique within the anamorphic fungi, but their role is unknown (Sutton and Cole 1983). Thozetellopsis Agnihothr. is similar to Thozetella but differs in absence of microawns (Agnihothrudu 1958; Sherwood 1974). Future phylogenetic analysis might show they represent the same genus.

At present there are 22 described species in the genus *Thozetella* (Pirozynski and Hodges 1973; Shearwood 1974; Nag Raj 1976; Sutton and Cole 1983; Castañeda-Ruiz 1984;



Fig. 206 Maximum likelihood (ML) tree based on ITS sequence data for the genus *Thozetella*. Bootstrap support values $\geq 60\%$, Bayesian posterior probability values ≥ 0.95 are shown at the nodes. *Chaetosphaeria myriocarpa* CBS24175B was chosen as the outgroup. Ex-

Castañeda-Ruiz and Arnold 1985a, b; Mercado Sierra et al. 1997a, b; Natalia et al. 2004; Paulus et al. 2004; Jeewon et al. 2009; Silva and Grandi 2011; Barbosa et al. 2011; Sliva and Grandi 2013; Monteiro et al. 2016; Perera et al. 2016; Hyde et al. 2020). Species concept in this genus is mainly based on limited characters of microawns and conidia (shape and size). This was questioned by Pirozynski and Hodges (1973), who recognized that T. cristata, T. tocklaiensis, and T. radicata were a series of species differentiated on conidial, microawn, and synnemata dimensions and development, and could represent a single species with geographical variations. This was further supported by experimental data by Sutton and Cole (1983), Waipara et al. (1996), Sliva and Grandi (2013) who showed a great variation of T. effusa and many other species on different substrates. Knowledge of variation with growth conditions and age was limited for

type strains are indicated with "T" in the end of the taxa labels. Latin names and ex-type strain numbers of the new species described in the current study are shown in font

most species. Keys to described species were provided by Paulus et al. (2004), Whitton et al. (2012) and Barbosa et al. (2011). Barbosa et al. (2011) and Monteiro et al. (2016) also illustrated the microawns from all known species.

Paulus et al. (2004) successfully used the ITS sequences to distinguish the 5 new species of *Thozetella*, since then the ITS sequences have been used for species identification (Jeewon et al. 2009; Perera et al. 2016). Including of *T. ciliata* is doubtful due to lacking microawns and producing setae. In our phylogenetic analysis (Figs. 3, 206), the sporodochial or synnematous genus *Thozetella*, typified by *T. nivea*, was resolved as a monophyletic clade with strong support value in all analysis. The relationship between *Chaetosphaeria*. and *Thozetella* was suggested by Paulus et al. (2004) and later confirmed with *Chaetosphaeria rivularis* (Ariyawansa et al. 2015). *Chaetosphaeria rivularis*, originally described with both teleomorph and *Thozetella*-like anamorph on

	↑↑ Thozetella fanglanii 78390
100/1	Those tella fanglanii 76092 T
100	Thozetella wenyingiae 776045
	Thozetella wenyingiae 76012
99/0.99 _	Thozetella wenyingiae 776044
92/	Thozetella wenyingiae 76043
93/-	Thozetella wenyingiae 57578 T
	Thozetella wenyingiae 57596
9//- /	Those we we must be a set of the
	Thosetella verniformis 77559
	Thozetella vermiformis 77659
	Thozetella lithocarpi 78391
91/-	Thozetella lithocarpi MFLUCC 16-0194 T
	Thozetella lithocarpi 78391
	Thozetella lithocarpi 78384
	Thozetella lithocarpi 78383
	Thozetella lithocarji 78372
	Thozetella lithocarpi /8255
93/-	1 //024/el/il/ ////104 5 / 765/ Thoratella //india 5 / 766/
	Thoseful a lunata 57633
	Thozetella lunata 57653
	Thozetella lunata 57651
	Thozetella lunata 57701
89-	Thozetella lunata 57700
	Thozetella lunata 57702
991 -	Thozetella lunata 57656
84/0.97	Thosefella lunata 57647 T
	Thozetella tocklaiensis 76249
	i Thozefella quozhondii 77068
	Thozetella guozhongii 76974
	Thozetella guozhongii 76973
	Thozetella guozhongii 76972
	Thozetella guozhongii 76971
	Thozetella guozhongii 76970
	Thosetella guozhongii 76969 T
99.	I nozetella guiznongii ///uc/ Thoratella guiznongii //uc/
	90/
99/	Thozetella asetula 44829
	Juni Thozetella asetula 54235 T
90'-	Thozetella septata 78222
	Thozetella septata 78221 T
· · · · · · · · · · · · · · · · · · ·	Thozetella nivea EU825201
	Inozetella pandanicola MELUCC 16-0253 1
	Thorzetella pandanicola 76704
	Thozetella pandanicola 76604
	Thozetella pandanicola 76603
	Thozetella pandanicola 57662
99/-	Thozetella pandanicola 57661
	Thozetella palmicola 78448 T
+	' Thozetella palmicola 78415

1.

1.

Fig. 206 (continued)

wood submerged in freshwater in southern France, is the only known *Chaetosphaeria* species with the *Thozetella* anamorph. Phylogenetically *C. rivularis* is closely related to other members of the genus *Thozetella*, while very distinct from other *Chaetosphaeria* species. Here we proposed to transfer *Chaetosphaeria rivularis* into *Thozetella* and emend the concept of the genus *Thozetella* with its teleomorph characters.

Only one species, *T. havanensis*, was reported from China (Wang and Zhang 2010). Here we report 24 species, including 13 new species. In addition, *Chaetosphaeria rivularia*. is transferred to this genus as new combination. The living strains of many studied species were also studied on PDA (Fig. 207), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Key to all known species of Thozetella.

2. Conidiomata stromatic without setae	2.
2. Conidiomata synnemata and bearing setae	2.
T. ciliata	
3. Conidia without setulae or only with rudimentary setu-	3.
lae4	
3. Conidia with long setulae5	3.
4. Microawns $12-17 \times 2-2.5 \mu m$, conidia $3.5-5.5 \times 1.5-$	4.
1.7 μm <i>T. asetula</i>	
4. Microawns $13-21 \times 2-2.5 \ \mu m$; conidia $8-10 \times 1.8-$	4.
2.5 μm <i>T. lunata</i>	
5. Microawns T-shaped and/or L-shaped6	5.
5. Microawns other than T- or L-shaped16	5.
6. Microawns predominantly T-shaped, 18–65 μm long	6.
T. aculeata	
6. Microawns predominately awn-like and/or L-sha	6.
ped7	



Fig. 206 (continued)

7.	Microawns apex undulating or geniculate8
7.	Microawns apex straight10
8.	Microawns 0–2-septate, 60–80×3.5–4.5 μm
	T. acerosa
8.	Microawns aseptate
9.	Microawns $48-75 \times 3-5$ µm; conidia $10-15 \times$
	2–3 μm <i>T. boonjiensis</i>
9.	Microawns aseptate, $50-70 \times 3-4 \mu mT$. nivea
10.	Microawns with acute apexT. cubensis
10.	Microawns with rounded apex11
11.	Conidiomata with sterile setae; microawns
	70–100×3.5–5 μm, aseptate; conidia 13.7–15.5×2.1–
	2.7 µm; setulae 4.8–5.7 µm long
11.	Conidiomata without setae12
12.	Microawns 70–280×2.5–8 μmT. gigantea
12.	Microawns up to 80 µm long13
13.	Microawns 0–1-septate, $19-75 \times 1.5-3.5 \mu m$; conidia
	lunate, $13.5-18 \times 1.5-2 \mu m$; setulae 4.5-7 μm long
	T. pindobacuensis
13.	Microawns aseptae14

14.	Microawns irregularly L-shaped, sigmoid, basal part strongly curved, (20–)50–96 µm long; conidia lunate,
	$10-12 \times 2-2.5 \ \mu\text{m}$; setulae 3.5-7.5 $\ \mu\text{m}$ long
	T. moganshanensis
14.	Microawn more or less L-shaped, base part straight or
	slightly curved15
15.	Microawns 20–80×1.5–1.8 μ m; conidia 12.5–13.5×
	2.5 μm; setulae 5–7 μm <i>T. paragiganitea</i>
15.	Microawns up to 100 μ m long; conidia 11–15 \times 2 μ m;
	setulae 3–5 µm long <i>T. hunanensis</i>
16.	Microawns Y-shaped, capitate, coronate17
16.	Conidia other shape19
17.	Microawns Y-shapedT. ypsiloidea
17.	Microawns other than Y-shaped18
18.	Microawns clavate, apical part swollen with 5-6 coro-
	nate projectionsT. coronata
18.	Microawns capitate, apical part verruculose
	T. capitata
19.	Microawns cylindrical, fusiform, elliptic-fusiform, fili-
	form, straight or slightly curved20



Fig. 207 Colony of *Thozetella* species on PDA after 20 days at 25 °C. a, b *Thozetella asetula* (ex-type strain 54235). c, d *T. aunstrupii* (ex-type strain 77,539). e, f *T. fanglanii* (ex-type strain 76,092). g, h *T. guozhongii* (ex-type strain 76,969). i, j *T. hunanensis* (ex-type strain 53,378). k, l *T. palmicola* (ex-type strain 76,448). m, n *T. paragigan*-

- 19. Microawns other shape, usually strongly curved
- Microawns filiform, smooth, septate, 30–60 × 3–4.5 μm; conidia 11–13×2–2.5 μm.....*T. radicata*
- 20. Microawns not filiform, aseptate......21
- 21. Microawns elliptic-fusiform, slightly curved, smooth, 16–25×3–4 μm.....*T. submersa*

78,410). q, r *T. lithocarpi* (78,221). s, t *T. suttonii* (ex-type strain 44785). u *T. japonica* (ex-type strain 77,262). v *T. lunata* (ex-type strain 57647). w *T. lithocarpi* (76,016). x, y *T. moganshanensis* (ex-type strain 77,338)

itea (ex-type strain 76,039). o, p T. pseudotocklaiensis (ex-type strain

22.	Microawns sickle-shaped, strongly curved, upper
	tapering to an acute or obtuse apex23
22.	Microawns not typically sickle-shaped24
23.	Microawns 40–60×2.5–3 μ m, conidia 11.5–14.5×2.3–
	2.7 μm
23.	Microawns $40-95 \times 2.5-5 \mu m$, conidia
	$13-16 \times 1.5-3 \ \mu mT. falcata$
24.	Microawns sickle-like, tapering to an acute apex,
	smooth-walled or slightly verruculose25
24.	Microawns vermiform, hamate, smooth or verrucu-
25	Microavers streight to sigmaid or importantly average
25.	Microawins straight to sigmoid or irregularly curved,
	$0-3$ septate, $05-130 \times 4-6.5 \ \mu\text{m}$; contata funate to
	aliantoid, $11-13 \times 1.8-2.5 \ \mu\text{m}$; setulae 2.8-5.5 μm
25	Microsymp strongly sympodium to 50 ym long
23.	
26.	Microawns smooth-walled, apex acute27
26.	Upper part of microawns finely verrucose
27.	Microawns awn-like, smooth, $32-56 \times 1.7-2.8 \ \mu m$;
	conidia $11.5-14.5 \times 2.2-3.4 \ \mu\text{m}$; setulae $2-3.5 \ \mu\text{m}$
	longT. fabacearum
27.	Conidia with longer setulae
28.	Microawns straight or curved, L-shaped or sigmoid,
	$22-55 \times 2.5-5 \mu m$; conidia $12.5-19 \times 5-6.5 \mu m$; setulae
	7–11 μm long <i>T. pinicola</i>
28.	Microawns variously shaped, bulbous base, ace-
	rose apex, straight, undulate, uncinate or bent 18–38
	$(-44) \times 1.5 - 4 \mu m$; conidia $9 - 13(-18) \times 1.5 - 3 \mu m$
	T. tocklaiensis
29.	Microawns $24-59 \times 3-4.2 \mu m$, outer curved surface
	finely vertucose; conidia fusoid, $11.5-17 \times 2-3 \mu m$;
	setulae 6–8 µm long <i>T. serrata</i>
29.	Microawns variously shaped, awn-like, L-shaped,
	curved or almost straight, recurved, aseptate,
	$20-52 \times 3-3.5 \mu m$, smooth or slightly vertuculose;
	conidia fusiform, $12-14 \times 2-2.5 \ \mu\text{m}$; setulae 6–8 μm
	longT. lithocarpi
30.	Microawns awn-like, claw-like, irregularly sigmoid,
	curved, recurved, as eptate, 14–36 \times 3–4 $\mu m;$ basal part
	lageniform with lumen, thin-walled and frequently col-
	lapsed, smooth, $6-12 \times 2.5-3.5 \mu m$; conidia fusiform,
	lunate, $10-13.5 \times 1.8-2.5 \ \mu\text{m}$; setulae $4.5-7 \ \mu\text{m} \ \text{long}$
	T. aunstrupii
30.	Microawns vermiform, hamate, apex obtuse31
31.	Conidiomata effuse; microawns $20-30 \times 3 \mu m$; conidia
	$16-19 \times 4-4.5 \ \mu m$; setulae $6-11.5 \ \mu m \ long$
	T. effusa
31.	Conidiomata sporodochial or synnematous32
32.	Microawns smooth-walled
32.	Microawns verrucose

33.	Microawns hamate, aseptate, $21-34 \times 2-4 \mu m$; conidia 9-12 × 1.5-2.5 µm
33	Microawns vermiform curved or straight
55.	$0-1$ -septate $25-38 \times 35-5$ µm; conidia fusiform
	$10 13 \times 2$ 25 µm; setulae 3.5 55 µm long
	$10-13 \times 2-2.5 \ \mu \text{m}$, seturae $5.5-5.5 \ \mu \text{m}$ rong
~ .	
34.	Microawns sigmoid, verruculose, $17-45 \times 2-3.5 \ \mu\text{m}$;
	conidia $10.5-17.5 \times 2-3 \mu\text{m}T.$ buxifolia
34.	Conidia mostly hamate, sometime fusiform or subcylin-
	drical35
35.	Conidia 13–16 µm long36
35.	Conidia less than 13 µm long in average
36.	Microawns 40–55 \times 3–4 µm; conidia fusoid, straight or
	slightly curved, $(12-)13-14(-15) \times (2.5-)3 \mu m$; Setu-
	lae 5–8 μ m long
36	Microawns $32-37 \times 25-3$ µm ² conidia
20.	$13-16 \times 2-25$ µm T canadensis
37	Microawns with 6 uniform width sigmoid allantoid
57.	uncipate verruculose 224 35×15 3.2 um conidia
	unclinate, vertuculose, $22.4-35 \times 1.5-3.2$ µm, contuita
27	$11-14 \times 2.5 \mu \text{m}$
37.	Microawns without uniform width
38.	Microawns produced from conidiogenous cells,
	vermiform-shaped, curved, recurved, 0–1-septate,
	$15-20 \times 3.3-3.8 \ \mu\text{m}$; basal cells very short, 3–5 μm
	long; apical cells verruculose; conidia fusiform,
	$11-14.5 \times 2-2.5 \ \mu m$, setulae 5.5-7 μm long
	T. wenyingiae
38.	Conidial setulae up to 5 µm long
39.	Microawns 1-septate, 20-47 µm long; basal cell
	$8-17.5 \times 3-3.5$ µm; apical cell recurved, apex obtuse,
	verruculose: conidia fusiform, $10-13 \times 2$ um; setulae
	4–5 um long <i>T. pseudotocklaiensis</i>
39	Microawns 10–28 µm long 40
40	Microawns predominantly hamate curved 1-septate
40.	10.27 um long: basal part thin and smooth walled
	5.7 um long, 2.25 um wide: upper pert verrueulese
	$3-7 \mu m$ long, $2-2.5 \mu m$ wide, upper part vertucitose,
	$2-3 \mu\text{m}$ where; contain tustion, $9-11 \times 1.8-2 \mu\text{m}$; setu-
40	iae 4–5 μm iong
40.	Microawns 1-septate, 20–28 µm long; basal part
	$5-10 \times 2.5-3.0 \ \mu\text{m}$; upper part verruculose, $3-3.5 \ \mu\text{m}$
	wide, apex obtuse; conidia lunate, fusiform,
	$8-12 \times 2-3 \mu m$; setulae $3-4.5 \mu m \log$
	T. palmicola

Thozetella acerosa Paulus, P. Gadek & K.D. Hyde, Mycologia 96: 1076, 2004. Figure 208

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, sessile, cream, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a cylindrical to ellipsoid or ovoid shaped white mass of conidia and microawns, stroma up to 60-85 µm high, and up to 60 µm wide.



Fig. 208 *Thozetella acerosa.* (**a–h** Wu13236, **i–o** Wu13240). **a–e**, **i**, **j** Conidia. **i**, **o** Conidiophores and conidiogenous cells with narrower sporulating channel and inconspicuous collarettes. **j–h**, **k–n** Microawns and conidia. Scale bar: 5 μm

Conidiophores pale brown to brown, cylindrical, irregularly branched, thin- and smooth-walled, arising from a basal plate, $30-50 \times 2.5-3.5 \ \mu\text{m}$. Conidiogenous cells monophialidic, integrated, terminal, pale brown, irregularly cylindrical to ellipsoid, with no or minute collarette, periclinal wall thickened, $11-14 \times 2-2.5 \ \mu\text{m}$, tapering towards the apex, apex 1 μm wide. Microawns predominantly L-shaped to almost straight, hyaline, smooth, $60-68 \ \mu\text{m}$ long; basal part thin-walled, aseptate, sometime collapsed, cylindrical to lageniform, $13-24 \times 4-4.5 \ \mu\text{m}$; apical part acerose, smooth and thick-walled, apical part with a serrated edge, $25-45 \times 0.5-1.2 \ \mu\text{m}$. Conidia falcate to lunate, aseptate, finely guttulate, hyaline and smooth, $13-15.5 \times 2.5 \ \mu\text{m}$, with one filiform setula at each end, $5-8 \ \mu\text{m}$ long.

Materials examined: **China**, Sichuan Province, Yaan, Wanguang, Bifengxia, on dead leaves of identified trees, 15 December 2013, W.P. Wu (Wu13252); Sichuan Province, Ya An, Wan Guan, Bi Feng Xia, on dead leaves of identified trees, 15 December 2013, W.P. Wu (Wu13240); Sichuan Province, Ya An, Wan Guan, Bi Feng Xia, on dead leaves of identified trees, 15 December 2013, W.P. Wu (Wu13236). Living strains: 57,532 (from Wu13236), 57,589 (from Wu13240), 57,593 (from Wu13252a) and 57,559 (from Wu13252b).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Australia and China (Paulus et al. 2004).

Description and illustration: Paulus et al. (2004).

Note: Thozetella acerosa resembles T. aculeata P. Silva & Grandi, T. boonjiensis B.C. Paulus, Gadek & K.D. Hyde, T. cubensis R.F. Castañeda & G.R.W. Arnold, T. gigantean B.C. Paulus, Gadek & K.D. Hyde and T. nivea (Berk.) Kuntze in L-shaped microawn (Castañeda-Ruiz & Arnold, 1985a, b; Paulus et al. 2004; Silva and Grandi, 2013; Monteiro et al. 2016). Thozetella acerosa differs from T. aculeata in its inverted T-shaped microawns with a basal part resembling a foot-cell or T-shape in T. aculeata; differs from T. nivea by its shorter and narrower conidia and longer microawns than reported for *T. nivea* (conidia $17.5-24 \times 3-3.8 \mu m$; microawn 50–70×1.3–4 μ m); differs from *T. cubensis* and T. gigantea by much longer microawns in the two later species $(71-280 \times 2.5-8 \ \mu m \text{ in } T. gigantean; 49-110 \ \mu m \log 1000 \ m m \log 10000 \ m m \log 1000 \ m m m \log 1000 \ m m \log 1000 \ m m \log 1000 \ m m m \ m m \log 1000 \ m m \log 1000 \ m m \log 1000 \ m m \ m \ m \ m m \ m \ m \ m m \ m$ in T. cubensis); differs from T. boonjiensis by its smooth microawn without a serrated edge, while the microawns in T. acerosa have distinguished serrated edge. Furthermore, their ITS sequences from these species are also very different. The conidia in the Chinese specimens are somewhat smaller $(13-15.5 \times 2.5 \,\mu\text{m})$ than those in the original description $(14-20 \times 2-3 \mu m)$, however they all have identical ITS sequences with T. acerosa.

Thozetella asetula W.P. Wu & Y.Z. Diao, sp. nov., Fig. 209, MycoBank MB841639.

Etymology: Refers to its conidia without setulae.

Diagnosis: Differs from other known species in producing hamate microawns, and smaller conidia without setulae.

Typification: **China**, Guangdong Province, Zhaoqing, Dinghushan, on dead leaf sheath of bamboo, 3 March 2012, W.P. Wu, Holotype HMAS 352,066 (=Wu12089), ex-type strain CGMCC 3.20645 (=NN54235).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to gray, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a globose, ovoid, or otherwise shaped white mass of conidia and microawns, stroma up to 120 µm wide and 60 µm high. Conidiophores pale brown to brown, irregularly cylindrical, branched, compact at base, more or less free toward the upper part of sporodochia, smooth- and thin-walled, $25-45 \times 2.5-3$ µm. Conidiogenous cells monophialidic, integrated, terminal, light brown to subhyaline, irregularly cylindrical, without collarettes, periclinal wall thickened, $10-15 \times 1.5-2$ µm. Microawns, predominantly hamate, strongly curved, hyaline, 1-septate, $12-17 \times 2-2.5 \mu m$; basal cell thin-walled, cylindrical, taping towards a truncate or flatten base; apical cell thick-walled, rough-walled, with rounded apex. Conidia lunate, ellipsoid to irregularly shaped, aseptate, hyaline, thin- and smooth-walled, one end obtuse and the other end acute, $3.5-5.5 \times 1.5-1.7$ µm, no setula.

Colonies on PDA effuse, colonies 1.3–1.8 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, pale grey, reverse yellow brown (Figs. 207a, b).

Other materials examined: **China**, Guangdong Province, Dinghushan, on rotten wood of unidentified plant, 9 October 1998, W.P. Wu (Wu1862a); Guangdong Province, Dinghushan, on dead branches of unidentified plant, 12 October 1998, W.P. Wu (Wu1966). Living strains: 44,653 (from Wu1862a) and 44,829 (from Wu1966).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Thozetella asetula* differs from all known species in the genus by its 1-septate, hamate-shaped microawns in smaller size, and lunate, smaller conidia without setulae. Among the known species in the genus *Thozetella*, all of them produces conidia with setulae (Paulus et al. 2004; Silva 2012; Silva and Grandi 2013; Monteiro et al. 2016). There seems to be some variation on microawns production among the examined specimens, abundant microawns were found from the specimen Wu12089, while no microawn was observed from the specimens Wu1862a and Wu1966. However, the conidial morphology from them is identical and furthermore, the strains obtained from the relevant strains



Fig. 209 *Thozetella asetula* (F Wu1916, all others Wu12089 holotype). **a, d, e** Conidiophores and conidiogenous cells. **b, c** Sporodochial conidiomata with wet spore mass. **f–r** Microawns. **s–u** Conidia. Scale bar: **a, f–u** 5 µm, **b, c** 50 µm

have identical ITS sequences, which are also significantly different from any known species (Paulus et al. 2004; Jeewon et al. 2009; Silva and Grandi 2011; Barbosa et al. 2011; Monteiro et al. 2016).

Thozetella aunstrupii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 210, MycoBank MB841640.

Etymology: named after the President of Novozymes China, Knud Aunstrup, who has given strong support to our work.

Typification: **China**, Guangdong Province, Shenzhen, Lianhuashan Park, on dead leaves of unidentified tree, 11 November 2019, W.P. Wu, Holotype HMAS 352,067 (=Wu17144), ex-type strain CGMCC3.20744 (=NN77539).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a globose, ovoid or otherwise shaped white mass of conidia and microawns, up to 60 μ m high, basal part cylindrical, 35–45 μ m wide, upper part up to 80 μ m wide. Basal stroma dark brown, composed of dark brown, irregularly shaped cells of 2–4 μ m wide. Conidiophores brown, irregularly cylindrical, branched, 1–2-septate, smooth, thin-walled, compact at

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base, more or less free toward of upper part of sporodochia, 30–50×2–2.5 µm. Conidiogenous cells monophialidic, integrated, terminal, light brown to subhyaline, irregularly cylindrical, lageniform, collarettes inconspicuous, periclinal wall thickened, 8–15×2–3.5 µm. Microawns—awn-like, claw-like, irregularly sigmoid, curved, recurved, aseptate, refractive, hyaline, 14–36 µm long; basal part lageniform with lumen, thin-walled and frequently collapsed, smooth, $6–12\times2.5–3.5$ µm; upper part tapering toward the obtuse apex, verruculose, 3–4 µm wide. Conidia fusiform, lunate, curved, aseptate, hyaline, smooth, 10–13.5×1.8–2.5 µm, tapering toward an obtuse end, bearing one setula at each end, 4.5–7 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1.3–1.8 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white in the center, becoming brown towards the margins, reverse yellow to dark brown in the center and becoming dark brown towards the margin (Figs. 207c, d).

Other materials examined: **China**, Guangdong Province, Nanshan, on dead seed pod of unidentified *Leguminosae*, 18 August 2019, W.P. Wu (Wu16721,Wu16722); Guangdong Province, Guangzhou, South China Agricultural University, on dead leaves of unidentified tree, 3 December 2018,



Fig. 210 Thozetella aunstrupii (Wu17144, holotype). a, b Microawns. c-e Conidiophores and conidiogenous cells from basal stroma. f Conidia. Scale bar: 5 µm

W.P. Wu (16,335); Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead leaves of unidentified tree, 25 August 2019, W.P. Wu (Wu16886) November. Living strains: 76,630 (from Wu16335), 77,028 (from Wu16721a), 77,029 (from Wu16721b), 77,030 (from Wu16722a), 77,031 (from Wu16722b), 77,163 (from Wu16886a), 77,164 (from Wu16886b) and 77,540 (from Wu17144).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Thozetella aunstrupii is closely related to T. havanensis on producing awn-like, sigmoid microawns with verruculose upper part. However, in T. havanensis, the conidiomata are synnematous, the microawns (22-35 µm long) are sigmoid, allantoid and unciform, and the conidia $(11.5-16.3 \times 1.9-2.8 \,\mu\text{m})$ are much longer (Castañeda-Ruiz, 1984; Silva and Grandi 2013). Silva and Grandi (2013), in comparing the type specimen and the Brazilian specimens of T. havanensis, reported much larger conidia than those in the type. Among the specimens examined from China, the microawns from the type specimen Wu17144 are more or less uniformed in both shape (awn-like or sigmoid shape) and size $(14-36 \times 3-3.6 \,\mu\text{m})$; while in the specimen Wu16886, the microawns have broad variation in size and shape. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,539 include Thozetella *neonivea* (GenBank NR_165579, 97% identity) and *T. pan-danicola* (GenBank MH388366, 97% identity).

Thozetella bambusicola H.B. Jiang, Phookamsak & K.D. Hyde, Fungal Divers. 103: 241, 2020.

Typification: **China**, Sichuan Province, Yibin City, Changning County, Shunan Bamboo Forest, on dead bamboo branches, 23 July 2019, H.B. Jiang and R. Phookamsak, SC025 (KUN-HKAS 101,776, holotype).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China (Hyde et al. 2020).

Description and illustration: Hyde et al. (2020).

Notes: *Thozetella bambusicola* is a recently described species and differs from other *Thozetella* species in sporodochia surrounded by black setae and L-shaped microawns (Hyde et al. 2020). In their phylogenetic analysis, *Thozetella bambusicola* forms an independent lineage distinct from other *Thozetella* taxa based.

Thozetella fabacearum R.H. Perera & K.D. Hyde, Mycosphere 7: 1313, 2016. Figures 211a–r

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears an ovoid to cylindrical, white mass of conidia and microawns, 40–50 µm



Fig. 211 *Thozetella fabacearum* (**a**-**r** Wu16377) and *T. falcata* (**s**-**z**, **aa** Wu13153). **a**-**c** Conidiophores and conidiogenous cells from basal stroma. **d**-**k**, **t**-**v** Microawns. **i**-**r**, **v**-**z**, **aa** Conidia. **e**-**g**, **s**, **t** 20 μm, **d**-**r**, **u**-**z**, **aa** 5 μm

high, basal part cylindrical, 20-35 µm wide, upper part up to 50 µm wide. Basal stroma dark brown, composed of dark brown, irregularly shaped cells. Conidiophores macronematous, pale brown to brown, irregularly cylindrical, branched, 2-3 septate, smooth, compact at base, more or less free toward of upper part of sporodochia, 25-50×2-3 µm. Conidiogenous cells monophialidic, integrated, terminal, light brown, cylindrical, lageniform, smooth- and thin-walled, $8-12 \times 2-2.5$ µm, without collarettes or inconspicuous, periclinal wall thickened, apex up to 1 µm wide. Microawns predominantly hamate, curved, aseptate, 15–53 µm long; basal part, straight, lageniform, thick- and smooth-walled, with an obtuse or truncate base, $(2.5-)3-4.5 \mu m$ wide; upper part tapering towards the apex, smooth or slightly verruculose, 2–2.5 µm wide, with an obtuse or slightly acute apex. Conidia fusiform, curved, aseptate, hyaline, guttulate, smooth, $13.5-16 \times 2-2.5 \mu m$, tapering towards both ends, provided with a single filiform setula at each end, 4.5-5.5 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 10–13 mm diameter in 14 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, brown to dark brown, reverse of the same color.

Materials examined: China, Guangdong Province, Guangzhou, Nanshan, on decaying fruit of Phoenix sylvestris, 18 August 2019, W.P. Wu (Wu16745); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of Fagacae, 2 December 2018, W.P. Wu (Wu16281); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (Wu16309); Guangdong Province, Shenzhen, Yangtaishan Forest Part, on decaying fruit of Acacia sp., 17 October 2020, W.P. Wu (Wu17485); Guangdong Province, Guangzhou, South China Agricultural University, on dead laves of Acacia sp., 3 December 2018, W.P. Wu Wu16377); Guangdong Province, Shenzhen, Lianhuashan, on dead fruit of unidentified tree, 11 November 2019, W.P. Wu (Wu17260); Hainan Province, Sanya, Yalongwan Park, on dead leaves of unidentified tree, 29 December 2020, W.P. Wu (Wu17674); China: Hainan Province, Sanya, Yalongwan Park, on dead leaves of unidentified tree, 28 December 2020, W.P. Wu (Wu17686); Hainan Province, Sanya, Yalongwan Park, on dead leaves of unidentified tree, 29 December 2020, W.P. Wu (Wu17678, Wu17688). Living strains: 77,030, 77,039 and 77,082 (rom Wu16745); 76,701 and 76,703 (from Wu16309), 76,611 (from Wu16281), 77,702 and 77,672 (from Wu17260), 78,244 and 78,245 (from Wu17485), 76,671 and 76,672 (from Wu16377), 78,439, 78,497 and 78,535 (from Wu17674), 78,441 and 78,442 (from Wu17678), 78,501 (from Wu17686), 78,502 (from Wu17686) and 78,504 (from Wu17688).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Thailand (Perera et al. 2016).

Description and illustration: Perera et al. (2016).

Notes: *Thozetella fabacearum* is also a recently described species on seed pod of *Fabaceae* from Thailand. It is characterized by sporodochial conidiomata and aseptate L-shaped microawns with smooth or only slightly verruculose wall. Apart from the slightly shorter conidial setulae, the fungus from China is identical to those in the original description of *T. fabacearum*. The ITS sequences obtained from them are almost identical among each other and also to the one from the ex-type strain.

Thozetella falcata B.C. Paulus, Gadek & K.D. Hyde, Mycologia 96: 1078, 2004. Figures 211s-z

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial or synnemata, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a globose, ovoid, or otherwise shaped white mass of conidia and microawns. Basal stroma dark brown, composed of dark brown, irregularly shaped cells of 2-3.5 µm wide, up to 60 µm high, basal part cylindrical, 35-45 µm wide, upper part up to 80 µm wide. Conidiophores macronematous, brown, irregularly cylindrical, branched, 1-2-septate, compact at base, more or less free toward of upper part of sporodochia, 18-22×2-2.5 µm. Conidiogenous cells monophialidic, integrated, terminal, light brown to subhyaline, irregularly cylindrical, without collarettes, periclinal wall thickened, 6-10×2-3.5 µm. Microawns predominantly falcate, L-shaped, strongly curved, with a smooth or verrucose apex, up to 45 μ m long, lower part 20–30 \times 2.5–4 μ m, upper part $15-20 \times 1-2 \mu m$, with acute apex. Conidia fusiform, curved, continuous, hyaline, guttulate, smooth, $13-15 \times 2 \mu m$, provided with a single filiform setula at each end, 3–5 µm long.

Materials examined: China, Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of Macadamia ternifolia, 4 March 2012, W.P. Wu (Wu12318); Guangdong Province, Guangzhou, South China Botanical Garden, on dead seed sheath of Sindora tonikinensis, 10 December 2013, W.P. Wu (12666a,b); China: Guangdong Province, Zhaoqing, Dinghuashan, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu (Wu12167a); Guangdong Province, Zhaoqing, Dinghuashan, on dead leaves of unidentified tree, 3 March 2012, W.P. Wu (Wu12098); Guangdong Province, Guangzhou, South China Botanical Garden, on dead branches of palm tree, 10 December 2013, W.P. Wu (Wu12642a,b); Guangdong, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (Wu16232); Guangdong, Guangzhou, on dead branches of palm,10 December 2013, W.P. Wu (Wu12642); Guangdong, Shenzhen,

Lianhuashan Park, on dead leaves of unidentified tree, 11 November 2019, W.P. Wu (Wu17115b); Guangdong Province, Guangzhou, Nanshan, on dead fruit of Phoenix sylvestris, 18 August 2019, W.P. Wu (Wu16745); Guangdong Province, Guangzhou, South China Agricultural University, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (Wu16309); Guangdong Province, Guangzhou, South China Agricultural University, on dead leaves of *Quercus* sp., 3 December 2018, W.P. Wu (Wu16281); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead fruit of Acacia sp., 17 Oct 2020, W.P. Wu (Wu17485); Guangdong, Guangzhou, South China Agriculture University, 3 December 2018, W.P. Wu (Wu16375); Guangxi Province, Nanning, Subtropical Botanical Garden, on dead leaves of Acacia sp., 15 November 2013, W.P. Wu (Wu13094); Guangxi Province, Nanning, Subtropical Botanical Garden, on dead leaves of Acacia sp., 15 November 2013, W.P. Wu (Wu13153); Guangxi Province, Nanning, Subtropical Botanical Garden, on dead leaves of Acacia sp., 15 November 2013, W.P. Wu (Wu13153a-57459); Guangxi Province, Nanning, Subtropical Botanical Garden, on dead seed sheath of Bauhinia blakeana, 15 November 2013, W.P. Wu (Wu13069-57,389). Living strains: 54,237 (from Wu12167a), 54,238 (from Wu12098), 57,389 (from Wu13069), 57,396 (from Wu13094), 57,458 (from Wu13153), 57,459 (from 13153a), 54,327 (from Wu12318), 57,638 (from Wu12666a), 57,680 (from 12666b), 57,709 (from Wu12642a), 57,707 (from Wu12642b), 76,669 (from Wu16375), 76,567 (from Wu16232), 77,523 (from Wu17115b), 76,611 (from Wu16281), 76,701 and 76,703 (from Wu16309), 77,039, 77,040 and 77,082 (from Wu16745), 78,244 and 78,245 (from Wu17485).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Australia and China (Paulus et al. 2004).

Description and illustration: Paulus et al. (2004).

Notes: Thozetella falcata is a recently described species from Australia and characterized by synnematous conidiomata and predominantly sickle-shaped microawns (Paulus et al. 2004). Morphologically, Thozetella falcata, T. cristata, T. radicata and T. tocklaiensis produce synnemata, but can be distinguished by morphology of microawns. T. falcata, T. cristata and T. radicata are similar in microawn shape and in conidial dimensions, however, the microawns in T. falcata are considerably longer than those in other two species. The length and morphology of synnemata in T. tocklaiensis are similar to those of T. falcata, however, these two fungal taxa differ in microawn morphology and size (Paulus et al. 2004). Thozetella fabacearum and T. falcata, with identical ITS sequences from the type specimens, are very similar on morphology of microawns, and can only be distinguished by the conidiomata morphology (sporodochia vs. synnemata) and size of microawns (Perera et al. 2016). The ITS sequences obtained from the pure cultures of all studied specimens are almost identical to the known sequence from the ex-type strain of *T. falcata*.

Thozetella fanglanii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 212, MycoBank MB841641.

Etymology: Named after the former Chinese mycologist Fanglan Tai.

Typification: **China**, Beijing, Mentougou, Baihuashan, on rotten wood, 10 Aug 2018, W.P. Wu, Holotype HMAS 352,068 (=Wu15230), ex-type strain CGMCC 3.20662 (=NN76092).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears an ovoid to cylindrical, white mass of conidia and microawns, 40-60 µm high, basal part cylindrical, 25-35 µm wide, upper part up to 50 µm wide. Basal stroma dark brown, composed of dark brown, irregularly shaped cells. Conidiophores macronematous, pale brown to brown, irregularly cylindrical, branched, 2-3-septate, smooth, compact at base, more or less free toward of upper part of sporodochia, $25-40 \times 2-3 \mu m$. Conidiogenous cells monophialidic, integrated, terminal, light brown, cylindrical, lageniform, smooth- and thin-walled, $12-15 \times 2-2.5 \,\mu$ m, without collarettes or inconspicuous, periclinal wall thickened, apex 1-1.5 µm wide. Microawns predominantly hamate, vermiform, curved, narrowed towards the obtuse apex, 0–1-septate at the base, 25–38 µm long; basal part, curved, with an obtuse base, 3.5–5 µm wide; upper part tapering towards the apex, 2.5-3.5 µm wide, with an obtuse or slightly acute apex. Conidia fusiform, curved, aseptate, hyaline, guttulate, smooth, $10-13 \times 2-2.5 \mu m$, tapering towards both ends, provided with a single filiform setula at each end, 3.5–5.5 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 3–3.3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, grey, reverse yellow brown in the center and becoming pale colored towards the margin (Figs. 207e, f).

Other material examined: **China**, Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead seed of unidentified broad leaf tree, 17 October 2020, W.P. Wu (Wu17587). Living strains: 78,389 and 78,390 (from Wu17587).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Thozetella fanglanii* morphologically differs from other known species in the genus by hamate to vermiform, 0–1-septae, thin- and smooth-walled microawns (25–38 μ m long) and smaller conidia (10–13×2–2.5 μ m) with shorter setulae (3.5–5.5 μ m long) (Castañeda-Ruiz and Arnold,



Fig. 212 *Thozetella fanglanii* (**a–t** Wu17587, holotype; **u–z, aa–aj** Wu15230). **a, b, u** Conidiophores and conidiogenous cells. **c–m, v–z, aa–ad** Microawns. **n–t, ae–aj** Conidia. Scale bar: 5 μm



Fig. 213 *Thozetella guozhongii* Wu16696 (holotype). **a** Conidiophores and conidiogenous cells from basal stroma. **b–k** Microawns. **l–p** Conidia. Scale bar: 5 μm

1985a, b; Paulus et al. 2004; Sliva and Grandi 2013; Monteiro et al. 2016; Perera et al. 2016). Morphologically, *T. fanglanii* resembles *T. queenslandica* Paulus, P. Gadek & K.D. Hyde in the shape and size of microawns, conidia and conidial setulae. The microawns in the specimen Wu17587 are with 1-septum at the base, while they are aseptate in the specimen Wu15230.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 76,092 include *Thozetella falcata* (GenBank AY331004, 96% identity), *T. havanensis* (GenBank EF029184, 93% identity) and *T. tocklaiensis* (GenBank MH857817, 96% identity).

Thozetella guozhongii W.P. Wu & Y.Z. Diao, sp. nov., Figs. 213, MycoBank MB841642.

Etymology: Named after the Chinese mycologist Lu Guozhong from Dalian Minzu University, Dalian, Liaoning Province.

Typification: **China**, Guangdong Province, Guangzhou, Nansha, on dead leaves of palm, 18 August 2019, W.P. Wu, Holotype HMAS 352,069 (=Wu16696a), ex-type strain CGMCC 3.20667 (=NN76969).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears an ovoid to cylindrical, white mass of conidia and microawns, 40-50 µm high, basal part cylindrical, 20-35 µm wide, upper part up to 50 µm wide. Basal stroma dark brown, composed of dark brown, irregularly shaped cells. Conidiophores macronematous, pale brown to brown, irregularly cylindrical, branched, 2-3-septate, smooth, compact at base, more or less free toward of upper part of sporodochia, 25-50×2-3 µm. Conidiogenous cells monophialidic, integrated, terminal, light brown, cylindrical, lageniform, smooth- and thin-walled, $9-11 \times 2-2.2 \mu m$, without collarettes or inconspicuous, periclinal wall thickened, apex up to 1 µm wide. Microawns produced from conidiogenous cells, predominantly hamate, sigmoid, curved, 1-septate at the base, 10–27 µm long; basal part, straight, thin- and smooth-walled, with an obtuse base, 5-7 µm long, 2-2.5 µm wide; upper part tapering towards the apex, verruculose in the upper part, 2-3 µm wide, with an acute apex. Conidia fusiform, curved, aseptate, hyaline, guttulate, smooth, $9-11 \times 1.8-2 \mu m$, tapering towards both ends, provided with a single filiform setula at each end, 4-6 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 3–3.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey to pale brown, reverse dark brown in the center and becoming pale brown towards the margin (Figs. 207g, h).

Other materials examined: China, Guangdong Province, Guangzhou, Nansha, on dead leaves of palm, 18 August 2018, W.P. Wu (Wu16763, Wu16766, Wu16697, Wu16698); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead petiole of unidentified palm tree, 17 October 2020, W.P. Wu (Wu17454). Living strains: 76,970 (from Wu16696b), 76,971 (from Wu16697a), 76,972 (from 16697b), 76,973 (from Wu16698a), 76,974 (from Wu16698b), 77,066 (from Wu16763a), 77,067 (from Wu16763b), 77,068 (from Wu16766), 78,221 and 78,222 (from Wu17454).

Ecology/Substrate/Host: Saprobe on dead material of palm.

Geographical distribution: China.

Notes: Thozetella guozhongii is characterized by sporodochial conidiomata, hamate to sigmoid and 1-septate microawns with verruculose wall in the upper part, and smaller conidia $(9-11 \times 1.8-2 \ \mu m)$ with shorter setulae $(4-5 \ \mu m)$ long). On the morphology of microawns, it resembles T. canadensis Nag Raj and T. effusa, but can be distinguished by its strongly curved microawns with 1-septum at the base (Nag Raj 1976; Sutton and Cole 1983). The ITS sequences obtained from many studied strains are almost identical (>99% identity) from each other. The ITS sequences from T. guozhougii and T. lithocarpi are also close to be identical, however, these two species can easily be morphologically distinguished. In T. lithocarpi, the microawns are without septum and the conidia are much longer $(20-35 \times 2-3 \mu m)$ and bearing longer setulae (6.9–9.7 μ m) than those in T. guozhongii. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 76,969 include Thozetella lithocarpi (GenBank NR 164037, 99% identity), T. pandanicola (GenBank NR_168203, 98% identity) and T. tocklaiensis (GenBank MH857817, 97% identity).

Thozetella havanensis R.F. Castañeda, Revista Jard. Bot. Nac. Univ. Habana 5: 69, 1984.

Teleomorph: Not observed. Anamorph: Conidiomata sporodochial, superficial, Conidial mass cream to white, pyriform, globose, cylindrical. Microawns predominantly S-shaped, smooth, hyaline, aseptate, $21-35 \times 1.3-3.5$ µm. Conidia fusiform, lunate, curved, continuous, hyaline, smooth, $10.5-15 \times 2-3$ µm, provided with a single filiform setula at each end, 6.5-9 µm long (Wang and Zhang 2010).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Cuba (Castañeda-Ruíz 1984; Wang and Zhang 2010)).

Description and illustration: Castañeda-Ruíz (1984); Wang & Zhang (2010).

Notes: *Thozetella havanensis* was reported on decaying needle of *Pinus* sp. from Henan (HHAUF09 0336) by Wang & Zhang (2010). No specimen was examined by us and the above note is based on the literature (Wang & Zhang 2010).



Fig. 214 Thozetella hunanensis (Wu11044c). a–o Microawns. p–r, u–y conidia. s, t Conidiophores and conidiogenous cells. Scale bar: 5 µm

Thozetella hunanensis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 214, MycoBank MB841643.

Etymology: Refers to the locality where this fungus was originally discovered.

Typification: **China**, Hunan Province, Zhangjiajie, on dead leaf sheath of bamboo, 15 October 2010, W.P. Wu, Holotype HMAS 352,070 (=Wu11044c), ex-type strain CGMCC 3.20710 (=NN53378).

Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a globose, ovoid, or otherwise shaped white mass of conidia and microawns. Basal stroma dark brown, composed of dark brown, irregularly shaped cells of 2-4 µm wide, up to 80 µm high. Conidiophores macronematous, brown, irregularly cylindrical, branched, 1-2-septate, compact at base, more or less free toward of upper part of sporodochia, $30-60 \times 2-3 \mu m$. Conidiogenous cells monophialidic, integrated, terminal, light brown to subhyaline, irregularly cylindrical, without collarettes, periclinal wall thickened, $13-16 \times 2-3$ µm. Microawns predominantly L-shaped, strongly curved, with a smooth apex, up to 100 µm long, lower part $9-15 \times 3.5-4.5 \,\mu\text{m}$, upper part $14-80 \times 1.5-2 \,\mu\text{m}$, with obtuse apex. Conidia fusiform, curved, continuous, hyaline, guttulate, smooth, $11-15 \times 2 \mu m$, provided with a single filiform setula at each end, 3-5 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1.2–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, grey to slightly yellow, reverse soil brown in the center and becoming paler towards the margin (Figs. 207i, j).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Thozetella hunanensis is characterized by producing L-shaped and smooth-walled microawns and falcate to lunate conidia with one setula at each end. Morphologically T. hunanensis resembles T. acerosa, T. aculeata P, T. boon*jiensis, T. cubensis, T. gigantean* and *T. nivea* (in L-shaped microawn (Castañeda-Ruiz and Arnold 1985b; Paulus et al. 2004; Barbosa et al. 2011; Sliva and Grandi 2013; Monteiro et al. 2016). Thozetella hunanensis differs from T. acerosa by its microawns without serrated edge in the upper part; differs from T. aculeata in its inverted T-shaped microawns with a basal part resembling a foot-cell or T-shape in the latter species; differs from T. nivea by its smaller conidia and shorter microawns than those reported for T. nivea (conidia $17.5-24 \times 3-3.8 \ \mu\text{m}$; microawn $50-70 \times 1.3-4 \ \mu\text{m}$); differs from T. cubensis and T. gigantea by much longer microawns in the two latter species $(71-280 \times 2.5-8 \ \mu m \text{ in } T.$ gigantean; 49-110 µm long in T. cubensis). Furthermore, the ITS sequences obtained from the relevant strains are also different from those in other known species.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 53,378 include *Thozetella fabacearum* (GenBank KY212754, 94% identity), *T. falcata* (GenBank AY33104, 94% identity) and *T. cristata* (GenBank KJ183032, 93% identity).

Thozetella japonica W.P. Wu & Y.Z. Diao, sp. nov., Fig. 215, MycoBank MB841644.

Etymology: refers to the country where this fungus was originally discovered.

Typification: **Japan**, Mie Prefecture, Tsu, Mie Center for the Arts, on dead fruit of unidentified tree, 2 October 2019, W.P. Wu, Holotype HMAS 352,071 (=Wu16900a), ex-type strain CGMCC 3.20670 (=NN77262).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears an ovoid to cylindrical, white mass of conidia and microawns; sporodochia cylindrical, 40-50 µm high, basal part cylindrical, 25-45 µm wide, upper part up to 50 µm wide. Basal stroma dark brown, composed of dark brown, irregularly shaped cells. Conidiophores macronematous, pale brown to brown, irregularly cylindrical, branched, 2-3-septate, smooth, compact at base, more or less free toward of upper part of sporodochia, 45-50×1.5-2.5 µm. Conidiogenous cells monophialidic, integrated, terminal, light brown, cylindrical, lageniform, smooth- and thin-walled, $8-10 \times 1.5-2.5 \mu m$, without collarettes or inconspicuous, periclinal wall thickened, apex 1-1.5 µm wide. Microawns fusiform, clavate, ellipsoid, straight or curved, narrowed towards the obtuse base, aseptate, 17–22 (–28) µm long; basal part straight, thin- and smooth-walled, with an obtuse base, 2-2.5 µm wide; upper part verruculose, 3-3.5 µm wide, with an obtuse apex. Conidia fusiform, lunate, curved, aseptate, hyaline, guttulate, smooth, $11-13 \times 1.8-2.5$ µm, tapering towards both ends, provided with a single filiform setula at each end, $5-7 \mu m \log$.

Culture characteristics: Colonies on PDA effuse, colonies 1.5–2.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly grey, reverse yellow to soil brown in the center and becoming paler towards the margins (Figs. 207k, 1).

Other materials examined: **Japan**, Mie Prefecture, Tsu, Tsukairaku Park, on dead fruit of *Cyclobalanopsis* sp., 2 October 2019, W.P. Wu (Wu16961, Wu16962, Wu16966, Wu16959). Living strains: 77,361 (from Wu16959), 77,289 (from Wu16961), 77,362 (from Wu16962), 77,292 (from Wu16966) and 77,263 (from Wu16900b).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Japan.



Fig. 215 *Thozetella japonica* (Wu16900, holotype). **a** Sporodochial conidiomata. **b**, **c** Conidiophores and conidiogenous cells with inconspicuous collarettes. **d–p** Microawns. **q–v** Conidia. Scale bar: **a** 20 μm, **b–v** 5 μm



Fig. 216 *Thozetella lithocarpi* (Wu17569). **a** Sporodochial conidiomata. **b** Conidiophores and conidiogenous cells. **c–l** Microawns. **m–p** Conidia. **a**, **d–i** 10 μm, **b**, **c**, **j–p** 5 μm

Notes: Thozetella japonica can easily be distinguished from other known species by fusiform to clavate, ellipsoid, aseptate and verruculose microawns and smaller conidia. T. buxifolia (microawns irregularly sigmoid, twisted in two planes, $25-30 \times 3-3.5 \mu m$; conidia $13.5-15 \times 2.5-2.7 \mu m$; conidial setulae 10-13 µm long), T. canadensis (microawns vermiform, recurved, $19-30 \times (1.9-)2.8 \mu m$; conidia $10.5-14.4 \times 1-2 \mu m$; conidial setulae 4.8-7.5 $\mu m \log$) and T. effuse (microawns vermiform, sigmoid, recurved, $25-35.5 \times 1.9-2.8 \,\mu\text{m}$; conidia $11.5-19.2 \times 2.8 \,\mu\text{m}$; conidial setulae 9.6-14.4 µm long) also produce aseptate and verruculose microawns in similar shape, but in these two species, the microawns are narrower and recurved. In addition, the conidia in T. buxifolia and T. effuse are much larger and with longer setulae (Nag Raj 1976; Sutton and Cole 1983; Allegrucci et al. 2004).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 53,378 include unidentified leaf litter ascomycetes (GenBank AF502902, 96% identity), *Thozetella neonivea* (GenBank NR165579, 93% identity) and *T. lithocarpi* (GenBank NR164037, 93% identity).

Thozetella lithocarpi R.H. Perera & K.D. Hyde, Fungal Divers. 95: 147, 2019. Figures 207w, q, r, 216

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a globose, ovoid white mass of conidia and microawns. Basal stroma dark brown, composed of dark brown, irregularly shaped cells, 30-60 µm high. Conidiophores brown at the basal part, becoming pale brown toward apex, irregularly cylindrical, branched, 3-5 septate, compact at base, more or less free toward of upper part of sporodochia, $40-60 \times 2-2.5 \ \mu m$. Conidiogenous cells monophialidic, lageniform, integrated, terminal, light brown to subhyaline, irregularly cylindrical, collarettes inconspicuous, periclinal wall thickened, 10–13×1.5–2.5 µm. Microawns awn-like, L-shaped, curved or almost straight, recurved, aseptate, thin- and smoothwalled, 20-52 µm long; basal part thin- and smooth-walled, easily collapsed, $9-15 \times 3-3.5 \mu m$; upper part curved, sometimes recurved, tapering towards the obtuse apex, smooth or slightly verruculose, narrowed towards the apex, 1.5-2.5 µm wide. Conidia fusiform, curved, aseptate, hyaline, multiguttulate, smooth, $12-14 \times 2-2.5 \,\mu\text{m}$, provided with a single filiform setula at each end, 6-8 µm long.

Materials examined: **China**, Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead branches of *Acacia* sp., 17 October 2020, W.P. Wu (Wu17495); Guangdong



Fig. 217 Thozetella lunata (Wu12702, holotype). a, b Conidiophores and conidiogenous cells. c–s Microawns. t–z, aa–ab Conidia. Scale bar: 5 µm

Province, Shenzhen, Yangtaishan Forest Park, on dead fruit of unidentified tree, 17 October 2020, W.P. Wu (Wu17569, Wu17570, Wu17590, Wu17591); Province, Jinghong, Xishuangbanna, on dead leaves of unidentified tree, 6 December 2018, W.P. Wu (Wu15211, Wu15212). Living strains: 76,016 (from Wu15211), 76,017 and 76,018 (from Wu15212), 78,254 and 78,255 (from Wu17495), 78,372 (from Wu17569), 78,373 (from Wu17570), 78,382, 78,383 (from Wu17590), 78,384 (from Wu17590) and 78,391 (from Wu17591).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Thailand (Phookamsak et al. 2019).

Description and illustration: Phookamsak et al. (2019).

Notes: *Thozetella lithocarpi* is a recently described species from Thailand (Phookamsak et al. 2019). The fungus from the Chinese collections are identified to this species based on the ITS sequences. Morphologically they are somewhat different on both shape and size of microawns and conidia. In the original description of *T. lithocarpi*, the microawn was described as '24–54 μ m long, 3–3.5 μ m wide, visible as small hairs on the sporodochial mass, aseptate, variously-shaped, sigmoid or sickle-shaped, apex straight, hyaline, smooth-walled, thick-walled', while the microawns from the Chinese collections are L-shaped or

awn-like, incurved, verruculose in the upper part. The conidia $(20-35 \times 2-3 \ \mu\text{m})$ in the original description of *T. lithocarpi* are much larger than those from the Chinese connection.

Thozetella lunata W.P. Wu & Y.Z. Diao, sp. nov., Fig. 217, MycoBank MB841646.

Etymology: Refers to its lunate-shaped conidia.

Typification: **China**, Guangdong Province, Guangzhou, South China Botanical Garden, On dead leaf of palm, 10 Dec 2013, W.P. Wu, Holotype HMAS 352,073 (=Wu12701) ex-type strain CGMCC 3.20657 (=NN57647).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to gray, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a cylindrical, ovoid, or otherwise shaped white mass of conidia and microawns, stroma up to 60 μ m wide and 30–50 μ m high. Conidiophores pale brown to brown, irregularly cylindrical, branched, compact at base, more or less free toward of upper part of sporodochia. Conidiogenous cells monophialidic, integrated, terminal, light brown to subhyaline, irregularly cylindrical, without collarettes, periclinal wall thickened, $8-13 \times 2-2.5 \mu$ m. Microawns predominantly hamate, curved, thick-walled in lower part, refractive, with a rough apex, $13-21 \times 2-2.5 \mu$ m. Conidia lunate, continuous, hyaline,



Fig. 218 Thozetella moganshanensis (Wu17016, holotype). a–l Microawns. j–n Conidia. Scale bar: a–i 10 µm, j–n 5 µm

eguttulate, smooth, both ends acute, $8-10 \times 1.8-2.5 \mu m$, no setula or sometimes with a very short setula, up to 1.5 μm long.

Culture characteristics: Colonies on PDA effuse, colonies 2.8–3.2 cm diameter in 20 days, circular, flat, margin irregular, aerial mycelium well-developed, white, slightly grey, reverse pale brown in the center and becoming paler towards the margin (Fig. 207v).

Other materials examined: **China**, Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaf of palm, 10 December 2013, W.P. Wu (Wu12702a, b, c); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaf of palm, 10 December 2013, W.P. Wu (Wu12703a, b, c). Living strains: 57,651 (from Wu12702c), 57,652 (from Wu12702d), 57,656 (from Wu12701), 57,663 (from Wu12703a), 57,664 (from Wu12703b), 57,700 (from Wu12702a), 57,701 (from 12702b) and 57,702 (from Wu12701c).

Ecology/Substrate/Host: Saprobe on dead material of palm.

Geographical distribution: China.

Notes: *Thozetella lunata* differs from all known species in the genus by having small-sized microawns $(13-21 \,\mu\text{m} \log)$ and lunate conidia $(8-10 \times 1.8-2.5 \,\mu\text{m})$ without or with a very short setulae (< 1.5 μ m long) (Monteiro et al. 2016; Perera et al. 2016). *Thozetella asetula* described in this paper also produces conidia without setulae, but the conidia in this species are smaller. The strains isolated from the three specimens listed above have the identical ITS sequences, which are significantly different from those from the known species. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 53,378 include *T. acerosa* (GenBank AY330996, 95% identity) and *T. gigantea* (GenBank AY331001, 94% identity).

Thozetella moganshanensis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 218, MycoBank MB841648.

Etymology: Refers to the locality where this fungus was collected.

Typification: **China**, Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead bark of *Platanus occidentalis*, 16 October 2019, W.P. Wu, Holotype HMAS 352,075 (=Wu17016), ex-type strain CGMCC 3.20671 (=NN77338).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to gray, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a cylindrical, ovoid, or otherwise shaped white mass of conidia and microawns, stroma 35-50 µm high and 40-60 µm high. Conidiophores macronematous, pale brown to brown, irregularly cylindrical, branched, compact at base, more or less free toward the upper part of sporodochia, $35-50 \times 2-3 \mu m$. Conidiogenous cells monophialidic, integrated, terminal, light brown to subhyaline, irregularly cylindrical, lageniform, collarettes inconspicuous, periclinal wall thickened, $8-15 \times 2-3 \mu m$. Microawns predominantly awn-like, L-shaped, sigmoid, or irregularly curved at the base, aseptate, rigid, hyaline, refractive, (20-)50-96 µm long; basal part lageniform, thin-walled, sometimes curved, with lumen, and frequently collapsed, smooth, 3-4 µm wide, with an obtuse base; apical part acerose, thin-walled, straight or rarely recurved, 2-2.5 µm, apex acute. Conidia lunate, fusiform, curved, aseptate, hyaline, smooth, tapering toward both the rounded ends, $10-12 \times 2-2.5 \,\mu\text{m}$, with a setula at both ends, 3.5-7.5 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1.8–2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly grey, reverse soil to dark brown in the center and becoming paler towards the margins (Figs. 207x, y).

Other living strain: 77,376 (from Wu17016).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Thozetella moganshanensis* resembles *T. bamcusicola* (microawns straight or L–shaped, 70–100×3.5–5 µm; conidia 13.5–15.5×2.1–2.7 µm, setulae 4.8–5.7 µm long), *T. cubensis* (microawns awn–like, 37.5–105×2–5 µm; conidia 12.3–18×2.2–3.2 µm, setulae 4.8–10 µm long), *T. gigantea* (microawns awn–like, falcate, 100–120 µm long; conidia 11.5–17.5×1.7–2.5 µm, setulae 5.7–12.5 µm long), *T. pindobacuensis* (microawns awn–like, L-shaped, almost straight, 0–1-septate, 19–75×1.5–3.5 µm; conidia 13.5–18×1.5–2 µm, setulae 4.5–7 µm long) and anamorph of *Chaetosphaeria ribularia* (microawns straight or sigmoid or irregularly curved, 0–3-septate, 65–130×4–6.5 µm; conidia 11–13×1.8–2.5 µm, setulae 2.8–4.5 µm long) in morphology of microawns and conidia, but can be distinguished by the larger conidia in other species (Castañeda-Ruiz 1984; Castañeda-Ruiz and Arnold 1985b; Paulus et al. 2004; Barbosa et al. 2011; Silva and Grandi 2013; Ariyawansa et al. 2020). The anamorph of *Chaetosphaeria ribularia* also produces smaller conidia, but the microawns in this species are longer and not typical L-shaped (Ariyawansa et al. 2015).

In the phylogenetic tree generated by using the combined LSU and ITS sequences, *T. moganshanense* is clustered together with *Chaetosphaeria rivularia* and formed a separate clade. These two species are morphologically similar on shape of microawns and smaller conidia. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,338 include *Chaetosphaeria rivularia* (GenBank KR347356, 95% identity) and *Thozetella* sp. (GenBank MH268113, 90% identity).

Thozetella palmicola W.P. Wu & Y.Z. Diao, sp. nov., Fig. 219, MycoBank MB841649.

Etymology: Refers to the host plant from which the fungus was originally discovered.

Diagnosis: Morphologically similar to *T. pseudotock-laiensis* on shape of microawns, but differs by microawns with short basal cells.

Type: **China**, Hainan Province, Sanya, Yalongwan Park, on decaying seed of unidentified palm, 28 December 2020, W.P. Wu, Holotype HMAS 352,076 (= Wu17612), ex-type strain CGMCC 3.20763 (= NN78448).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to gray, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a cylindrical, ovoid, or otherwise shaped white mass of conidia and microawns. Conidiophores macronematous, pale brown to brown, irregularly cylindrical, branched, compact at base, more or less free toward of upper part of sporodochia. Conidiogenous cells monophialidic, integrated, terminal, light brown to subhyaline, irregularly cylindrical, without collarettes, periclinal wall thickened, 8-12×2-2.5 µm. Microawns predominantly hamate, awn-like, curved, 1-septate, 20-28 µm long; basal part cylindrical, thin- and smooth-walled, 5-10 µm long, 2.5-3.0 µm wide, with an obtuse or truncate base; upper part thin-walled, verruculose, 3-3.5 µm wide, with an obtuse or acute apex. Conidia lunate, fusiform, slightly curved, tapering towards both ends, aseptate, hyaline, guttulate, smooth,



Fig. 219 *Thozetella palmicola* (Wu17612, holotype). **a** Sporodochial conidiomata. **b** Conidiophores and conidiogenous cells. **c–j** Microawns. **k–m** Conidia. Scale bar: **a** 20 μm, **b–m** 5 μm



Fig. 220 Thozetella pandanicola (Wu16313). a, b Conidiophores and conidiogenous cells. c-m Microawns. n-t Conidia. Scale bar: 10 µm

 $8-12 \times 2-3 \mu m$, bearing an unbranched setula at each end and $3-4.5 \mu m \log$.

Culture characteristics: Colonies on PDA effuse, colonies 8–15 mm diameter in 14 days, circular, flat, margin entire, aerial mycelium abundant, not only restricted to the inoculation block, grey to light brown, reverse of the same color or yellow brown (Figs. 207k, 1).

Colonies on PDA effuse, colonies 1.7–2.3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium welldeveloped, white, slightly grey, reverse yellow to soil brown in the center and becoming paler towards the margins.

Other materials examined: Hainan Province, Sanya, Yalongwan Park, on decaying seed of unidentified palm, 28 December 2020, W.P. Wu (Wu17610, Wu17611, Wu17613). Living strains: 78,414 (from Wu17610), 78,415 and 78,448 (from Wu17612).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Thozetella palmicola* is characterized by awn-like and 1-septate microawns with a thin- and smooth-walled base and a cylindrical, verruculose apical cell, and smaller conidia (8–12×2–3 µm) with shorter setulae (3–4.5 µm). It resembles *T. pseudotocklaiensis* on shape and size of microawns, but differs in shorter basal cell of microawns. *Thozetella lithocarpi* also produces microawns in similar shape, but in this species, the microawns are longer (20–47 µm long) and with longer basal cells (8–17.5 µm long).

Thozetella pandanicola Tibpromma & K.D. Hyde, Fungal Divers. 93: 130, 2018. Figure 220

Materials examined: **China**, Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of unidentified tree, 2 December 2018, W.P. Wu (Wu16275); Guangdong Province, Guangzhou, on dead leaves of *Eucalyptus* sp., 10 December 2013, W.P. Wu (Wu12705); Guangdong Province, Shenzhen, Yangtaishan Forest Park, on dead seed pod of *Acacia* sp., 17 October 2020, W.P. Wu (Wu17582). Living strains: 57,661 and 57,662 (from Wu12705), 76,704 (from Wu16313), 76,603 and 76,604 (from Wu16275) and 78,379 (from Wu17582).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Thailand (Tibpromma et al. 2018).

Description and illustration: Tibpromma et al. (2018).

Notes: *Thozetella pandanicola* is a recently described species from Thailand (Tibpromma et al. 2018). The fungus from the Chinese collections are identified to this species based on the ITS sequences.

Thozetella paragigantea W.P. Wu & Y.Z. Diao, sp. nov., Fig. 221, MycoBank MB841650.

Etymology: Refers to its similarity with *Thozetella* gigantea.

Typification: **China**, Yunnan Province, Jinghong, Xishuangbanna, on dead leaves of identified trees, 10 August 2018, Yu Zhang, Holotype HMAS 352,077 (=Wu15205), ex-type strains CGMCC 3.20727 (=NN76039).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, sessile, cream, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a cylindrical to ellipsoid or ovoid shaped white mass of conidia and microawns, stroma up to 50-70 µm high, and up to 50 µm wide. Conidiophores macronematous, pale brown to brown, irregularly cylindrical, branched, thin- and smooth-walled, arising from a basal plate, $35-45 \times 2-3 \mu m$. Conidiogenous cells monophialidic, integrated, terminal, pale brown, irregularly cylindrical to ellipsoid, with no or minute collarette, periclinal wall thickened, $10-12 \times 2-2.5 \,\mu\text{m}$, tapering towards the apex, apex 1 µm wide. Microawns predominantly L-shaped, hyaline, smooth, (37-)60-120 µm long; basal part thin-walled, aseptate, sometime collapsed, 25-30 µm long, 2-3 µm wide; apical part cylindrical, smooth and thick-walled, apical part smooth and with a rounded apex, $20-80 \times 1.5-1.8$ µm. Conidia falcate to lunate, aseptate, finely guttulate, hyaline and smooth, $12.5-13.5 \times 2.5 \mu m$, with one filiform setula at each end, 5-7 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1.8–2.3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly grey to brown in the center, with pale colored margin, reverse dark brown in the center and becoming paler towards the margin (Fig. 207m, n).

Other materials examined: **China**, Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of identified trees, 12 June 2015, W.P. Wu (Wu13346). Living strains: 59019 and 59024 (from Wu13346), 76,082 (from Wu15205).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Thozetella paragigantea* resembles *T. cubensis* and *T. gigantean* in L–shaped microawn (Castañeda-Ruiz and Arnold 1985b; Mercado Sierra et al. 1997a, b; Paulus et al. 2004; Sliva and Grandi 2013). *Thozetella paragigantea* differs from *T. gigantea* by much longer microawns (71–280 μ m) and big conidia (14–18×2.5–3 μ m) in the latter species; differs from *T. cubensis* by microawns with acute apex and longer conidia (11–17×2–2.5 μ m) in the latter species.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 53,378 include *Thozetella acerosa* (GenBank AY330996, 96% identity), *T. gigantea*



Fig. 221 *Thozetella paragigantea* (Wu15205, holotype). **a** Sporodochial conidiomata. **b–d** L-shaped microawns. **e–j** Conidia. Scale bar: **a** 40 μm, **d** 20 μm, **b**, **c**, **e–j** 5 μm


Fig. 222 *Thozetella pinicola* (Wu17258). **a** Sporodochial conidiomata. **b** Conidiophores and conidiogenous cells. **c–l** Microawns. **m–o** Conidia. Scale bar: **a** 20 μm, **c–j** 10 μm, **b, k–m** 5 μm

(GenBank AY331002, 97% identity) and *T. pindobacuensis* (GenBank MH595849, 97% identity).

Thozetella pinicola S.Y.Q. Yeung, R. Jeewon & K.D. Hyde, Can. J. Microiol. 55: 681, 2009. Figure 222

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a globose, ovoid, or otherwise shaped white mass of conidia and microawns, 60-75 µm high. Basal stroma dark brown, composed of dark brown, irregularly shaped cells of 3-4 µm wide. Conidiophores macronematous, brown, irregularly cylindrical, branched, 1-3-septate, compact at base, more or less free toward the upper part of sporodochia, thin- and smooth-walled, $25-32 \times 2-3$ µm. Conidiogenous cells monophialidic, integrated, terminal, light brown to subhyaline, irregularly cylindrical, without collarettes, periclinal wall thickened, $8.5-10 \times 2-2.5 \mu m$. Microawns predominantly sigmoid, falcate, strongly curved, hyaline, smooth, 30-55 µm long; basal part subcylindrical, ellipsoid, lageniform, smooth- and thin-walled, 2.5-3.5 µm wide; apical part thick-walled, 1-1.5 µm, with an acute apex. Conidia lunate to fusiform, aseptate, hyaline, multi-guttulate, smooth-and thin-walled, $11-13 \times 2-2.5 \mu m$, provided with a single filiform setula at each end, 6–7 µm long.

Materials examined: China, Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaf of Areca sp., 10 December 2013, W.P. Wu (12639b, 12639a); Guangdong Province, Shaoguan, Danxiashan, on dead leaves of unidentified tree, 25 December 2012, W.P. Wu (Wu12480); Guangdong Province, Guangzhou, South China Agriculture University, on dead leaves of unidentified tree, 3 December 2018, W.P. Wu (Wu16360, 1Wu16361, Wu16366); Guangdong Province, Guangzhou, Yuexiu Garden, on dead culm of bamboo, 2 March 2012, W.P. Wu (WU12221); Guangdong Province, Dinghushan, on dead leaves of Smilax sp., 10 October 1998, W.P. Wu (WU1937b); Guangdong Province, Guangzhou, South China Botanical Garden, on dead leaves of Manglietia pachyphylla; 28 February 2016, W.P. Wu (Wu12725); Guangdong Province, Shenzhen, Lianhuashan, on dead fruit of unidentified tree, 11 November 2019, W.P. Wu (Wu17258); Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead fruit of Cyclobalanopsis sp., 25 August 2019, W.P. Wu (Wu16809a, Wu16877, Wu16883); Sichuan Province, Ya An, Wan Guan, Bi Feng Xia, on dead leaves of identified trees, 15 December 2013, W.P. Wu (Wu13193); Zhejiang Province, Huaian County, Qiandaohu, on dead leaves of unidentified tree, 18 October 2018, W.P. Wu (Wu16055); Japan, Mie Prefecture, Tsu, Mie Center for the Arts, on dead leaves of unidentified tree, 2 October 2019, W.P. Wu (Wu16920, Wu16922); Mie Prefecture, Tsu, Tsukairaku Park, on rotten seed of unidentified tree, 2 October 2019, W.P. Wu (Wu16929). Living strains: 54,236 (from Wu12221), 44,784 (from Wu1937b), 57,541 (from Wu12480), 57,594 (from Wu12639a), 55,292 (from Wu12480), 57,612 (from Wu12639), 76,211 (from Wu16055), 77,119, 77,120 and 77,157 (from Wu16809), 77,211 and 77,161 (from Wu16877), 77,215 (from Wu16883), 77,270 (from Wu17258), 77,272 and 77,273 (from Wu16920), 77,276 and 77,350 (from Wu16929), 77,280 (from Wu16946), 77,325 and 76,658 (from 16,360), 76,659 (from Wu16361) and 76,667 (from Wu16366)..

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China (Jeung et al. 2009). Description and illustration: Jeung et al. (2009).

Notes: *Thozetella pinicola* was originally described from the isolate obtained from the leaf litter of *Pinus elliotti* from Hongkong, China (Yeung et al. 2009). It resembles *Thozetella falcata*, *Thozetella gigantea* and *Thozetella nivea*, but can be distinguished by its distinct shape of microawns. The type material seems to be in bad shape from which no microawn was observed and only a few conidia were seen by Sliva and Grandi (2013).

In the original description of *T. pinicola*, the size of conidia produced from pure culture was described as 12.5–19.5 μ m long, 5–6.3 μ m wide, bearing a long seta at either end, 7–11 μ m long. Much smaller conidia were observed in the specimens on natural substrate collected from mainland China, they are 11–13×2–2.5 μ m and 6–7 μ m long setulae. The ITS sequences from those collections are identical to the one obtained from the type specimen (Jeewon et al. 2009).

Thozetella pseudotocklaiensis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 223, MycoBank MB841651.

Etymology: Refers its similarity of microawns to the other species *Thozetella tocklaiensis*.

Typification: **China**, Hainan Province, Sanya, Yalongwan Park, on dead seed pod of *Delonix regia*, 28 December 2020, W.P. Wu, Holotype HMAS 352,078 (=Wu17596), ex-type strain CGMCC 3.20762 (=NN78411).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a globose, ovoid white mass of conidia and microawns. Basal stroma dark brown, composed of dark brown, irregularly shaped cells of 2.5–4 µm wide, 65–90 µm high. Conidiophores macronematous, brown at the basal part, becoming pale brown toward apex, irregularly cylindrical, branched, 2–3-septate, compact at base, more or less free toward of upper part of sporodochia, 40–60×2–2.5 µm. Conidiogenous cells monophialidic, lageniform, integrated, terminal, light brown to subhyaline, irregularly cylindrical, collarettes inconspicuous,



Fig. 223 *Thozetella pseudotocklaiensis* (**a**, **b**, **d–g**, **j**, **o–q** Wu17596, holotype; **c**, **h**, **I**, **k–n**, **r**, **s** ex-type strain). a Sporodochial conidiomata with microawns and spore mass. **b**, **c** Conidiophores and conidiogenous cells. **d–l** Microawns. **m–s** Conidia. Scale bar: **a** 20 µm, **b–s** 5 µm

periclinal wall thickened, $10-13 \times 1.5-2.5 \ \mu\text{m}$. Microawns awn–like, sigmoid, fusiform, vermiform-shaped, curved or almost straight, recurved, 1-septate, thin- and smoothwalled, 20–47 μ m long; basal cell thin- and smooth-walled, easily collapsed, 8–17.5 × 3–3.5 μ m; apical cell curved, recurved, tapering towards the obtuse apex, verruculose, narrowed towards the apex. Conidia fusiform, curved, aseptate, hyaline, guttulate, smooth, 10–13 × 2 μ m, provided with a single filiform setula at each end, 4–5 μ m long. On PDA, the microawns is in similar morphology as observed on natural substrate, 17–20×2.5–3 μ m; conidia lunate, fusiform, aseptate, 13–15×2 μ m, bearing one setula at each end, 5–6.5 μ m long.

Culture characteristics: Colonies on PDA effuse, colonies1.5–2.3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium abundant at beginning, then disappeared, not only restricted to the inoculation block, white to grey in the center, brown towards the margin, reverse dark brown (Fig. 2070, p).

Other living strains: 78,411 and 78,443 (both from the specimen Wu17596).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Thozetella pseudotocklaiensis* resembles *T. canadensis* and *T. effusa* on verruculose microawns, but differs from them by strongly curved microawns and smaller conidia (Castañeda-Ruiz and Arnold 1985b; Paulus et al. 2004; Seifert et al. 2011; Sliva and Grandi 2013; Monteiro et al. 2016; Perera et al. 2016). It is phylogenetically closely related to *Thozetella tocklaiensis*, but clearly differs on morphology of microawns and conidia.

Thozetella rivularis (Réblová & J. Fourn.) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841735.

≡ Chaetosphaeria rivularia Réblová & J. Fourn., Fungal Divers. 75: 145, 2015.

Typification: France: Midi-Pyrénées, Ariège, Rimont, Grand Bois forest, Maury brook, 650 m a.s.l., submerged wood of *Fagus sylvatica* associated with *Minutisphaera japonica*, 17 November 2009, J. Fournier J.F. 09,308 (PRM 933,847, holotype); ex-type living culture CBS127686.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: France (Ariyawansa et al. 2015).

Description and illustration: Ariyawansa et al. (2015).

Notes: *Chaetosphaeria rivularia* is transferred into *Thozetella* based on both morphological similarity and phylogenetical analysis. On PCA, the ageing culture from single ascospore produced *Thozetella*-like sporodochia with microawns and falcate, setulate conidia (Ariyawansa et al. 2015). In the phylogenetic tree generated from the combined LSU

and ITS data, C. *rivularia* is clustered together with all other species of *Thozetella*. It is the only *Thozetella* species with teleomorph known so far (Ariyawansa et al. 2015).

Thozetella suttonii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 224, MycoBank MB841653.

Etymology: Named after the British mycologist, Brian C. Sutton, also the PhD supervisor for one of the authors in this work (Wu).

Typification: **China**, Guangdong Province, Zhaoqing, Dinghushan, on dead branches of unidentified plant, 10 October 1998, W.P. Wu, Holotype HMAS 352,080 (=Wu1940b), ex-type strain CGMCC 3.20637 (=NN 44,785).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears a globose, ovoid, or otherwise shaped white mass of conidia and microawns. Basal stroma dark brown, composed of dark brown, irregularly shaped cells of 2-4 µm wide, up to 200 µm high, 110 µm wide. Conidiophores macronematous, brown at the basal part, becoming pale brown toward apex, irregularly cylindrical, branched, 2-3-septate, compact at base, more or less free toward of upper part of sporodochia, $40-50 \times 2-2.5 \ \mu\text{m}$, sounded by brown and hairy hyphae. Conidiogenous cells monophialidic, integrated, terminal, light brown to subhyaline, irregularly cylindrical, without collarettes, periclinal wall thickened, $13-16 \times 2-3 \mu m$. Microawns absent. Conidia fusiform, curved, continuous, hyaline, guttulate, smooth, $17-20 \times 2.5-3 \mu m$, provided with a single filiform setula at each end, 10–14 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 2.5–2.8 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly grey, reverse very pale-yellow brown in the center and becoming paler towards the margins (Fig. 207s, t).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Thozetella suttonii* is a unique member of the genus in that no microawns are formed among conidia, thus not a typical member of the genus. However, the phylogenetic analysis based on the combined LSU and ITS sequence showed its close relationship with *Thozetella* (Castañeda-Ruiz and Arnold, 1985b; Paulus et al. 2004; Seifert et al. 2011; Sliva and Grandi 2013; Monteiro et al. 2016; Perera et al. 2016).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 44785 include *Thozetella gigantea* (GenBank AY331002, 93% identity)), *T. falcata* (GenBank AY330999, 93% identity) and *T. queenslandica* (GenBank AY330998, 95% identity).



Fig. 224 *Thozetellla suttonii* (Wu1940b, holotype). **a–c** Part of basal stroma and lateral wall of sporodochia. **d–n** Conidia. **o–p** Part of conidia bearing setulae. Scale bar: **a** 20 μm, **b–p** 5 μm



Fig. 225 Thozetella tocklaiensis (Wu17254). a-d Conidiophores and conidiogenous cells. e-n, p-z Microawns. o, aa-aj Conidia. Scale bar: 5 µm

Thozetella tocklaiensis (Agnihothr.) Piroz. & Hodges, Can. J. Bot. 51: 171, 1973. Figure 225

 \equiv *Thozetellopsis tocklaiensis* Agnihothr., Mycologia 50: 576, 1958.

=*Neottiosporella radicata* E.F. Morris, Mycologia 48: 735, 1956.

= Thozetella radicata (E.F. Morris) Piroz. & Hodges, Can. J. Bot. 51: 172, 1973.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial or effuse, solitary, pale brown to brown, up to 350 µm high and 250 µm wide; basal stroma pale brown to brown, fanshaped, with narrow base and broad sporulating region. Conidiophores cylindrical, pale brown, 1-3-septate, smooth- and thin-walled, branched, terminated with a conidiogenous cell, $20-35 \times 2-2.5 \mu m$. Conidiogenous cells phialidic, pale brown to hyaline, cylindrical, monophialidic, $10-15 \times 2-3 \mu m$, collarette inconspicuous. Conidia lunate, fusiform, naviculate, hyaline, aseptate, guttulate, $11-13 \times 2-2.5 \mu m$, provided with a single setula at each end and 4-6.5 µm. Microawns awn-like, claw-like, curved, strongly recurved, hyaline, refractive, aseptate, 11-15 µm long, verruculose; basal part lageniform with lumen, thinwalled and frequently collapsed, $8-11 \times 2.5-3.5 \mu m$; apical part acuminate, curved or tortuously, thick-walled, verruculose or smooth, $10-14 \times 1.3-1.5 \mu m$.

Materials examined: China: Guangdong Province, Shenzhen, Yangtaishan Park, on dead leaves of *Acacia* sp., 11 November 2019, W.P. Wu (Wu17254). China: Guangdong Province, Shenzhen, Yangtaishan Park, on dead leaves of *Acacia* sp., 17 October 2020, W.P. Wu (Wu17487). Living strains: 78248 and 78249 (from Wu17487), 77,748 (from Wu171254).

Ecology/Substrate/Host: Saprobe on dead material of plants including *Camellia sinensis*.

Known distribution: Argentina, Brazil, China, India, New Zealand and Panama (Morris 1956; Agnihothrudu 1958; Pirozynski and Hodges 1973; Waipara et al. 1996; Sliva and Grandi 2013)).

Description and illustration: Morris (1956); Agnihothrudu (1958); Pirozynski and Hodges (1973); Waipara et al. (1996); Sliva and Grandi (2013).

Notes: *Thozetella tocklaiensis* was fully documented in several publications, and morphological variations on conidiomata, microawns and conidia were noticed from different specimens (Sliva and Grandi 2013). The fungus from the Chinese specimen is with small-sized microawns which are strongly recurved.

Thozetella wenyingiae W.P. Wu & Y.Z. Diao, sp. nov., Fig. 226, MycoBank MB841655.

Etymology: Named after the Chinese mycologist Prof. Wenying Zhuang from the Institute of Microbiology The Chinese Academy of Science, Beijing.

Typification: **China**, Yunnan Province, Jinghong, Xishuangbanna, on dead leaves of unidentified tree, 12 June 2018, Zhang Yu, Holotype HMAS 352,082 (=Wu15209), ex-type strain CGMCC3.20729 (=NN76043).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears an ovoid to cylindrical, white mass of conidia and microawns. Basal stroma dark brown, composed of dark brown, irregularly shaped cells of 2-4 µm wide, up to 45 µm high, basal part cylindrical, 30-45 µm wide, upper part up to 50 µm wide. Conidiophores macronematous, brown, irregularly cylindrical, branched, 1-3-septate, compact at base, more or less free toward of upper part of sporodochia, $45-55 \times 1.5-2 \mu m$. Conidiogenous cells monophialidic, integrated, terminal, light brown, cylindrical, $13-18 \times 1.5-2$ µm, without collarettes or with inconspicuous collarettes, periclinal wall thickened, apex 1-1.5 µm. Conidia fusiform, curved, continuous, hyaline, guttulate, smooth, $11-14.5 \times 2-2.5 \mu m$, provided with a single filiform setula at each end, 5.5-7 µm long. Microawns produced from conidiogenous cells, vermiform-shaped, curved, recurved, gradually tapered towards both ends, 0-1-septate, $15-20 \times 3.3-3.8 \mu m$; basal cells very short, thin- and smooth-walled, 3-5 µm long, with obtuse or truncated base; apical cells verruculose, with obtuse apex.

Culture characteristics: Colonies on PDA effuse, colonies 1.3–1.6 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly grey, reverse soil to dark brown in the center and becoming paler towards the margins (Fig. 228a–d).

Otrher materials examined: **China**, Sichuan Province, Ya An, Wan Guan, Bi Feng Xia, on dead leaves of identified trees, 15 December 2013, W.P. Wu (Wu13258); Sichuan Province, Dujiangyan, Qingchengshan, on rotten seed of unidentified tree, 9 November 2019, W.P. Wu (HMAS 352,081 = Wu17201, 17,200); Yunnan Province, Jinghong, Xishuangbanna, on dead leaves of unidentified tree, 12 June 2018, Zhang Yu (Wu15233). Living strains: CGMCC 3.20656 (= 57,578) and 57,596 (from Wu13258), 76,044 (from Wu15209b), 76,045 (from Wu15209c), 77,559 and 77,560 (from Wu17200), 77,561 (from Wu17201) and 76,012 (from YN03a).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Thozetella wenyingiae* morphologically resembles *T. vermiformia* in shape and size of microawns and conidia, but differs in lacking microconidia, smaller-sized basal cell of microawns, and also ITS sequence. It also differs from



Fig. 226 Thozetella wenyingiae (Wu15209, holotype). a–f, u–w Conidia. g–t Microawns. Scale bar: 5 µm



Fig. 227 Thozetella ypsiloidea (Wu15159). a Sporodochial conidiomata. b-e Y-shaped microawns. f-l Conidia. a 40 µm, b-l 5 µm

other known species in the genus by a combination of vermiform microawns and falcate conidia with setulae (Castañeda-Ruiz and Arnold 1985b; Paulus et al. 2004; Sliva and Grandi 2013; Monteiro et al. 2016; Perera et al. 2016).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 76,043 include *Thozetella fabacearum* (GenBank KY212754, 94% identity) and *T. tocklaiensis* (GenBank MH857817, 97%).

Thozetella ypsiloidea J.S. Monteiro, R.F. Castañeda & Gusmão, Mycotaxon 131: 608, 2016. Figure 227

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Colonies on natural substrate creamcolored. Mycelium partly immersed and partly superficial, composed of dark brown, septate, and branched hyphae. Conidiomata sporodochial, superficial, cream to white, forming a flat or convex hymenium on a dark brown, stromatic base, which bears an ovoid to cylindrical, white mass of conidia and microawns. Basal stroma dark brown, composed of dark brown, irregularly shaped cells of 2–3.5 μ m wide, up to 60 μ m high, basal part cylindrical, 30–40 μ m wide, upper part up to 50 μ m wide. Conidiophores macronematous, brown, irregularly cylindrical, branched, 1–3-septate, compact at base, more or less free toward of upper part of sporodochia, 30–50×2–3 μ m. Conidiogenous cells monophialidic, integrated, terminal, light brown, cylindrical, $12-20 \times 2-2.5 \,\mu$ m, without collarettes or inconspicuous, periclinal wall thickened, apex 1–1.5 µm. Conidia lunate, fusiform, curved, continuous, hyaline, guttulate, smooth, $11-15 \times 2-3 \,\mu$ m, provided with a single filiform setula at each end, 5–8 µm long. Microawns produced from conidiogenous cells, Y-shaped, finally verrucose on arm which has rounded apex and partially verrucose or smooth on the other arm, partially smooth on stipe, hyphae, $12-22 \times 8-13 \,\mu$ m, $2-4 \,\mu$ m at the base.

Materials examined: **Puerto Rico**, on dead leaves of unidentified tree, 18 July 2018, W.P. Wu (Wu15159). Living strains: 75,994 and 75,996 (from Wu15159).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Brazil (Monteiro et al. 2016) and Potro Rico.

Description and illustration: Monteiro et al. (2016).

Notes: *Thozetella ypsiloidea* morphologically differs from all other known species in the genus by its Y-shaped microawns (Castañeda-Ruiz and Arnold 1985b; Paulus et al. 2004; Barbosa et al. 2011; Sliva and Grandi 2013; Monteiro et al. 2016; Perera et al. 2016). Based on ITS blast in NCBI's GenBank, the closest matches to the strain 75,994 include Fig. 228 Colony of *Thozetella* and *Verhulstia* species on PDA after 20 days at 25 °C. **a**, **b** *Thozetella wenyingiae* (ex-type strain 77561). **c**, **d** *T. wenyingiae* (ex-type strain 76043). **e**, **f** *Verhulstia biformis* (ex-type strain 77657). **g**, **h** *V. elegans* (ex-type strain 77590). **i–l** *V. minima* (**i–j** ex-type strain 77723, **k–l** 77720)



Thozetella ypsiloidea (GenBank KJ183031, 100% identity) and *T. fabacearum* (GenBank KY212754, 94% identity).

Verhulstia Hern.-Rest., Persoonia 39: 449, 2017.

Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, scattered to gregarious, superficial, hyaline becoming brown with age, globose, setose with a central white conidial mass; basal stroma of textura angularis. Setae arising from outer elements of the stroma, abundant, subulate to subcylindrical, basal cell pale brown, other cells brown to dark brown, apex paler, rounded, verrucose to warty, straight to flexuous, multiseptate. Conidiophores arising from the stroma in dense layers, unbranched, cylindrical, septate, hyaline to pale brown toward the apex. Conidiogenous cells integrated, terminal, lageniform to subcylindrical, phialidic with a collarette, hyaline to pale brown. Conidia cylindrical to ellipsoidal, or obovoid, straight or curved at the apex, aseptate, hyaline, smooth.

Type species. Verhulstia trisororum Hern.-Rest.

Ecology/Substrate/Host: Saprobe from soil or on dead material of plant.

Geographical distribution: China and Netherland.

Description and illustration: Crous et al. (2017).

Notes: Verhulstia was created for a setose sporodochial microfungus, V. trisororum, isolated from soil sample in Netherland (Crous et al. 2017). It was compared with Dinemasporium, Brunneodinemasporium, Pseudolachnea and Vermiculariopsiella in producing setose conidiomata with phialidic conidiogenous cells, and hyaline conidia, but can be distinguished from all of them in having hyaline,



Fig. 229 Verhulstia biformis (Wu17174, holotype). a-c Sporodochia with setae and basal stroma. d Conidiophores and conidiogenous cells. e-z, aa-ac Conidia. ad-ah Fusiform conidia. Scale bar: a-c 20 μm, d-z, aa-ah 5 μm

lageniform conidiogenous cells that eventually become brown with age and with a conspicuous collarette, and small conidia without setulae. Furthermore, the phylogenetic analysis based on ITS and 28S sequences from the type species (strain CBS143234) showed it formed a separate branch close to species of *Chaetosphaeria* with *Chloridium*-like anamorph, including *C. lignicola* (F. Mangenot) W. Gams & Hol.-Jech. and *C. pini* Crous & Akulov.

In our phylogenetic study (Figs. 3, Supplementary Fig. 8), several isolates representing 3 different species of *Verhulstia*

from China, are clustered together with *V. trisororum* and form a distinct clade with strong support.

Verhulstia biformis W.P. Wu & Y.Z. Diao, sp. nov., Fig. 229, MycoBank MB841656.

Etymology: Refers to two different types of conidia produced by this fungus.

Typification: **China**, Sichuan Province, Dujiangyan, Qingchengshan, on dead leaves of *Rubus* sp., 17 October 2019, W.P. Wu, Holotype HMAS 352,083 (=Wu17174), ex-type strain CGMCC 3.20749 (=NN77590).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, scattered to gregarious, superficial, ellipsoidal to cylindrical, setose with a central white conidial mass, $60-100 \,\mu\text{m}$ wide, 50–75 µm high, basal stroma of textura angularis. Setae arising from basal stroma, distributed among conidiophores, 10-13 per sporodochia, subcylindrical, apex acute, straight to flexuous, 120–210 µm long, 3.7–4.5 µm wide at the widest part, 4-7-septate, the thin-walled basal cell pale brown and $12-17 \times 3-3.5 \mu m$, other cells brown to dark brown, smooth, tapering towards the apex 1-2 µm wide at apex. Conidiophores arising from the stroma in a dense layer, branched, cylindrical, septate, pale brown, darker toward the apex, $35-55 \times 1-1.5 \mu m$. Conidiogenous cells integrated, terminal, lageniform to subcylindrical, monophialidic, with an inconspicuous collarette, subhyaline to pale brown, 8-11 µm long, 1-1.5 µm wide. Conidia cylindrical to ellipsoidal, straight or slightly curbed in one end, with rounded or truncate ends, hyaline, aseptate, thin-walled, smooth, $4.5-5 \times 1.2-1.6 \mu m$, guttulate with one at each end; the second type conidia, which is fusiform, asymmetrical, with one end obtuse and tapering toward other end, $8-12 \times 1.2-2 \mu m$, are also seen among the cylindrical to ellipsoidal.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–0.8 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, dark grey to brown, with white margins, reverse pale brown in the center and becoming paler towards the margins (Fig. 227e, f).

Other material examined: **China**, Sichuan Province, Dujiangyan, Qingchengshan, on dead leaves of *Rubus* sp., 17 October 2019, W.P. Wu (Wu17175). Living strains: 77,656 (from Wu17175), 77,657 (from Wu17175) and 77,689 (from Wu17174).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Verhulstia biformis differs from V. trisororum Hern.-Rest. by fewer setae per sporodochia, and production of two types of conidia. The short cylindrical conidia $(4.5-5\times1.2-1.6 \ \mu\text{m})$ in V. biformis is similar in shape but smaller than those in V. trisororum (cylindrical to ellipsoidal, $5-7\times1-2 \ \mu\text{m}$; or obovoid, $5-8\times2-3 \ \mu\text{m}$) (Crous et al. 2017). It differs from the other two new species described in this paper by longer conidia. Both LSU and ITS sequences were obtained from the type specimen and its phylogenetic affinity to Verhulstia and other genera in Chaetosphaeriaceae was confirmed. Phylogenetically, on a megablast search using the ITS sequence from the ex-type strain, the closest matches in NCBI's GenBank nucleotide database was members of Verhulstia, including Verhulstia trisororum (GenBank MG022181, 94% identity). *Verhulstia elegans* W.P. Wu & Y.Z. Diao, sp. nov., Fig. 230, MycoBank MB841657.

Etymology: *elegans* (L), beautiful, refers to it beautiful sporodochia.

Typification: **China**, Sichuan Province, Dujiangyan, Qingchengshan, on dead leaves of unidentified broadleaf tree, 17 Oct 2019, W.P. Wu, Holotype HMAS 352,084 (=Wu17163), ex-type strain CGMCC 3.20803 (=NN77657).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, scattered to gregarious, superficial, ellipsoidal to cylindrical, setose with a central white conidial mass, 30-55 µm wide, 40-60 µm high, basal stroma of textura angularis. Setae arising from basal stroma, distributed among conidiophores, less than 5 per sporodochia, subcylindrical, apex rounded, straight to flexuous, 100-155 µm long, $3.5-5.5 \mu m$ wide at the widest part, septate, the thinwalled basal cell pale brown and $12.5-17 \times 4-6 \mu m$, other cells brown to dark brown, smooth, tapering towards the apex 1.2-1.5 µm wide at rounded apex. Conidiophores arising from the stroma in a dense layer, branched, cylindrical, septate, pale brown, darker toward the apex, $40-60 \times 1.5-2$ µm. Conidiogenous cells integrated, terminal, lageniform to subcylindrical, monophialidic, with an inconspicuous collarette, subhyaline to pale brown, $8-12 \times 1.5-2$ µm. Conidia cylindrical, straight or slightly curved in one end, with rounded or truncate ends, hyaline, aseptate, thin-walled, smooth, $3.2-4.8 \times 1.5-2 \ \mu m$, guttulate with one at each end.

Culture characteristics: Colonies on PDA effuse, colonies 0.8–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly grey, reverse pale to yellow brown in the center and becoming paler towards the margins (Fig. 228g, h).

Other living strains: 77,591 and 77,688 (from Wu17163). Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Verhulstia elegans differs from V. biformis, V. minima and V. trisororum — and V. biformis by fewer setae per sporodochia (Crous et al. 2017). In addition, the conidia in this species are smaller than those in V. biformis and V. trisororum, but bigger than those in V. minima (Crous et al. 2017). Both LSU and ITS sequences were obtained from the type specimen and its phylogenetic affinity to Verhulstia and other genera in Chaetosphaeriaceae was confirmed. Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,590 include Verhulstia trisororum (GenBank MG022181, 96% identity).



Fig. 230 Verhulstia elegans (Wu17163 holotype). a, b Sporodochial conidiomata with setae. c-g Conidia. Scale bar: a, b 20 µm, c-g 5 µm

Verhulstia minima W.P. Wu & Y.Z. Diao sp. nov., Fig. 231, MycoBank MB841658.

Etymology: Refers to its small conidia.

Typification: **China**, Sichuan Province, Dujiangyan, Qingchengshan, on dead leaves of unidentified broad leaf tree, 9 November 2019, W.P. Wu, Holotype HMAS 352,085 (=Wu17227), ex-type strain CGMCC 3.20674 (=NN77723).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata sporodochial, scattered to gregarious, superficial, brown, globose to ellipsoid, setose with a central white conidial mass, basal stroma of textura angularis. Setae arising from the cell of basal stroma, 9–13 per sporodochia, basal cell pale brown, other cells brown to dark brown, subulate to subcylindrical, apex rounded, smooth, straight, multiseptate, 140–210 μ m long, 3.5–4 μ m wide in the middle, basal cell 20–27 × 3.5–4.5 μ m, tapering toward the 1–2 μ m wide apex. Conidiophores arising from the stroma in a dense layer, branched, cylindrical, septate, pale brown, 25–35 × 1.5–2 μ m. Conidiogenous cells integrated, terminal, lageniform to subcylindrical, phialidic with an inconspicuous collarette, subhyaline to pale brown,



Fig. 231 *Verhulstia minima* (**a–f** Wu17227 holotype, **g**, **h** ex-type strain on PDA). **a**, **b** Sporodochial conidiomata with setae. **c** Conidiophores and conidiogenous cells. **d–g** Conidia. **h** Chlamydospore. Scale bar: **a**, **b** 20 μm, **c–h** 5 μm

 $8-11 \times 1.5-2$ µm long. Conidia ellipsoidal, cylindrical, 2.5-3.5 × 1.5 µm, straight or slightly curved, hyaline, aseptate, smooth, guttulate, rounded or slightly truncate at both ends.

Culture characteristics: Colonies on PDA effuse, colonies 0.5–0.7 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white then slightly grey to pale brown, reverse soil brown in the center and becoming paler towards the margins. Chlamydospores abundant, single or in chain, dark brown, globose, ellipsoidal, oblong, smooth- and thick-walled (Fig. 228i, j).

Other living strains: 77,720, and 77,724 (all from the holotype specimen Wu17227).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Verhulstia minima* differs from all other three species in the genus by smaller conidia (Crous et al. 2017). In addition, massive chlamydospores are produced in pure culture, which is not seen in other species. Both LSU and ITS sequences were obtained from the ex-type strain. Based on ITS blast in NCBI's GenBank, the closest matches to the extype strain 77,723 include *Verhulstia trisororum* (GenBank MG022181, 98% identity).

Coelomycetous anamorphs of phialidic chaetosphaeriaceous fungi

A total of 12 coelomycetous genera are assigned to Chaetosphaeriaceae, including *Brunneodinemasporium*, *Calvolachnella*, *Conicomyces*, *Dendrophoma*, *Dinemasporium*, *Hoehneliella*, *Infundibulomyces*, *Neopseudolachnella*, *Polynema*, *Pseudodinemasporium*, *Pseudolachnea* and *Pseudolachenlla* (Lin et al. 2019; Hashimoto et al. 2015a, b; Crous and Groenewald 2018; Li et al. 2020). Some other genera, including *Dwayalomella* and *Plectronidiopsis*, are morphologically closely related to these assigned genera, but future phylogenic analysis is needed to elucidate their relationship with Chaetosphaeriaceae.

Conidiomata from almost all these genera are superficial, stromatic, acervular or cupulate. Conidiomatal setae from basal stroma or excipula are commonly found in most of these genera, except for *Calvolachnella* and *Infundibulomyces*, and presumed to contribute to conidial dispersal by trapping water drops as well as preventing small arthropods from feeding on the conidial mass (Nag Raj 1993). Species in all these genera produces hyaline or very pale brown conidia bearing one to several setulae, potentially enhancing fungal encounter with substrata by increasing the functional length of conidia (Nag Raj 1993).

The result from our phylogenetic analysis (Figs. 3, 232, 233) shows that all the coelomycetous genera are monophyletic (Crous et al. 2012; Hashimoto et al. 2015a, b). All species of *Pseudolachnea* and *Pseudolachnella* are clustered together as one strongly supported group, which is phylogenetically closely related to another well-supported group including *Brunneodinemasporium*, *Neopseudolachnella*, and *Pseudodinemasporium*. While the genus *Dinemasporium* is more closely related to *Menispora* in the phylogenetic tree.

Dinemasporium-like genera

Several genera with a morphological resemblance to *Dinemasporium* are known, including *Diarimella*, *Dwayalo-mella*, *Polynema* and *Stauronema* (Sutton 1980b; Nag Raj 1993). These genera share some similarity on morphology, such as acervular or cupulate and setose conidiomata which are closed at first and open at maturity exposing a slimy conidial mass, cylindrical conidiophores, phialidic conidiogenous cells and one-celled conidia bearing setulae appendages at both ends and sometimes also lateral. They are delimited by morphological characters of conidiomata and conidia, which has been shown to be problematic (Léveillé 1846; Agnihothrudu 1958, 1962/1963a, Sutton 1980b; Nag Raj and Kendrick 1986; Nag Raj 1993; Crous et al. 2012; Hashimoto et al. 2015a; Li et al. 2020).

The insert position and number of appendages in conidia have been historically used as the important characters to delimit some of these genera. For example, Saccardo (1884) divided Dinemasporium into two subgenera on the basis of conidial appendages: Eu-Dinemasporium comprising species with bipolar appendaged conidia (incl. the type species D. graminum) and Stauronema for species having conidia with bipolar and lateral appendages (including D. platense and D. cruciferum); Sydow et al. (1916) raised Stauronema to generic rank. Polynema differs from Dinemasporium and Stauronema by producing similar conidia but with 1 apical and 3–5 basal appendages (Nag Raj 1993). However, Crous et al. (2012) in their assessment of the phylogeny of *Din*emasporium and its allied genera based on the sequences of nuclear ribosomal internal transcribed spacer (ITS) and nuclear large subunit (LSU) ribosomal RNA gene regions, concluded that the circumscriptions of Dinemasporium and Stauronema placing emphasis on their conidial appendage features were artificial, and that the two genera were congeneric. Consequently, Stauronema was reduced to a synonym of Dinemasporium, even though the type species of Stauronema (S. cruciferum) was not examined in their analyses (Crous et al. 2012). This was further confirmed by the phylogenetic analysis with additional species including the type species S. cruciferum (Hashimoto et al. 2015a; Fig. 232). Furthermore, Hashimoto et al. (2015a), based on phylogenetic analysis of species highly consistent with Diarimella B. Sutton, also treated Diarimella as the synonym of Dinemasporium. The genus Polynema, based on phylogenetic analysis of a new species P. podocarpi, was showed to



Fig. 232 Maximum likelihood (ML) tree based on ITS sequence data for the genus *Dinemasporium*. Bootstrap support values $\geq 60\%$, Bayesian posterior probability values ≥ 0.95 are shown at the nodes. *Dendrophoma cytosporoides* CBS223.95 was chosen as the outgroup.

Ex-type strains are indicated with "T" in the end of the taxa labels. Latin names and ex-type strain numbers of the new species described in the current study are shown in font

100/0 96	🕇 🕇 🕝 Dinemasporium ambiguum АН11 Т
97/-	99/0.95 Dinemasporium ambiguum 57383
]	Dinemasporium ambiguum 57382
	Dinemasporium sp. MAFF 237940
	95/- 92/- Dinemasporium iriomotense 43900
	Dinemasporium iriomotense HHUF 30112 T
	Diremasporium sp. MAFF 238784
	Dinemasporium triabashariaala CBS 138.898 1
	Dinemasporium pseudoindicum CBS 127402 T
92/-	Dinemasporium pseudostrigosum CBS 71785 T
	Dinemasporium pseudostrigosum 76785
	99/- Dinemasporium pseudostrigosum 76783
	_100/1 Dinemasporium pseudostrigosum 76782
	Dinemasporium tubakii 71224
	Linov Dinemasporium tubakii 71229 T
	Dinemasporium ligongense 15055
	100/1 Dinemasporium ligongense 15052
	Dinemasporium ligongense 12050
	Dinemasporium bambusicola HHUF 29983 T
	Dinemasporium multisetulum 54975 T
91/-	Dinemasporium multisetulum 54980
	Dinemasporium multisetulum 57315
	Dinemasporium japonium 7/125
	Dinemasponum japonium 77124
	Dinemasporium japonicum 57317
	Dinemasponium japonicum 57315
	Dinemasporium japonicum 44100
	Dinemasporium japonium 77122
	Dinemasporium japonicum 43195
	Dinemasporium japonicum 43050
	Dinemasporium japonicum 77310
	Dinemasporium japonicum 77305
	Dinemasporium japonicum 77296
	Dinemasporium japonicum 77294
	Dinemasporium japonicum 77329
	Dinemasporium japonicum 77123
	Dinemasporium japonicum 76823
	Dinemasporium japonicum 76822
	Dinemasporium japonicum 76844
	Dinemasponum japonicum 76843
	Dinemasporium japonicum 76709
	Dinemasponium japonicum 76798
	Dinemasporium japonicum 76875
	Dinemasporium japonicum 13451
	Dinemasporium japonicum 57348
	Dinemasporium japonicum 57325
	Dinemasporium japonicum HHUF 30103 T
	Dinemasporium japonicum 55221
	Dinemasporium japonicum 55258
	Dinemasporium japonicum 55222
92/-	Dinemasporium japonicum 55228
	Dienmasporium japonicum 77330
	Dinemasporium japonicum 54971
	Dinemasporium japonicum 44077
	Dinemasponum japonicum 75818
97/-	Dinemasporium japonicum 73377
	Dinemasporium japonicum 75817
	Dinemasporium japonicum 75818
83/-	Dinemasporium japonicum 75816
98/-	Dinemasporium japonicum 55390
	Dinemasporium japonicum 55225
	Dinemasporium japonicum 57361
95/0.95	Dinemasporium japonicum 76863
	Dinemasporium japonicum 57360
¥	

Fig. 232 (continued)



Fig. 232 (continued)

be an independent genus from *Dinemasporium* (Crous et al. 2018a, b). Phylogenetic relationship of the other relevant genus *Dwayalomella*, typified by *D. vaccinia* isolated from stems of *Vaccinium angustifolium*, remains to be studied by molecular phylogeny.

Pseudolachnea-like genera

Several genera with a morphological resemblance to Pseudolachnea are known, including Brunneodinemasporium, Conicomyces, Dendrophoma, Hoehneliella, Neopseudolachnella, Plectronidiopsis, Pseudodinemasporium, and Pseudolachnella (Hino and Katumoto 1954, 1958, 1960, 1961; Sutton 1980a, b; Nag Raj 1993; Hashimoto et al. 2015b). They are very similar on morphology of conidiomata (acervular or cupulate conidiomata surrounded by numerous black setae), conidial ontogeny, and hyaline, septate conidia with setulae appendages at both ends, but differ on number of conidial septa and phylogeny (Teng 1933, 1936; Hino and Katumoto 1961; Sutton 1980b; Castañeda-Ruiz 1987; Nag Raj 1993; Crous et al. 2012; Hashimoto et al. 2015b). Recent phylogenetic analysis showed that most of these genera are closely related, which is supported by our phylogenetic study (Figs. 3 and 250).

Pseudolachnella is a genus separated from Pseudolachnea to accommodate a species with multiseptate conidia, Pseudolachnea scolecospora (Teng and Ling 1933; Teng 1936)). For the same reason Hino and Katumoto (1958) proposed a new genus Chaetopatella for Pseudolachnea-like species with phragmoconidia, probably without knowing the publication of *Pseudolachnella*. Sutton and Hodges (1977) and Sutton (1980b), however, thought that conidial septation is not an important character for generic circumscription among Pseudolachnea, Pseudolachnella and Chaetopatella and merged the latter two genera with Pseudolachnea. On the other hand, Nag Raj (1993) divided Pseudolachnea sensu . Sutton and Hodges (1977) and Sutton (1980b) into Pseudolachnea with one-septate conidia, Pseudolachnella with multiseptate conidia and synonymized Chaetopatella with Pseudolachnella. For many years, both the broad generic concept of Pseudolachnea (Sutton and Hodges 1977; Sutton 1980a, b) and the narrower interpretation of *Pseudolachnea* and *Pseudolachnella* placing emphasis on the differences in conidial septation were accepted by different authors (Teng 1936; Hino and Katumoto 1954, 1958, 1960, 1961; Castañeda-Ruiz 1987; Matsushima 1987; Nag Raj 1993; Melnik 1997; Zhao et al. 2004; Sato et al. 2008; Kirk et al. 2008; Seifert et al. 2011; Crous et al. 2012). In this paper, we accepted both genera Pseudolachnea and Pseudolachnella

as defined by Nag Raj (1993), which is supported by the phylogenetic studies.

Conicomyces, typified by *C. transvaalensis*, produces typical synnematous and setulate conidiomata with a cylindrical stalk and a slightly swollen head bearing a concave conidial hymenium which are excipulate and setose. The conidiophores are arising from the inner elements of the stalk and lining the cavity of the conidiomata, hyaline, simple or branched, septate and terminating with a phialidic conidiogenous cells. The conidia are elongate fusiform, multiseptate, hyaline, attenuated toward each end and bearing one appendage at each end (Sinclair et al. 1983; Nag Raj 1993; Liu et al. 2015).

Hoehneliella, typified by *H. perplexa*, has cornute to cupulate conidiomata with setae formed from basal stroma or excipulate part of the cavity of the conidiomata. The conidiophores are arising from the inner elements of the conidiomata and lining the cavity of the conidiomata, hyaline, simple or branched, septate and terminating with a phialidic conidiogenous cells. The conidia are cylindrical, fusiform to ellipsoidal, 1-septate, pale brown, bearing a breached appendage at each end (Nag Raj 1993).

Plectronidiopsis, typified by *P. chilensis* on culms of *Hierochloe utriculata* from Chile, produces acervular conidiomata with setae and hyaline, cylindrical and 1-septate conidia bearing 1 apical, 2–3 basal and 1–3 lateral appendages (Nag Raj 1993).

By combing the morphological examination and phylogenetic analyses of a combined dataset of nuclear rDNA sequences, Pseudolachnea-like fungi were recently classified into five monophyletic genera: Calvolachella, Conicomyces, Neopseudolachnella, Pseudolachnea and Pseudolachnella (Crous et al. 2012, 2014; Hashimoto et al. 2015b; Hernandez-Restrepo et al. 2016; Fig. 233). Above studies suggested that the conidiomatal structures, such as thickness of basal stroma and the excipulum, were more reliable for generic delimitation, instead of conidial septation. Under the new generic concept, Calvolachella is characterized by cupulate conidiomata without setae and pale-colored and septate conidia with appendages at both ends (Hernandez-Restrepo et al. 2016;); Conicomyces is characterized by synnematous conidiomata with cupulate conidiomata with numerous setae, hyaline and septate conidia with both apical and basal appendage (Sinclair et al. 1983; Liu et al. 2015); Both Pseudolachnea and Pseudolachnella produce acervular or cupulate conidiomata with black setae, hyaline conidia with appendages, and are distinguished by conidial septation (1-septate conidia in Pseudolachnea and multiseptate conidia in *Pseudolachnella*; Hashimoto et al. 2015b); Neopseudolachnella is similar to Pseudolachnea and Pseudolachnella in conidial morphology but was characterized by the conidiomata lacking an excipulum (Hashimoto et al. 2015b). Our phylogenetic analysis further supports this, and *Hoehneliella* is also added into the family. The type species of the genus has cornute to cupulate conidiomata with setae, cylindrical to fusiform, pale brown and 1-septate conidia bearing a branched appendage at each end (Nag Raj 1993).

Key to all accepted coelomycetous genera in Chaetosphaeriaceae

1.	Conidiomata without setae2
1.	Conidiomata setose
2.	Conidiomata nidulariaceous; conidia hyaline, aseptate,
	with 2 appendages at each endInfundibulomyces
2.	Conidiomata eustromatic; conidia pale brown, septate
	and with 1 setulae at each endCalvolachnella
3.	Conidia septate4
3.	Conidia aseptate
4.	Conidiomata synnematousConicomyces
4.	Conidiomata acervular or cupulate5
5.	Conidia 1-septate, pale brown, with branched setulae
	Hoehneliella
5.	Conidia 1- to several septate, hyaline
6.	Conidia cylindrical to fusiform, with 1 apical and sev-
	eral basal setulaePolynema
6.	Conidia not as above7
7.	Conidiomata stromatic, acervuloid, without lateral
	excipulumNeopseudolachnella
7.	Conidiomata cupulate with lateral excipulum8
8.	Conidia 1-septatePseudolachnea
8.	Conidia multiseptatePseudolachenlla
9.	Conidiomata no excipulum; setae formed throughout
	basal stromaBrunneodinemasporium
9.	Conidiomata with excipulum; setae formed from lat-
	eral excipulum and basal stroma10
10.	Conidiomata superficial and stipitate, becoming cupu-
	lateDendrophoma
10.	Conidiomata not stipitate
	Dinemasporium & Pseudodinemasporium*

(*morphologically very difficult to be distinguished, but phylogenetically different).

Dinemasporium Lév., Ann. Sci. Nat., Sér.3, 5: 274, 1846.

= Pycnidiochaeta Sousa da Câmara, Agron. Lusit. 12: 109, 1950.

=*Amphitiarospora* Agnihothr., Sydowia 16:75, 1962 (published 1963).

=Dinemasporium (Lev.) subg. *Stauronema* Sacc., Syll. Fung. 3: 686, 1884.

= *Stauronema* (Sacc.) Syd., P. Syd. & E.J. Nutler, Ann. Mycol. 14: 217, 1916.

=Belaina Batista & Peres, Mem. Soc. Broteriana 14: 50, 1961.

=Belainopsis Batista & Maia, Rev. Biol. (Lisbon), 5: 84, 1965.

= Diarimella B. Sutton, The Coelomycetes: 452, 1980.

Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, scattered or aggregated, blackish, conical to cupulate; basal wall of textura angulari composed of brown, thick-walled cells, the inner layer tend to be hyaline, thin-walled; lateral wall of textura porrecta composed of brown, thick-walled, long, septate and branched hyphae, inner layer pale brown to hyaline and thin-walled. Setae dark brown to black, erect, tapering towards the apex, wall thick and smooth, arising from lateral wall and sometime also from the base. Conidiophores hyaline to pale brown, septate, branched, or unbranched, cylindrical, formed from the inner layer of both basal and lateral walls. Conidiogenous cells enteroblastic, phialidic, discrete, hyaline, cylindrical, straight, wall thin and smooth; collarettes inconspicuous. Conidia hyaline, occasionally becoming pale brown, aseptate, navilicate to fusiform, curved or straight, wall thin, smooth, or rough, bearing 1 or more setulae at each end, and sometimes also lateral (Adapted from Sutton 1980b; Nag Raj 1993; Crous et al. 2012).

Type species: Dinemasporium strigosum (Pers.) Sacc.

Ecology/Substrate/Host: Saprobe on dead material of plant, especially dead leaves and culm of various grass and bamboo.

Geographical distribution: Widely distributed in worldwide.

Description and illustration: Sutton (1980a, b); Nag Raj (1993); Crous et al. (2012); Hashimoto et al. (2015a).

Notes: Léveillé (1846) introduced Dinemasporium with D. graminum((=D. strigosum) as the type species, which is characterized by superficial, cupulate, setose conidiomata which are initially closed, becoming erumpent, and unicellular conidia with bipolar appendages. Inclusion of two additional species, D. platense and D. cruciferum, further expanded the concept of the genus to accommodate species with both bipolar and lateral conidial appendages (Spegazzini 1880; Ellis 1882). Saccardo (1884) established the subgenus Stauronema to accommodate taxa with conidia bearing apical, basal and lateral appendages. Stauronema was elevated to generic level by Sydow et al. (1916) on the basis of insertion of conidial appendages. Sutton (1980a, b) and Nag Raj (1993) adapted this proposal and used Dinemasporium to include only species with aseptate conidia bearing setulae only at the end of the conidium. Conidial appendages are taxonomically informative in separating species and genera (Morgan-Jones 1971; b; Sutton 1980a; Nag Raj and Castañeda-Ruiz, 1989; Nag Raj 1993; Duan et al. 2007). However, Stauronema and Diarimella Sutton were reduced to synonyms of Dinemasporium, because of their equal phylogenetic status, which suggests that the morphological characteristics of appendage alone cannot be used as the basis for genus classification. With these results, the generic concept of *Dinemasporium* is expanded to accommodate species producing conidia with unicellular, unbranched or branched, single or multiple, bipolar and lateral appendages at each end (Crous et al. 2012; Hashimoto et al. 2015a; Li et al. 2020).

Recent review of the genus *Dinemasporium* was given by Duan et al. (2007) and total of 14 species were accepted with a provided key. Afterwards, 13 new species were introduced in this genus by Crous et al. (2012) and Hashimoto et al. (2015a).

In this study, based on morphological and molecular study of all herbarium specimens and relevant living strains collected from China, Japan and UK, we identified 24 species of the genus *Dinemasporium*, including 7 new species (Fig. 233). The DNA barcodes are also provided for all these species, including two species previously described by us, *D. ligongense* and *D. sinense*. In addition, one new species (*D. longisporum*) and one new combination (*D. pingue*) were also described based on the herbarium specimens in IMI. Living strains of many studied species were also studied on PDA (Figs. 234, 235), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species (Fig. 236).

Key to all accepted species of *Dinemasporium* (D.)

1.	Conidia pale brown, $5.5-8 \times 1.5-2.5 \mu m$, setulae
	5–7 µmD. aberrans
1.	Conidia colorless
2.	Conidia without setulaeD. asetulum
2.	Conidia with setulae
3.	Conidia with terminal setulae only, simple or branched
3.	Conidia with both terminal and lateral setulae26
4.	Conidia fusiform to ellipsoid, straight5
4.	Conidia naviculate to ellipsoid, curved
5.	Conidia ellipsoid, 10-16 µm in length; setulae
	branched6
5.	Conidia fusiform or ellipsoid, < 10 µm in average; setu-
	lae unbranched7
6.	Conidia ellipsoid, $11-16 \times 3-4 \mu m$; dicho-branched ter-
	minal setulae 6–10.5 µmD. bambusicola
6.	Conidia ellipsoid, 10.5–14×2.5–3 µm; 1 branched set-
	ulae 1.5–4.5 µmD. rishiriense
7.	Conidia with setulae more than 5 µm in length8
7.	Conidia with setulae less than 5 µm in length10
8.	Conidia ellipsoid, $6.5-8.5 \times 2-3 \mu m$; setulae 4–7 μm
	longD. iriomotense
8.	Conidial setulae 7–15 µm long9
9.	Conidia ellipsoid, $6.5-8 \times 2-3 \mu m$; terminal setulae
	9–15 µmD. sasae



Fig. 233 Maximum likelihood (ML) tree based on ITS sequence data for the genus Pseudolachnea and related fungi. Bootstrap support values \geq 60%, Bayesian posterior probability values \geq 0.95 are shown at the nodes. Dinemasporium morbidum CBS12966 was chosen as the

outgroup. Ex-type strains are indicated with "T" in the end of the taxa labels. Latin names and ex-type strain numbers of the new species described in the current study are shown in font

9.	Conidia fusiform, straight, $8.5-10.5 \times 2.5-3.5 \ \mu m$
	wide; setulae 7–11 µmD. fusiforme
10.	Setulae less than 2 µm in length11
10.	Setulae 2–5 μm15
11.	Conidia more than 6 µm in length12
11.	Conidia less than 6 µm in length13
12.	Conidia 6–11×1.2–1.5 μmD. sinense
12.	Conidia 7–9.5×2.5–5 µmD. dugutiae
13.	Conidia botuliform to naviculate, $3.5-6 \times 1-1.5 \ \mu m$
	wideD. cytosporoides
13.	Conidia 1.5–2.1 µm wide14
14.	Conidia naviculate to subellipsoidal,
	$3.5-5 \times 1.5-2 \ \mu mD.$ affine
	$5.5-5 \times 1.5-2 \mu m$

14.	Conidia	naviculate	to	fusiform,	$3.5 - 5.6 \times$
	1.7–2 μm.		••••	D. neott	iosporioides

- 15. Conidia falcate to naviculate, $8-12.5 \times 2.5-3.5 \,\mu\text{m}$, setulae 2-5 µm in length.....D. rhodophaeum
- Conidia naviculate, less than 10 µm long in aver-15. age......16
- 16. Conidia $4-7 \times 2-2.5 \,\mu\text{m}$, setulae 1.5–7 μm in length...D. setulosa
- 16. Conidia setulae less than 5 µm in length......17
- 17. Conidia $5-7.5 \times 2-3$ µm, setulae 2-4 µm in length.....D. pseudodecipens
- 17. Conidia $4.5-9 \times 2-2.5 \,\mu\text{m}$, setulae $1-5 \,\mu\text{m}$ in length...D. decipiens



Fig. 234 Colony of *Dinemasporium* species on PDA after 20 days at 25 °C. **a**, **b** *Dinemasporium*. *beijingensis* (ex–type strain 54964). **c–f** *D*. *fanglanii* (**d–g** ex–type strain 54975; **e**, **f** 76979). **g**, **h** *D*. *multisetulum* (ex–type strain 77298). **i**, **j** *D*. *suttonii* (ex–type strain 77032).

k-n *D. yongnianii* (**k**, **l** ex-type strain 76866; **m**, **n** 57357). **o**, **p** *D. iriomotense* (43900). **p**, **q** *D. japonicum* (44100); **r**, **s** *D. morbidum* (43618)

18.	Conidia $6.3-8 \times 1.2-2 \mu m$, setulae 2.5-4 μm in
	lengthD. ligongense
18.	Setulae > 5 µm in length19
19.	Conidia $13-27 \times 2-2.5 \ \mu\text{m}$, setulae $4-9 \ \mu\text{m}$ in length
	D. lanatum
19.	Conidia less than 15 µm in length in average20
20.	Conidia $8-11 \times 2-2.7 \ \mu m$, setulae $11-20 \ \mu m$ in
	lengthD. longicapillatum
20.	lengthD. longicapillatum Setulae < 15 μm in length in average21
20. 21.	$\label{eq:length} \begin{array}{l} \mbox{length} D. \mbox{ longicapillatum} \\ \mbox{Setulae} < 15 \mbox{m} \mbox{ in length } \mbox{in average} 21 \\ \mbox{Conidia } 1214\mbox{-}253 \mbox{m} 22 \end{array}$
20. 21. 21.	lengthD. longicapillatumSetulae < 15 μ m in length in average
20. 21. 21. 22.	$\label{eq:condition} \begin{array}{llllllllllllllllllllllllllllllllllll$
20. 21. 21. 22.	lengthD. longicapillatum Setulae < 15 μ m in length in average

length......D. morbidum

23.	Conidia 7–10×2–2.5 μ m; setulae 7–12 μ m in
	lengthD. japonicum
23.	Conidia 8–13 µm24
24.	Conidia $10-12 \times 2.5-3 \ \mu\text{m}$; setulae $10-13 \ \mu\text{m}$ in
	lengthD. polygonum
24.	Conidia 8-13 µm in length; setulae 6.5-11 µm in
	length25
25.	Conidia 8–12.5 × 1.5–2.5 μ m; setulae 6.5–9 μ m in
	lengthD. strigosum
25.	Conidia $8-13 \times 2-3 \mu m$; setulae $8-11 \mu m$ in length
	D. parastrigosum
26.	Conidia fusiform, ellipsoid, straight27
26.	Conidia naviculate to fusiform or ellipsoid,
	curved



Fig. 235 Colony of *Dinemasporium* species on PDA after 20 days at 25 °C. **a**, **b** *D. cruciferum* (54977, 54978). **c**, **d** *D. japonicum* (44100, 53377). **e** *D. ligongense* (54665). **f**, **g** *D. multisetulum* (54971,

- 27. Conidia fusoid-ellipsoid, 7–9×2.5–3 μm; 3 terminal appendages 3–5 μm in length.....D. *ipomoeae*
- 28. Conidia fusiform, $8-16 \times 2.5-3.5 \mu m$; with 1 terminal setulae at each end and 2–3 lateral setulae inserted at the middle of the conidial body, 9–15 um in length...D. sacchari
- 28. Conidia with terminal or subterminal setulae, not at the middle of conidial body......29
- 29. Conidia fusiform, slightly curved, $14-20 \times 2.5-2.8 \mu m$, with 1 terminal setulae at each end and 2 subapical setulae inserted right below apex, $9-17.5 \mu m$ in length......D. longisporum
- 29. Conidia ellipsoid, slightly curved, $11-14 \times 4-5.5 \mu m$; with 1 terminal setulae at each end and 1-2 subapical setulae inserted right below apex, $15-25 \mu m$ in length......D. pingue
- 30. Conidia naviculate, 14–22×3.5–4.5 μm; with 1 terminal setulae at each end and 1 lateral setulae inserted

54980). **h** *D. pseudodecipens* (46487). **i, j** *D. sinensis* (154678, 54677). **k** *D. beijingensis* (ex-type strain 54864). **l–p** *D. yongnianii* (47605, 54969, 54968, 54970, 54981 respectively)

	at the middle of the conidium body, $14-20 \ \mu m$ in
	lengthD. platense
30.	Conidia less than 14 µm in length31
31.	Conidia with only 1 lateral setulae, inserted at the mid-
	dle of the conidial body32
31.	Conidia with 2–3 lateral setulae
32.	Conidia 8–11.5 × 2–4 μ m; setulae 4–10 μ m in
	lengthD. ambiguum
32.	Conidia 9–12×2.5–3 μ m; terminal setulae 10–15 μ m
	in length, lateral 4–8 µm in lengthD. stauronema
33.	Conidia subnaviculate to allantoid, $4-7 \times 2.5-3 \mu m$;
	with 1 or occasionally 2 setulae at apex, usually 2
	rarely 3 basal or sub-basal, and rarely 1 lateral, 1-5 µm
	in lengthD. yerbae
33.	Conidial setulae longer than 5 µm34
34.	Conidia lunate or ellipsoid, $6-12 \times 3-4$; with 1 setulae
	at each end and 2-4 lateral setulae inserted at different
	loci but mostly in the upper half of the conidium body,
	8–13 in lengthD. spinificis

Fig. 236 Colony of Brunneodinemasporium, Neopseudolachnella and Pseudodinemasporium species on PDA after 20 days at 25 °C.). a-d Brunneodinemasporium sinensis (a, b ex-type strain 58989. c, d 58990). e-h Neopseudolachnella microsperma (e, f ex-type strain 54767; g, h 77756). i, j Pseudodinemasporium elegans (ex-type strain 43192). k, l P. minimum (ex-type strain 55372)



- 35. Conidia ellipsoid, naviculate, 7–13×2–3 μm; with one terminal setulae at each end and 2 subapical (3–4 um below apex) setulae, 8–20 μm in length......D. indicum
- 35. Conidia 2.5–4 μm wide......36
- 36. Conidia $9-13 \times 3-4 \mu m$; with 1 terminal setulae at each end, $9-22 \mu m$ in length; and 2 lateral setulae, $10-17 \mu m$ in length......D. pseudoindicum
- 36. Conidia 9.5–13×2.5–3.5 μm; with 1 terminal setulae at each end, 8–13.5 μm; and 2 subapical setulae, 7–16 μm in length.....D. cruciferum

Dinemasporium ambiguum A. Hashim. & Kaz. Tanaka, Mycoscience 56: 88, 2015. Figure 237

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata stromatic, scattered, cupulate, superficial, globose, unilocular, 100–400 μ m diam, up to 180 μ m high, dark brown to black, with white conidial mass in center, setose; basal stroma 15–30 μ m



Fig. 237 *Dinemasporium ambiguum* (Wu13050). **a** Part of the conidiomata with setae and excipulum. **b** Part of conidiomata with basal stroma, conidiophores, and excipulum. **c** Curved apical cell of excipu-

lum. d, e Conidiophores and conidiogenous cells bearing developing conidia. f-k Conidia. Scale bar: a 25 μm, b 10 μm, c-k 5 μm

thick, composed of hyaline to very pale brown, globose, 2.5-3.5 µm diam cells; excipulum well-developed, textura porrecta, formed by dark brown, thick-walled, longer cells in the outer layer and pale brown to hyaline, thin-walled cells in the inner layers, 50-70 µm high, up to 35 µm thick, cell 2-3 µm wide; apical cells of the out layers extended into hair-like structure, curved, with acute ends. Setae arising out layer of the lateral wall or basal stroma, cylindrical, straight or curved, dark brown, thick-walled, smooth, septate, unbranched, 150-350 µm long, 4-7 µm wide at the lower part, tapering towards the apex. Conidiophores lining the basal stroma cylindrical, hyaline, simple or branched, 1-3-septate, 15-30×2.5-3 µm. Conidiogenous cells phialidic, cylindrical to lageniform, $7-20 \times 2-2.5$ µm, collarette inconspicuous. Conidia naviculate to ellipsoid, obtuse or slightly acute at the apex, truncate at the base, unicellular, hyaline, smooth, guttulate, $(7-)8-11.5 \times 2-4 \mu m$, bearing one unbranched setula at each end and often lateral; setulae 5-12 µm long.

Materials examined: **China** Guangxi Province, Nanning, Wufengshan, on dead culm of unidentified grass, 13 November 2013, W.P. Wu (Wu13050). Living strains: 57,382 and 57,383 (from Wu13050).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Japan (Hashimoto et al. 2015a).

Description and illustration: Hashimoto et al. (2015a).

Notes: Dinemasporium ambiguum was originally described from dead culms of Miscanthus sp. from Japan, it has Stauronema-like conidia bearing one unbranched setula at each end and on the sides (Hashimoto et al. 2015a). Dinemasporium ambiguum superficially resembles Stauronema indicum Kalani (conidia 7-13×2-3 µm, terminal appendage 6.5–17 μ m long, lateral appendages 8–20 μ m long), D. cruciferum (conidia $9.5-14 \times 2-3.5 \mu m$, terminal appendages 8–13.5 µm, lateral appendages 7–16 µm), D. pseudoindicum Crous & M. Chr. (conidia $9-13 \times 3-4 \mu m$, terminal appendages 9-22 µm, lateral appendages 10-17 µm and 4-6 µm) and D. trichophoricola Crous & Quaedvlieg (conidia 9–11×2.5–3 μ m, terminal appendages 9–13 μ m long, lateral appendages 8-11 µm long) on conidial morphology (Sutton 980; Nag Raj 1993; Crous et al. 2012, 2014; Hashimoto et al. 2015a). Among them, Stauronema indicum, D. cruciferum and D. pseudoindicum have slightly longer conidia than those in D. ambiguum. In addition, S. indicum and D. pseudoindicum have conidia with much longer lateral appendages (8-20 µm). Dinemasporium trichophoricola has similar size of conidia and appendages, but it has only one appendage at each end. Furthermore, the ITS sequences from these species are also significantly different from each other.

Some variations on structure of excipulum and number of conidial setulae were observed from different specimens collected from China. In the original description of *D. ambiguum* provided by Hashimoto et al. (2015a), excipulum seems to be poorly developed and without the extended and curved apical cells, and the conidia usually have one setula at the apex, 1–2 at the base, and one lateral. In the Chinese collection, the excipulum of conidiomata is well-developed with extended and curved apex, and the conidia are with one basal and apical setula at each end, and one lateral setulae. However, the ITS sequences from two isolates of the Chinese collections are identical with those one from the ex-type strain.

Dinemasporium americana Crous & Tuthill, Persoonia 28: 132, 2012. Figure 238

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata stromatic, scattered or aggregated, superficial, dark brown to black, cupulate, unilocular, globose, up to 400 µm diam, setose with a central white to pink conidial mass; basal stroma of textura angularis, 15-35 µm thick; excipulum well-developed, textura porrecta, formed by dark brown, thick-walled, longer cells in the outer layer and pale brown to hyaline, thin-walled cells in the inner layers, 96-120 µm high, up to 30 µm thick, cells 2-3 µm wide, 5-8-septate, uniformally dark brown, thick-walled; upper part of the wall separated from each other, with an acute or obtuse apex. Setae cylindrical, erect, straight, or slightly flexuous, brown to black, simple, 5-8-septate, subulate with acute apex, verruculose, thickwalled, $130-235(-270) \times 5-10 \ \mu m$, $1-1.5 \ \mu m$ wide at acute apex, arising from basal stroma or lateral from excipulum. Conidiophores lining the basal stroma, septate, branched, cylindrical, thin-walled, smooth, base pale brown, upper part hyaline, $20-35 \times 2-3 \mu m$. Conidiogenous cells phialidic with periclinal thickening, hyaline, smooth, subcylindrical, 9-13×2-3 µm. Conidia hyaline, aseptate, thin-walled, smooth, naviculate to fusiform or ellipsoid, gently curved or straight, apex obtuse to subobtusely rounded, base truncate, eguttulate or guttulate at both ends, $11.5-13.5 \times 2.5-3 \mu m$, with a single, unbranched, flexuous, tubular appendage at each end, 6–10 µm; basal appendage excentric.

Materials examined: **China**, Shanghai, Shanghai Botanical Garden, on dead culm of unidentified grass, 3 November 2013, W.P. Wu (Wu15137, 15,138); Shan' Xi Province, Zhouzhi, Qingling mountain, on dead culm of unidentified grass, 22 August 2019, W.P. Wu (Wu16522); Shan'Xi Province, Zhouzhi, Qingling mountain, on dead leaves, culm and seed of unidentified grass, 22 August 2019, W.P. Wu (Wu16534). Living strains: 5360 (from Wu15137), 57,361 (from Wu15138), 76,792 (from Wu16522) and 76,893 (from Wu16534).



Fig. 238 Dinemasporium americana (Wu16522). **a** Conidiomata. **b**, **c** Part of excipulum showing setae and tissue. **e** Conidiophores and conidiogenous cells. **d**, **f**–**l** Conidia. **a** 50 μm, **b–d** 10 μm, **e–l** 5 μm



Fig. 239 *Dinemasporium beijingensis* (Wu15095, holotype). a Part of the conidiomata with excipulum and setae. b, c Part of excipulum. d Basal stroma and conidiophores. e Upper part of the excipulum with

rounded or slightly pointed apical cell. **f** Conidiophores and conidiogenous cells from the inner layer of excipulum. **g–j** Conidia. Scale bar: **a** 50 μ m, **b–j** 5 μ m

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and USA (Crous et al. 2012).

Description and illustration: Crous et al. (2012).

Notes: D. americana was a recently descried species from USA and is morphologically similar to D. strigosum but differs from it by size of setae, conidia and appendages (Crous et al. 2012; Hashimoto et al. 2015a). Compared with the original description (conidia (9–)12–13 (–16) \times (2.5–)–3 μ m, setulae $(11-)12-14(-16) \mu m$ long), the fungus from the Chinese specimens is with well-developed excipulum and shorter conidial setulae (Crous et al. 2012). Some variations on size of setae, conidia and setulae were also observed among the specimens studied by us. For examples in the specimen Wu16534, the setae are up to 400 µm long, the conidia are $9-11 \times 2-2.5 \mu m$ and with shorter setulae $(6-8 \mu m \log)$; while in the specimen Wu16522, the setae are up to 270 μ m long, the conidia are 11.5–13.5×2.5–3 μ m and with longer setulae (8-10 µm). In addition, the microconidia $(5-8 \times 1.5-2 \ \mu m)$ were also observed. However, they have identical ITS sequences with those from the ex-type strain.

Dinemasporium beijingense W.P. Wu & Y.Z. Diao, sp. nov., Fig. 239, MycoBank MB841659.

Etymology: Refers to the locality where this fungus was discovered.

Typification: **China**, Beijing, Huairou, Beigou, Mutianyu, on dead culms of unidentified herbaceous plant, 9 October 2012, W.P. Wu, Holotype HMAS 351998 (=Wu15095), extype strain CGMCC 3.20650 (=NN54964).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, scattered or aggregated, cupulate to discoid, oblong to ovoid shaped on the top view, up to 600 mm long and 400 mm wide; basal stroma of textura angularis, 20-40 µm thick; excipulum well-developed, textura porrecta, formed by dark brown, thick-walled, longer cells in the outer layer and pale brown to hyaline, thin-walled cells in the inner layers, 130–190 µm high, up to 35 µm thick, cells 1.5–3 µm wide, 5–10-septate, uniformally dark brown, thick-walled; upper part of the wall separated from each other, with an acute or obtuse apex. Setae brown to black, septate, cylindrical, tapering towards the apex and apex acute or obtuse, wall thick and smooth, $250-530 \times 6-10 \,\mu\text{m}$, arising from the outer layer of basal and lateral walls. Conidiophores hyaline, septate, simple to branched, aseptate or septate, wall smooth, cylindrical, originating from the upper cells of basal stroma and also inner layer of lateral walls, $15-35 \times 1.8-2.5$ µm. Conidiogenous cells enteroblastic phialidic, discrete or integrated, hyaline, wall smooth, cylindrical with minute periclinal thickenings in the collarette zone, collarette inconspicuous, $6-10 \times 1.8-2 \mu m$. Conidia hyaline, aseptate, naviculate, curved or straight, smooth-walled, ends obtuse, $8-10 \times 1.5-2 \mu m$; with one setula at each end, $6.5-9.5 \mu m$ long.

Culture characteristics: Colonies on PDA effuse, colonies 1.8–2.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly grey, reverse yellow to soil brown in the center and becoming paler towards the margins (Fig. 234a, b).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Dinemasporium beijingense* belongs to *D. strigosum* group with well-developed excipulum, naviculate conidia with one setula at each end. It differs from other similar species by smaller conidia and long setulae, and the unique ITS sequence (Sutton 1980b; Nag Raj 1993; Crous et al. 2012; Hashimoto et al. 2015a).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 54964 include *Dinemasporium pseudodecipens* (GeMH864432, 98% identity) and *D. strigosum* (GenBank NR_121540, 98% identity).

Dinemasporium cruciferum Ellis, Bull. Torrey Bot. Club 9: 20, 1882. Figures 235a, b, 240

= Stauronema cruciferum (Ellis) Syd., P. Syd. & E.J. Bulter, Ann. Mycol. 14: 217, 1916.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, cupulate and circular to ellipsoidal on the top view, unilocular, superficial, scattered, blackish, up to 300 µm diam. Basal wall of textura angulari composed of brown, thick-walled, irregular-shaped cells and become pale brown to hyaline, thin-walled smaller cells towards the inner layers, 30-50 um thick; excipulum well-developed, textura porrecta, formed by dark brown to blackish, thick-walled, longer cells in the outer layer and pale brown to hyaline, thin-walled cells in the inner layers, 70–150 µm high, up to 40 µm thick; upper part separated, straight or curved, darker than basal part, with acute apex. Setae present, dark brown, septate, simple, cylindrical, straight, wall smooth and thick, $250-320 \times 7.5-10$ µm, tapering towards an acute or obtuse apex, 5-6 µm. Conidiophores pale brown, become hyaline towards apex, 1-3-septate, branched at the base, cylindrical, straight, wall thin and smooth, $10-25 \times 2-3 \mu m$, arising from inner layer of both basal and lateral walls. Conidiogenous cells discrete or integrated, determinate, apical or lateral, cylindrical, straight, wall thin and smooth, apex narrow with narrow sporulating channel and prominent thicking around the channel, $10-15 \times 1.5-2.5 \mu m$. Conidia hyaline, aseptate, fusiform, slightly curved, apex obtuse, base truncate, guttulate, $11-14 \times 2.5-3 \mu m$; apical and basal appendages single, subapical appendage 1-2, 10-13 µm long.



Fig. 240 *Dinemasporium cruciferum* (Wu15104). **a, b** Conidiomata with setae. **c** Poorly developed excipulum with setae. **d, e** Conidiophores and conidiogenous cells bearing developing conidia. **f–j** Conidia. **a** 100 µm, **b** 25 µm, **c** 10 µm, **d–j** 5 µm

Materials examined: **China**, Beijing, Huairou, Beigou, Mutianyu, on dead culm of grass, 09 October 2012, W.P. Wu (Wu15101, Wu15102, Wu15103, Wu15104). Living strains: 54,976 (from Wu15101), 54,977 (from Wu15102), 54,978 (from Wu15103) and 54,979 (from Wu15104).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China, Japan and USA (Nag Raj 1993; Hashimoto et al. 2015a).

Description and illustration: Ellis (1882); Sydow et al. (1916); Nag Raj (1993); Hashimoto et al. (2015a); Li et al. (2020).

Notes: Dinemasporium cruciferum clearly belongs to a small group of species under Stauronema and Dinemasporium with both polar and lateral appendages in the conidia, including Stauronema indicum Kalani (conidia $7-13 \times 2-3 \mu m$, terminal appendage 6.5–17 μm long, terminal appendages 8-20 µm long), D. ambiguum (conidia $8-11.5 \times 2-4 \mu m$, terminal appendages $5-12 \mu m$, lateral appendages 4-10 µm), D. pseudoindicum (conidia $9-13 \times 3-4 \mu m$, terminal appendages $9-22 \mu m$, lateral appendages 10-17 µm and 4-6 µm) and D. trichophoricola (conidia 9–11×2.5–3 μ m, terminal appendages 9–13 μ m long, lateral appendages 8–11 µm long) (Nag Raj 1993; Crous et al. 2014; Hashimoto et al. 2015a). They can be distinguished from others by their conidial morphology (shape, size and appendage) and the ITS sequences (Sutton 1980a, b; Nag Raj 1993; Crous et al. 2012; Hashimoto et al. 2015a). Among them, S. indicum and D. pseudoindicum have conidia with longer lateral appendages (8-20 µm); Dinemasporium ambiguum and D. trichophoricola have smaller conidia than those in D. cruciferum.

Traditionally, the condiogenous cells in the genus *Stauronema* were described as enteroblastic phialidic, however the SEM photographs included in one specimen under *Stauronema cruciferas* in Herbarium IMI clearly show they are annellidic.

Dinemasporium fanglanii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 241, MycoBank MB841660.

Etymology: Named after the famous Chinese mycologist, Prof. Fanglan Tai, from the Institute of Microbiology, The Chinese Academy of Science, Beijing.

Typification: **China**, Guangdong Province, Guangzhou, Nansha, on dead leaves of unidentified grass, 18 August 2019, W.P. Wu, Holotype HMAS 351999 (=Wu16730), ex-type strain CGMCC 3.20668 (=NN77032).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, scattered or aggregated, cupulate to discoid but oblong to ovoid shaped on the top view, $150-300 \mu m$ long and $150-250 \mu m$ wide; excipulum poorly developed, lateral wall of textura porrecta formed by hyaline to pale brown cells in the inner layer and brown to dark brown cells in the outer layer, 30–50 µm high, cells 1.5–2.5 µm wide, the apex of the outer wall separated, with acute or obtuse apex; basal stroma of textura angulari with brown, isodiametric cells which are hyaline in the upper layer. Setae cylindrical, brown to black, septate, tapering towards the apex, apex acute or obtuse, wall thick and smooth, $130-310 \times 6-9 \mu m$, arising from the outer layer of basal and lateral walls. Conidiophores hyaline, septate, simple to branched, aseptate or septate, wall smooth, cylindrical, originating from the upper cells of basal stroma and also inner layer of lateral walls, $15-25 \times 2-3 \mu m$. Conidiogenous cells phialidic, determinate, discrete or integrated, hyaline, wall smooth, cylindrical, with minute periclinal thickenings in the collarette zone, collarette inconspicuous, $8-15 \times 1.5-2$ µm. Conidia hyaline, aseptate, naviculate, curved or straight, smooth-walled, ends obtuse, $7-9 \times 2-2.3 \mu m$, with one setulae of $5-8 \mu m \log at$ each end.

Culture characteristics: Colonies on PDA effuse, colonies 2.7–3.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly soil brown, reverse yellow to soil brown in the center and becoming paler towards the margins (Fig. 23c–f).

Other materials examined: **China**, Guangdong Province, Guangzhou, Nansha, on dead leaves of unidentified grass, 18 August 2019, W.P. Wu (Wu16713, Wu16731, Wu16714). Living strains: 76,979, 76,980, 76,981 and 76,982 (from Wu17613), 77,034 (from Wu16731) and 77,033 (from Wu16730).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Dinemasporium fanglanii is characterized by smaller conidiomata with short setae and poorly developed excipulum, and smaller conidia bearing shorter setulae (Sutton 1980b; Nag Raj 1993; Crous et al. 2012; Hashimoto et al. 2015a). It resembles *D. iriomotense* (conidia ellipsoid, straight, $6.5-8.5 \times 2-3 \mu m$; setulae 4–6 μm long) and *D. japonicum* (conidia naviculate to ellipsoid, curved, $7-10 \times 2-2.5 \mu m$; setulae 7–12 μm long), but can be distinguished by conidial shape and length of setulae. The ellipsoid conidia in *D. iriomotense* makes it easily distinguishable from *D. fanglanii*. The conidia setulae in *D. japonicum* are much longer (7–12 μm) than those in *D. fanglanii*.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,032 include *Dinemasporium cruciferum* (GenBank AB900893, 95% identity), *D. longicapillatum* (GenBank AN900868, 98% identity) and *D. sasae* (GenBank NR155038, 95% identity).

Dinemasporium iriomotense A. Hashim. & Kaz. Tanaka, Mycoscience 56: 91, 2015. Figure 242



Fig. 241 *Dinemasporium fanglanii* (**a–f** Wu17630, holotype; **g–m** Wu17613). **a**, **b** Conidiomata with setae and wet spore mass. **c**, **d** Poorly developed excipulum with setae and acute apical cells. **g** Conidiogenous cells. **e**, **f**, **h–m** Conidia. Scale bar: **a** 50 μm, **b** 20 μm, **c–m** 5 μm



Fig. 242 Dinemasporium iriomotense (Wu1460). a, b Setae from the excipulum. c-j Conidia. Scale bar: 5 µm

Description on the natural substrate: Mycelium immersed, composed of septate, branched, smooth and brown hyphae. Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, black, cupulate, ellipsoid to spherical in top view, 150–250 µm in diam; basal stroma of textura angularis composed of hyaline to brown, isodiametric cells; lateral wall of textura prismatica to textura porrecta formed by brown, thick-walled cells that are hyaline towards the inner layer. Setae brown to black, simple, 0-2 septate, cylindrical with an acute or obtuse apex, wall thick and smooth, $60-130 \times 3-5.5 \,\mu\text{m}$, arising from lateral excipulum. Conidiophores pale brown at the base, becoming hyaline towards the apex, 1-2-septate, branched or unbranched, cylindrical, wall thin and smooth, $10-20 \times 1.5-2.5 \mu m$. Conidiogenous cells phialidic, hyaline, cylindrical, apex with narrow channel and an inconspicuous collar, 8-10×1.5-2 µm. Conidia hyaline, aseptate, wall thin and smooth, ellipsoid, slightly curved, ends rounded, guttulate, $7.5-9.5 \times 2.5-3.2 \mu m$, with a single, unbranched setulae at each end, 6.5–7 µm long.

Materials examined: **China**, Guangxi Province, Damingshan, on dead leaves of grass, 20 December 1997, W.P. Wu (Wu1460a). Living strain: 43900 (from Wu1460a).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Japan (Hashimoto et al. 2015a).

Description and illustration: Hashimoto et al. (2015a).

Notes: *Dinemasporium iriomotense* is characterized by ellipsoid conidia with a single and unbranched appendage at each end. It differs from the closely related species including *D. strigosum* by having naviculate to ellipsoid, shorter but broader conidia. The conidia from our specimen are slightly larger and with slightly longer appendages (conidia $6.5-8.5 \times 2-3 \mu m$, appendage $4-6(-7) \mu m$ long in the original description; Hashimoto et al. 2015a).

Dinemasporium japonicum A. Hashim., G. Dato & Kaz. Tanaka, Mycoscience 56: 92, 2015.

Description on the natural substrate: Mycelium immersed, composed of septate, branched, smooth and brown hyphae. Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, black, cupulate, ellipsoid to spherical in top view, 150–800 μ m in diam; basal stroma of textura angularis composed of hyaline to brown, isodiametric cells; excipulum well-developed, lateral wall of textura prismatica to textura porrecta formed by brown, thick-walled cells that are hyaline towards the inner layer, 120–180 μ m high, cells 2.5–3.5 μ m wide, apical cell not separated and with rounded apex. Setae brown to black, simple, septate, cylindrical with acute or obtuse apex, wall thick and smooth, 100–380×5–8 μ m, 8.5–15 μ m at the base, 3–4.5 μ m at the apex, arising from out layer of lateral excipulum or basal stroma. Conidiophores hyaline, septate, branched or unbranched, cylindrical, wall thin and smooth, $10-25 \times 2-3 \mu m$. Conidiogenous cells phialidic, hyaline, cylindrical, apex with narrow channel and an inconspicuous collar, $8-15 \times 1.5-2.5 \mu m$. Conidia hyaline, aseptate, wall thin and smooth, naviculate, curved, ends rounded, guttulate, $(6-)7-10 \times 1.8-2.0 \mu m$, with a single, unbranched setulae at each end, $5-7(-9.5) \mu m$ long.

Materials examined: China, Guangdong Province, Shaoguan, Danxiashan, on dead leaf sheath of grass, 25 December 2012, W.P. Wu (Wu12388); Guangdong Province, Shaoguan, Danxiashan, on dead culm of grass, 25 December 2012, W.P. Wu (Wu12389, Wu12393); Guangdong Province, Shaoguan, Danxiashan, on dead leaves and leaf sheath of grass, 25 December 2012, W.P. Wu (Wu12391); Guangdong Province, Shaoguan, Danxiashan, on dead leaves of Miscanthus sp., 25 December 2012, W.P. Wu (Wu12547); Guangdong Province, Shaoguan, Danxiashan, on dead culm of grass, 25 December 2012, W.P. Wu (Wu12392); Guangxi Province, Damingshan, on dead culm of bamboo, 19 December 1997, W.P. Wu (Wu1439b, Wu1425a); China: Guangxi Province, Damingshan, on dead culms of bamboo, 19 December 1997, W.P. Wu (Wu11044a); Guangxi Province, Damingshan, on dead culms of Miscanthus sp., 20 December 1997, W.P. Wu (Wu1468); Hubei Province, Yichang, on dead culm of grass, 12 August 2017, W.P. Wu (Wu13451); Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead leaves of grass, 25 August 2019, W.P. Wu (Wu16824, Wu16825, Wu16826); Jiangsu Province, Wuxi, Wuxi Forestry Park, on dead leaves of Photinia sp., 25 August 2019, W.P. Wu (Wu16827); Shan'Xi Province, Xi An, Huaqingchi, on dead leaves of grass, 15 August 2016, W.P. Wu (Wu15595); Shan'Xi Province, Zhouzhi, Qinling mountain, on dead culm of grass, 2 August 2019, W.P. Wu (Wu16592); Shan'Xi Province, Zhouzhi, Qingling mountain, on dead leaves and culms of grass, 2 August 2019, W.P. Wu (Wu16527, Wu 16,528, Wu16529, Wu16536); Zhejiang Province, Hangzhou, Longjing, on dead culm of grass, 1 October 2013, W.P. Wu (Wu13001, Wu13002); Zhejiang Province, Hangzhou, Longjing, on dead leaves of grass, 1 October 2013, W.P. Wu (Wu13014); Zhejiang Province, Hangzhou, Longjing, on dead leaves and culms of grass, 1 October 2013, W.P. Wu (Wu13015); Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead leaves of grass, 16 October 2019, W.P. Wu (Wu16973); Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead culm of grass, 16 October 2019, W.P. Wu (Wu16977, Wu16981, Wu16982, Wu16983, Wu17040); Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead leaf petiole of palm, 16 October 2019, W.P. Wu (Wu17019); Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead leaf sheath of bamboo, 16 October 2019, W.P. Wu (Wu17039); Zhejiang Province, Anji, Bamboo garden, on dead leaves and sheath of bamboo, 17 June 2021, W.P. Wu (Wu18003, Wu18004, Wu18005,

Wu18006, Wu18011, Wu18012, Wu18013, Wu18014). Living strains: 43050 (from Wu1425), 43195 (from Wu1425a), 44,077 (from Wu1439b), 44,100 (from Wu1468), 53,377 (from Wu11044a), 55,221 (from Wu12393), 55,390 (from Wu12547), 57,316 (from Wu13001), 57,317 (from Wu13002), 57,325 (from Wu13014), 57,348 (from (Wu13015), 76,799 (from Wu16529), 76,802 (from Wu16536), 76,822 and 76,823 (from Wu16593a), 76,824 and 76,875 (from Wu15594), 76,843 and 76,844 (from 16,592), 76,863 (from Wu16527), 76,798 (from Wu16528), 77,122 (from Wu16824), 77,123 (from Wu16825), 77,124 (from Wu16826), 77,125 (from Wu6827), 77,329 (from Wu16973), 77,294 (from Wu16977), 77,295 (from Wu16982), 77,296 (from Wu16983), 77,310 (from Wu17040), 77,330 (from Wu16981), 77,304 and 77,305 (from Wu17019), 77,308 and 77,309 (from Wu17039), 75,816, 75,817 and 77,818 (from Wu13451), 78,542 and 78,543 (from Wu18004), 78,544 (from Wu18006), 78,548 and 78,549 (from Wu18011), 78,550 and 78,551 (from Wu18012), 78,552 and 78,553 (from 18,013), and 78,554 and 78,555 (from Wu18014).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Japan (Hashimoto et al. 2015a).

Description and illustration: Hashimoto et al. (2015a).

Notes: *Dinemasporium japonicum* is characterized by naviculate to ellipsoid and smaller conidia with a single and unbranched appendage at each end, it can easily be distinguished from the two closely related species, *D. iriomotense* and *D. strigosum*, by its smaller conidia with longer appendages and also very different ITS sequences. Compared to the original description, the fungus from the Chinese collections are with shorter setulae (7–12 µm in the original description vs. 4–9.5 µm from the Chinese collections) (Hashimoto et al. 2015a). Among the examined collections from China, some variations were observed, for example, the conidia in the specimen Wu17019 are smaller (7–8×2 µm) than those in the specimens Wu13002 and Wu17698 (8–10×1.8–2 µm). However, the ITS sequences obtained from them are identical.

This fungus was commonly found from different woody and herbaceous plants including *Miscanthus*, *Sasa*, *Phragmites* and *Juncus* and appears to be widely distributed in Japan. Likewise, it seems to be also a rather common species from China, and collections were made from different substrates and several provinces in China.

Dinemasporium ligongense W.P. Wu, J.X. Duan & X.Z. Liu, Fungal Divers. 26: 211, 2007. Figure 243

Typification: **China**, Hebei Province, Chengde, on dead culms of unidentified herbaceous plant, 12 September 1991, W.P. Wu, Holotype Wu910508a.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, scattered or aggregated, cupulate to discoid but oblong to ovoid shaped on the top view, up to 2 mm long and 1 mm wide; lateral wall of textura porrecta formed by hyaline to pale brown cells in the inner layer and brown to dark brown cells in the outer layer, the apex of the outer wall prolong into brown, aseptate or 1-septated, curved setae which are $25-40 \times 1-1.5$ µm; basal stroma of textura angulari with brown, isodiametric cells which are hyaline in the upper layer. Setae brown to black, septate, cylindrical, tapering towards the apex and apex acute or obtuse, wall thick and smooth, $110-750 \times 3-5 \mu m$, arising from the outer layer of basal and lateral walls. Conidiophores hyaline, septate, simple to branched, aseptate or septate, wall smooth, cylindrical, originating from the upper cells of basal stroma and also inner layer of lateral walls. Conidiogenous cells phialidic, discrete or integrated, hyaline, wall smooth, cylindrical with minute periclinal thickenings in the collarette zone, collarette inconspicuous, $8-16 \times 1-1.8 \mu m$. conidia hyaline, aseptate, naviculate, curved or straight, smooth-walled, ends obtuse, $6.3-8 \times 1.2-2 \mu m$, with one setulae of 2.5-4 $\mu m \log$ at each end.

Other materials examined: **China**, Hebei Province, Chengde, on dead culms of herbaceous plants, 12 September 1991, W.P. Wu (Wu910503, Wu910517); Hebei Province, Chengde, Bishushanzhuang, on dead culms of unidentified grass, 11 September 2012, W.P. Wu (Wu15050, Wu15052, Wu15055). Living strains: 54,653 (from Wu15050), 54,665 (from 15,052) and 54,675 (from Wu15055).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Know distribution: China (Duan et al. 2007).

Description and illustration: Duan et al. (2007).

Notes: *Dinemasporium ligongense* was a recently described species and differs from all other species in the genus by its two types of setae on conidiomata and smaller conidia with very shorter terminal appendages. Several species including *D. aberrans*, *D. affine*, *D. decipiens* and *D. rhodophaeum* have similar conidial morphology with *D. ligongense* (Sutton 1965, 1980a, b; Nag Raj 1993; Crous et al. 2012; Hashimoto et al. 2015a). However, the conidia in *D. aberrans* are pale brown to brown with longer setulae $(5.5-7 \ \mu\text{m})$; the conidia of *D. affine* are smaller $(3.5-5 \times 1.5-2 \ \mu\text{m})$ with shorter setulae $(1.5 \ \mu\text{m long})$; the conidia of *D. rhodophaeum* are larger $(8-12.5 \times 2.5-3.5 \ \mu\text{m})$; and the conidia of *D. decipiens* are wider $(2-2.5 \ \mu\text{m})$ (Sutton 1969, 1980a, b; Nag Raj 1993; Crous et al. 2012; Hashimoto et al. 2015a).

To obtain the living strain in this study, two fresh specimens of *D. ligongense* were recollected from the same locality as the type specimen. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 54653 include



Fig. 243 *Dinemasporium ligongense* (Wu15050). **a** Setae. **b**, **c** Part of excipulum with short setae in out layer. **d**, **e** Conidiophores and conidiogenous cells. **f–p** Conidia. Scale bar: **a** 20 μm, **b–p** 5 μm


Fig. 244 *Dinemasporium longicapillatum* (**a-h** Wu16735, **i**, **j** Wu16756). **a** Conidiomata. **b** Part of excipulum. **c** Conidiophores and conidiogenous cells. **d** Setae. **e**–**j** Conidia. Scale bar: **a** 50 μm, **b** 20 μm, **c**–**j** 5 μm



Fig. 245 *Dinemasporium longicapillatum* (Wu13442). **a, b** Part of excipulum with setae. **c** Part of excipulum showing the conidiophores and conidiogenous cells. **d** Excipulum showing the rounded apex of

the hyphae. e-g Conidiophores and conidiogenous cells with developing conidia. h-o Conidia. a-d $10 \mu m$, e-o $5 \mu m$

Dinemasporium cruciferum (GenBank AB900893, 96% identity), *D. morbidum* (GenBank NR_137788, 95% identity)) and *D. sasa* (GenBank NR_155038, 95% identity).

Dinemasporium longicapillatum Y. Yamag. & Masuma, Mycoscience 46: 367, 2005. Figures 244, 245

Description on the natural substrate: Mycelium immersed, composed of septate, branched, smooth and brown hyphae. Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, black, cupulate, ellipsoid to spherical in top view, 200-450 µm in diam; basal stroma of textura angularis composed of hyaline to brown, isodiametric cells; excipulum well-developed, lateral wall of textura prismatica to textura porrecta formed by brown, thick-walled cells that are hyaline towards the inner layer, 60–160 µm high, cells 2–3 µm wide, apical cell not separated and with obtuse or rounded apex. Setae brown to black, simple, septate, cylindrical with acute or obtuse apex, wall thick and smooth, $130-490 \times -12 \,\mu\text{m}$, $7-16 \,\mu\text{m}$ at the base, 2-4 µm at the apex, arising from out layer of lateral excipulum or basal stroma. Conidiophores hyaline, 1-3-septate, branched or unbranched, cylindrical, wall thin and smooth, $10-20 \times 2-2.5 \mu m$. Conidiogenous cells phialidic, hyaline, cylindrical, apex with narrow channel and an inconspicuous collar, $7-10 \times 1.5-2.5$ µm. Conidia hyaline, aseptate, wall thin and smooth, naviculate, curved, ends rounded, guttulate, $7-10 \times 1.8-2.3 \mu m$, with a single, unbranched setulae at each end, 6–12 µm long.

Materials examined: **China**, Guangdong, Guangzhou, Nansha, on dead leaves of grass, 18 August 2019, W.P. Wu (Wu16735); Hubei, Yichang, on dead culm of grass, 18 August 2019, W.P. Wu (Wu16756); Jiangsu, Zhenjiang, Mingdu Hotel, on dead leaves of grass, 23 August 2015, W.P. Wu (Wu13422a); Jiangsu Province, Zhenjiang, Jinshan Park, on dead leaves of unidentified tree, 23 August 2015, W.P. Wu (Wu13442) August. Living strains: 71,169 and 71,170 (from Wu13422), 71,224 and 71,225 (from Wu13442), 76,996 and 76,997 (from Wu16735), 77,105, 77,064 and 77,083 (from Wu16756).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Japan (Yamaguchi et al. 2005).

Description and illustration: Yamaguchi et al. (2005); Hashimoto et al. (2015a).

Notes: Dinemasporium longicapillatum (conidia $8-11 \times 2-2.7 \mu m$, appendage $11-20 \mu m$ long from the type material) was described for a fungus isolated from sugar cane from Japan and is characterized by fusiform to allantoid conidia with longer terminal appendages (Yamaguchi et al. 2005). Hashimoto et al. (2015a) redescribed the species *D. longicapillatum* with shorter conidial setulae (conidia $8-11 \times 2-3 \mu m$, appendage 7-12 μm long) from dead stems

of herbaceous plant incl. bamboo, *Miscanthus* sp. and *Saccharum officinarum*. The ITS sequences were obtained from both ex-type culture (MAFF 239,569) and other specimens they collected. The conidia and setulae vary a lot among the different specimens from China, for example, in the specimen Wu13422, the conidia are $7-8 \times 2-2.3 \mu m$ and with longer setulae (10–12 μm); in the specimen Wu16756, the conidia are $8-10 \times 2 \mu m$ and with longer setulae (10–15 μm); while in the specimen Wu13442 and Wu16775, the conidia are $7.5-9 \times 2 \mu m$ and with shorter appendages (6–9 μm). The ITS sequences obtained from these specimens are almost identical to the reported one from the ex-type strain.

Dinemasporium longisporum W.P. Wu & Y.Z. Diao, sp. nov., Fig. 246, MycoBank MB841662.

Etymology: Refers to its long conidia.

Typification: **USA**, Texas, Austin, Barton Creek, on *Bothriochloa auccaroides*, collected date not mentioned, J. Loftis (D65), Holotype IMI238583.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, cupulate and circular to ellipsoidal on the top view, unilocular, superficial, scattered, blackish, up to 800 µm diam. Basal wall of textura angulari composed of brown, thick-walled, irregular-shaped cells and become pale brown to hyaline, thin-walled smaller cells towards the inner layers, 30-50 um thick; lateral wall of textura porrecta, formed by dark brown to blackish, thick-walled, longer cells in the outer layer and pale brown to hyaline, thin-walled cells in the inner layers, up to 40 µm thick. Setae present, dark brown, septate, simple, cylindrical, straight, wall smooth and thick, tapering towards the apex and apex acute or obtuse, $150-350 \times 3-7 \mu m$. Conidiophores hyaline, 1 to 3 septate, branched at the base or unbranched, cylindrical, straight, wall thin and smooth, $10-25 \times 1.5-2 \mu m$, arising from inner layer of both basal and lateral walls. Conidiogenous cells discrete or integrated, determinate, apical or lateral, cylindrical, straight, wall thin and smooth, apex narrow with narrow sporulating channel and prominent thicking around the channel, $7-15 \times 1.5-2 \mu m$. Conidia hyaline, aseptate, fusiform, slightly curved, apex obtuse, base truncate, guttulate, $14-20 \times 2.5-2.8 \mu m$, apical appendage single, 10-17.5 μm long, basal appendages 1 or rarely 2, 8-18 µm long, lateral appendages mostly 2, rarely 1, simple, 9-17 µm long, arising from 2 to 3 µm subapical.

Materials examined: **USA**, Texas, Austin, Barton Creek, on *Bothriochloa auccaroides*, collected date not mentioned, J. Loftis(D65), IMI238583 (Holotype); India: Uttar Pradesh; Almora, on leaves of *Eleusine*, October 1988, R.C. Gupta, IMI336569.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Know distribution: India and USA.



Fig. 246 *Dinemasporium longispora* (IMI238583, holotype). a Vertical section of a conidioma. b Basal stroma. c Lateral wall. **d** Conidiophores and conidiogenous cells. **e** Conidia. Scale bar: a 50 μm, **b–e** 10 μm



Fig. 247 *Dinemasporium morbidum* (Wu16503). **a** Part of excipulum with lateral wall and setae. **b** Conidiophores and conidiogenous cells. **c–k** Conidia. Scale bar: **a** 10 μm, **b–k** 5 μm

Notes: *Dinemasporium longisporum* differs from other species in *Dinemasporium* by fusiform, slightly curved and longer conidia with one (rarely 2) subapical and two lateral appendages (Sutton 1980b; Nag Raj 1993). *Stauronema pingue* also produces conidia with both subapical and lateral appendages, but its conidia are much shorter but wider ($11.2-14 \times 4.2-5.5 \mu m$) with thick and somewhat rough wall. The type specimen IMI238583 is in a good condition with abundant conidiomata in well-developed state.

Dinemasporium morbidum Crous, Persoonia 28: 131, 2012. Figure 247

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata stromatic, scattered or aggregated, superficial, dark brown to black, cupulate, unilocular, globose, 160–350 μ m diam, setose with a central white to slightly pink conidial mass; basal stroma of textura angularis, composed of subhyaline to pale brown, irregularly shaped cells, 2–4 μ m wide; excipulum welldeveloped, lateral wall of textura prismatica to textura porrecta formed by brown, thick–walled cells that are hyaline towards the inner layer, 140-160 µm high, cells 2.5-3 µm wide, apical cell not separated and with acute or obtuse apex. Setae brown to black, simple, septate, subulate with acute apex, unbranched, smooth, thick-walled, septate, $135-320 \times 7-11 \mu m$, $1.5-2 \mu m$ wide at acute apex, arising from basal stroma or lateral from excipulum. Conidiophores lining the basal stroma, hyaline, 1-3-septate, sparingly branched, cylindrical, thin-walled, smooth, $15-20 \times 2-3 \mu m$. Conidiogenous cells phialidic with periclinal thickening, hyaline, smooth, subcylindrical to lageniform, $8-11 \times 1.5-2.2 \mu m$. Conidia hyaline, aseptate, thinwalled, smooth, allantoidal, subcylindrical to fusiform, gently curved or straight, apex obtuse to rounded, base truncate, eguttulate or guttulate, $9.5-11 \times 2-2.2 \mu m$, with a single, unbranched, flexuous, tubular appendage at each end, 4-6.5 µm; basal appendage excentric.

Materials examined: **China**, Ningxia Province, Jingyuan County, Liupanshan, on dead culm of unidentified grass, September 1997, W.P. Wu (Wu1017). Living strains: 43618 (from Wu1017), 76,772 and 76,773 (from Wu16503); **UK**, Scotland, Newton Steward, Galloway Forestry Park, on dead culm of unidentified grass, July 2019, W.P. Wu (Wu16503).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China, Netherlands, New Zealand and UK (Crous et al. 2012).

Description and illustration: Crous et al. (2012); Li et al. (2020).

Notes: Morphologically *Dinemasporium morbidum* resembles *D. strigosum* but has longer conidia and appendages than those in *D. strigosum*. The conidia from the examined specimens by us are with slightly smaller conidia and shorter setulae than those in the original description (conidia $12-14 \times 3 \mu m$, setulae 7–10 μm long). The ITS sequences obtained from the two collections are identical to the one from the ex-type strain.

Dinemasporium multisetulum W.P. Wu & Y.Z. Diao, sp. nov., Fig. 248, MycoBank MB841663.

Etymology: Named after its more than one appendaged conidia.

Typification: **China**, Beijing, Huairou, Beigou, Mutianyu, on dead culm of grass, 09 October 2012, W.P. Wu, Holotype HMAS 352,001 (= Wu15100), ex-type strain CGMCC 3.20651 (= NN54975).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, cupulate and circular to ellipsoidal on the top view, unilocular, superficial, scattered, blackish, up to 400 μ m diam; basal wall of textura angulari composed of brown, thick-walled, irregular-shaped cells and become pale brown to hyaline, thin-walled smaller cells towards the inner layers, 35–45 um thick; excipulum well-developed, lateral wall of textura

porrecta, formed by dark brown to blackish, thick-walled, longer cells in the outer layer and pale brown to hyaline, thin-walled cells in the inner layers, 100-135 um high, up to 45 µm thick. Setae present, dark brown, septate, simple, cylindrical, straight, wall smooth and thick, tapering towards the apex and apex acute or obtuse, 75-300 um long, 7.5–10 μ m wide at the base, 3.5–6 um wide at the apex. Conidiophores pale brown to hyaline, 1–3-septate, branched at the base or unbranched, cylindrical, straight, wall thin and smooth, $10-20 \times 1.5-3 \mu m$, arising from inner layer of both basal and lateral walls. Conidiogenous cells discrete or integrated, apical or lateral, cylindrical, straight, wall thin and smooth, apex narrow with narrow sporulating channel and prominent thicking around the channel, $7-12 \times 1.5-2.5 \,\mu\text{m}$. Conidia hyaline, aseptate, fusiform, slightly curved, apex obtuse, base truncate, guttulate, $9-12 \times 2.3-3.0$ µm, apical and basal appendage single, 10-15 µm long, lateral appendages 0–1, 4–8 µm long, arising from 2/3 of the conidial body from the base.

Culture characteristics: Colonies on PDA effuse, colonies 1.8–2.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, slightly grey or soil brown, reverse yellow to soil brown in the center and becoming paler towards the margins (Figs. 235f, g).

Other materials examined: **China**, Beijing, Huairou, Beigou, Mutianyu, on dead culm of grass, 09 October 2012, W.P. Wu (Wu15098, Wu15105); Zhejiang Province, Hangzhou, Longjing, on dead culm of grass, 1 October 2013, W.P. Wu (Wu13000). Living strains: 54,971 (from Wu15098), 54,980 (from Wu15105) and 57,315 (from Wu13000),

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Dinemasporium multisetulum* differs from other species in the genus by its shorter and slightly curved conidia with long terminal appendages and shorter lateral appendages (Sutton 1980a, b; Nag Raj 1993; Crous et al. 2012, 2014; Hashimoto et al. 2015a). The ITS sequences show high identity to those from *D. japonicum* (Conidia $7-10 \times 2-2.5 \mu$ m, setulae $7-12 \mu$ m in length), but morphologically it can be easily distinguished by larger conidia and with lateral appendages in *D. multisetulum* (Hashimoto et al. 2015a). Some variation on conidial setulae were observed within the same specimen and also among different collections. For example, the conidia in the specimen Wu15105 are found to be with 1 basal and apical setulae or also with 1-2 lateral setulae; the conidia in the specimen Wu15098 are only with polar setulae.

Dinemasporium multisetulum belongs to a small group of known species traditionally known under *Stauronema* and Dinemasporium with both polar and lateral setulae including *Stauronema indicum*, D. ambiguum, D. cruciferum, D. pseudoindicum and D. trichophoricola (Nag Raj 1993;



Fig. 248 Dinemasporium multisetulum (Wu15100, holotype). a Conidiomata. b-c Excipulum, setae and superficial hyphae. d Conidia. Scale bar: a 50 µm, b 20 µm, d 5 µm

Crous et al. 2014; Hashimoto et al. 2015a). These species can be easily distinguished from each other by conidial morphology (shape, size and subapical appendage) and the ITS sequences (Sutton 1969, 1980b; Nag Raj 1993; Crous et al. 2012; Hashimoto et al. 2015a). *Dinemasporium multisetulum* differs from all of them by conidia bearing shorter lateral appendages (4–8 µm long).

Dinemasporium parastrigosum A. Hashim. & Kaz. Tanaka, Mycoscience 56: 94, 2015. Figure 249

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata stromatic, scattered, cupulate, superficial, globose, unilocular, 150–500 μ m, 140–160 280 μ m high, dark brown to black; basal stroma 15–25 μ m thick, composed of pale brown to hyaline,



Fig. 249 *Dinemasporium parastrigosum* (Wu16519). **a** Conidiomata. **b** Excipulum and setae. **c**, **d** Conidiophores and conidiogenous cells. **e–o** Conidia. Scale bar: **a** 100 μm, **b** 20 μm, **c–o** 5 μm

rectangular; excipulum composed of hyaline inner layer and brown out layer. Setae arising from the basal stroma, straight or curved, septate, brown but pale at the apex, thick-walled, smooth, unbranched, 250–500 μ m long, acute and 4–7 μ m wide at the apex, 7–10 μ m wide at the base. Conidiophores lining the basal stroma, rectangular to cylindrical, smooth,

pale brown to hyaline, unbranched, $10-25 \times 2-3 \mu m$. Conidiogenous cells phialidic, cylindrical, hyaline, smooth, $5-14 \times 1.5-2.5 \mu m$. Conidia naviculate to ellipsoid, obtuse or slightly acute at the apex, slightly truncate at the base, unicellular, hyaline, smooth, $8-13 \times 2-3 \mu m$, bearing a single unbranched appendage at each end; apical appendage $6-11 \ \mu m$ long, central; basal appendage excentric, similar size as apical appendage.

Materials examined: **China**, Shan'Xi, Zhouzhi, Qinling mountain, on dead leaves of grass, 22 August 2019, W.P. Wu (Wu16518); Shan'Xi, Zhouzhi, Qinling mountain, on dead culm of grass, 22 August 2019, W.P. Wu (Wu16617, Wu16519); Shan'Xi, Zhouzhi, Qinling mountain, on dead leaves of *Phragmites australias*, 22 August 2019, W.P. Wu (Wu16524). Living strains: 76,789 (from Wu16518), 76,790 (from Wu16519), 76,793 (from Wu16524), 76,857 (from Wu16617).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Japan (Hashimoto et al. 2015a).

Description and illustration: Hashimoto et al. (2015a).

Notes: Morphologically *D. parastrigosum* has close affinities with *D. strigosum*. In fact, they can hardly be distinguished from each other on conidia and appendage, but their ITS sequences have 18–22 bp differences and they form two distinct clades in the phylogenetic tree (Hashimoto et al. 2015a).

Dinemasporium pingue (Nag Raj) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841736.

 \equiv *Stauronema pingue* Nag Raj, Coelomycetous anamorphs with appendages-bearing conidia. p. 908, 1993.

≡ *Dinemasporium pingue* (Nag Raj) W.J. Li & K.D. Hyde, Fungal Divers. 100: 495, 2020 (Invalid).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, blackish, scattered or aggregated, cupulate, unilocular, circular to oblong on top view, 150-400 µm diam and 250-350 µm high; Basal wall of textura angulari composed of brown, thick-walled cells and become pale brown to hyaline towards the inner layers, up to 35 µm thick; lateral wall of textura porrecta, formed by dark brown, thick-walled and longer cells in the outer layers and become pale brown to hyaline, thin-walled cells in inner layers, up to 30 um thick. Setae black, 3-9-septate, straight, or slightly curved, tapering towards the apex, apex acute, wall thick and smooth, $80-160 \times 3.5-6$ µm. Conidiophores hyaline, 1-2-septate, unbranched or branched at the base, cylindrical, wall thin and smooth, $7-15 \times 3-5 \mu m$, arising from the inner layer of both basal and lateral walls. Conidiogenous cell discrete or integrated, hyaline, cylindrical to lageniform, wall thin and smooth, apex narrow with a prominent thicking and a narrow sporulating channel, $3.5-7.5 \times 2-3.5 \mu m$. Conidia holoblastic, hyaline, aseptate, ellipsoidal, straight or slightly curved, apex rounded, base truncate, wall thick and somewhat rough, guttulate, $11.2-14 \times 4.2-5.5 \mu m$, basal appendage single, 15–28 µm long; apical appendage single, 13–25 µm long;

lateral appendages 2 or rarely 1, subapical, $15-25 \mu m \log r$, located at 3.5 μm below the apex.

Materials examined: **India**, Mt. Maknln Res. St., Bhilanga, N, Rhoderia, on *Rottboellia exaltata*, 20 February 1962, PPNR 4033, IMI95775a.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: India and Portugal (Nag Raj 1993).

Description and illustration: Nag Raj (1993); Li et al. (2020).

Notes: *Stauronema pingue* was described from India and is characterized by much wider conidia with subapical lateral appendages (Nag Raj 1993; Li et al. 2020). The examined specimen IMI95775 (originally identified as *Stauronema* sp.) represents the second collection of this species.

Dinemasporium polygonum Crous & Verkley, Persoonia 27: 133, 2012.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata stromatic, scattered or aggregated, superficial, dark brown to black, cupulate, unilocular, globose, 150-300 µm diam, setose with a central white to slightly pink conidial mass; basal stroma of textura angularis, composed of subhyaline to pale brown, irregularly shaped cells, 2-4 µm wide; excipulum well-developed, lateral wall of textura prismatica to textura porrecta formed by brown, thick-walled cells that are hyaline towards the inner layer, 140-180 µm high, cells 2.5-3 µm wide, apical cell not separated and with obtuse or rounded apex. Setae brown to black, simple, septate, subulate with acute apex, unbranched, smooth, thick-walled, septate, $110-300 \times 5-10 \mu m$, $1.5-2 \mu m$ wide at acute apex, arising from basal stroma or lateral from excipulum. Conidiophores lining the basal stroma, hyaline, 1–3-septate, sparingly branched, cylindrical, thin-walled, smooth, $40-50 \times 2-4$ µm. Conidiogenous cells phialidic with periclinal thickening, hyaline, smooth, subcylindrical to lageniform, $15-20 \times 1.5-2 \mu m$. Conidia hyaline, aseptate, thin-walled, smooth, naviculate to fusiform or ellipsoid, gently curved or straight, apex obtuse to subobtusely rounded, base truncate, eguttulate or guttulate, 10-11.5 $(-12.5) \times 2 - 2.5 \mu m$, with a single, unbranched, flexuous, tubular appendage at each end, 6-8 µm; basal appendage excentric.

Materials examined: UK, Scotland, Newton Steward, Galloway Forestry Park, on dead culms of unidentified grass, July 2019, W.P. Wu (Wu16502). Living strains: 76,775 and 76,777 (from Wu16502).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Netherland (Crous et al. 2012) and UK.

Description and illustration: Crous et al. (2012).

Notes: Dinemasporium polygonum has conidia $(10-12 \times 2.5 \ \mu\text{m})$ with longer appendages $(10-12 \ \mu\text{m})$ than D. strigosum (Pers.) Sacc. though shorter than in D. americanum (6–9 μm long in D. strigosum, 11–16 μm in D. americanum) (Crous et al. 2012). Morphologically the fungus from the UK collection fits well to those in the original description, however its conidia are with slightly shorter setulae.

Dinemasporium pseudodecipens A. Hashim. & Kaz. Tanaka, Mycoscience 56: 95, 2015.

Description on the natural substrate: Mycelium immersed, composed of septate, branched, smooth and brown hyphae. Teleomorph: Unknown. Anamorph: Conidiomata stromatic, scattered to gregarious, superficial, black, cupulate to discoid with lateral prosenchymatic wall of textura porrecta composed of hyaline to pale colored, septate hyphae in the inner layer and brown, septate hyphae in the outer layer; basal wall of textura angularis composed of pale brown to hyaline and thin-walled cells in the upper layer and of brown, thick-walled and isodiametric cells in the lower layer, 150–600 µm diam. Setae brown to dark brown, tapering to an acute or rounded apex, unbranched, septate, wall thick and smooth, arising from the outer layer of basal stroma and sometimes from the outer layer of lateral excipulum, 55-230×4.5-8.5 µm. Conidiophores hyaline, smoothwalled, septate, branched at the base, cylindrical, formed from the upper cells of basal stroma, $10-30 \times 1.5-2.5 \mu m$. Conidiogenous cells phialidic, hyaline, cylindrical with a slightly tapered apex, apical channel minute and collarette not prominent, $8-20 \times 1.5-2.5 \mu m$. Conidia hyaline, aseptate, eguttulate or guttulate, naviculate, curved or straight, wall smooth, ends obtuse, $5.5-8 \times 2.5-3 \mu m$, setulae straight or curved, unbranched, 1.5-4 µm long.

Materials examined: China, Hebei Province, Zhangjiakou, Chicheng, Haituoshan, on dead branches of tree, 25 September 2020, W.P. Wu (Wu17386a, 17386b); Hebei Province, Zhangjiakou, Chicheng, Haituoshan, on dead culm of unidentified grass, 25 September 2020, W.P. Wu (Wu17389a, Wu17389b, Wu17390, Wu17391); Hebei Province, Zhangjiakou, Chicheng, Haituoshan, on dead stem of unidentified grass, 25 September 2020, W.P. Wu (Wu17415a, Wu17415b, Wu1746a, Wu17416); Hebei, Shijiazhuang, on dead branched of Sophor japonica L., 10 September 1990, W.P. Wu (Wu1529); Jilin Province, Dunhua, on dead branches of unidentified plant, 14 August 2000, W.P. Wu & Yang Huang (Wu4562b); Jilin Province, Changbaishan, on dead wood of ?Salix sp., 5 September 1998, W.P. Wu (Wu1735a); Jilin Province, Changbaishan, on dead wood of ?Alnus sp., 5 September 1998, W.P. Wu (Wu1752b); Jilin Province, Changbaishan, on dead branches of Salix sp., 5 September 1998, W.P. Wu (Wu1767a); Jilin Province, Changbaishan, on rotten wood of Betula sp., 5 September

1998, W.P. Wu (Wu1823b); Liaoning Province, on unidentified hosts, 8 August 1993, W.P. Wu (Wu0571); Shan'Xi Province, on dead branch of Acer sp., 11 October 1992, W.P. Wu (Wu1533); Shaanxi Province, on dead branches of Syringa sp., 3 October 1992, W.P. Wu (Wu1512); Shaanxi Province, Xian, on unidentified hosts, 10 October 1992, W.P. Wu (Wu1537, Wu1541, Wu1546); Yunnan, Kunming, Botanical Garden, on dead branches of unidentified plant, 22 October 1999, W.P. Wu and Yan Huang (Wu2526); Yunnan, Kunming, Shilin, on dead branches of unidentified plant, 24 October 1999, W.P. Wu and Yan Huang (Wu2546a). Living strains: 44,551 (from Wu1735a), 44,567 (from Wu1752d), 44,597 (from Wu1767a), 45,693 (from Wu2546a), 47,604 (from FSDA2), 46,487 (from Wu4562b), 78,123 (from Wu17386a), 78,146 (from Wu17386b), 78,124 (from Wu17389a), 78,125 (from Wu17389b), 78,126 (from Wu17390a), 78,127 (rom Wu17390), 78,128 (from Wu17391), 78,138 (from Wu17415a), 78,139 (from Wu17415b), 78,141 (from Wu17416) and 78,140 (from Wu17416a).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Japan (Hashimoto et al. 2015a).

Description and illustration: Hashimoto et al. (2015a); Li et al. (2020).

Notes: D. pseudodecipens resembles D. decipiens in producing small conidia with short terminal appendages, but differs by narrower conidia and longer setulae in the latter species (Sutton 1969, 1980a, b; Nag Raj 1993; Crous et al. 2012; Hashimoto et al. 2015a). For comparison, the type specimen of D. decipiens (IMI94869, slide ex Herb. K) was examined by us and the conidia are $4-6.5 \times 1.0-1.6 \,\mu\text{m}$ with one setula at each end and measured 3.5-6 µm long. The type specimen of *D. robinae* (IMI94857, slide ex Herb. K) was also examined and it was concluded that it is conspecific with D. decipiens. Furthermore, the ITS sequences are very different between these two species (Crous et al. 2012; Hashimoto et al. 2015a). Dinemasporium pseudodecipens from the Chinese collections is more or less identical to the one described from Japan (conidia $5-7.5 \times 2-3 \mu m$, appendage 2-4 µm long). All the strains obtained from the fresh specimens in China have almost identical ITS sequences to those reported by Hashimoto et al. (2015a). Dinemasporium pseudodecipens is a common species on dead twigs and wood of many deciduous trees such as Acer, Ailanthus, Fraxinus, Robinia, etc. Dinemasporium acerinum Peck reported in China by Teng (1963) and Wu (1993) should be transferred to D. pseudodecipiens.

Dinemasporium pseudostrigosum Crous, Persoonia 28: 134, 2012.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata stromatic, scattered or aggregated, superficial, dark brown to black, cupulate, unilocular, globose, up to 350 µm diam, setose with a central buff conidial mass; basal stroma of textura angularis, layer 15–25 µm thick. Setae brown to black, simple, septate, subulate with acute apex, unbranched, smooth, thick-walled, septate, 280–510 (-550) \times 5–8 µm, 1.5–2 µm wide at acute apex, arising from basal stroma or lateral from excipulum. Conidiophores lining the basal stroma, hyaline, septate, sparingly branched, cylindrical, thin-walled, smooth, 20-35 µm long. Conidiogenous cells phialidic with periclinal thickening, hyaline, smooth, subcylindrical to lageniform, $12-18 \times 2-2.5 \mu m$. Conidia hyaline, aseptate, thinwalled, smooth, naviculate to fusiform or ellipsoid, gently curved or straight, apex obtuse to subobtusely rounded, base truncate, eguttulate or guttulate, $11-14.5 \times 2-2.5 \mu m$, with a single, unbranched, flexuous, tubular appendage at each end, 5–6 µm log; basal appendage excentric.

Material examined: **UK**: Scotland, Newton Steward, Galloway Forestry Park, on dead culm of grass, July 2019, W.P. Wu (Wu16500). Living strain: 76,782 and 76,783 (from Wu16500).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Cuba (Crous et al. 2012).

Description and illustration: Crous et al. (2012).

Notes: Morphologically *D. pseudostrigosum* is similar to *D. strigosum*, but distinct in that it has larger conidia with longer appendages. The conidial setulae from the British collection are much shorter than those from the type specimen (Crous et al. 2012).

Dinemasporium sinense W.P. Wu, J.X. Duan & X.Z. Liu, Fungal Divers. 26: 215, 2007. Figure 250

Description on the natural substrate: Mycelium immersed, hyaline to brown, branched, septate. Teleomorph: Not observed. Anamorph: Conidiomata eustromatic, unilocular, superficial, scattered to aggregated, setose, black, cupulate to discoid, ellipsoid to spherical on the top view, 0.3-1.2 mm long and 200-500 µm wide; basal wall of textura angulari composed of brown, thick-walled, isodiametric cells which are hyaline and thin-walled on the upper layer; lateral wall of textura prismatica with thick-walled, brown to dark brown, elongated cells, well developed or very poor. Setae black, septate, simple, wall thick and smooth, straight, cylindrical and tapering towards the apex, apex acute or obtuse, $200-600 \times 5.5-8$ µm. Conidiophores hyaline, 1-septate, branched or unbranched, wall thin and smooth, cylindrical, $7-12 \times 1.2-2$ µm. Conidiogenous cells phialidic, discrete or integrated, hyaline, thin- and smooth-walled, cylindrical with a marked periclinal thickings around the sporulating channel, the collar in conspicuous, $5-12 \times 1.2-2$ µm. conidia hyaline, aseptate, naviculate, end rounded, curved or straight, wall smooth and thin, $6-11 \times 1.2-1.5$ µm, with one setula of 0.5–1.2 µm long.

Materials examined: **China**, Hebei Province, Chengde, on dead culms of unidentified grass, 12 September 1991, W.P. Wu (Wu525, holotype; Wu0552, Wu0521, Wu0551, Wu0553); Hebei Province, Chengde, Bishushanzhuang, on dead culms of unidentified grass, 11 Sept 2012, W.P. Wu (Wu15058); Hebei Province, Chengde, Bishushanzhuang, on dead culms of unidentified grass, 11 September 2012, W.P. Wu (Wu15059); Hebei Province, Chengde, Bishushanzhuang, on dead culms of unidentified grass, 11 September 2012, W.P. Wu (Wu15060). Living strains: 54,655 (from Wu15059), 54,677 (from Wu15058) and 54,678 (from Wu15060).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China (Duan et al. 2007).

Description and illustration: Duan et al. (2007).

Notes: *Dinemasporium sinensis* is characterized by fusiform conidia with very short appendages (< 1.5 μ m long) (Duan et al. 2007). Three strains were obtained from fresh specimens recently collected on the same host growing in the same locality as the holotype specimen. Except for smaller conidiomata, morphologically they are identical to the fungus from the type specimen. The ITS sequences of those 3 strains are identical and clearly different from other known species. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 54678 include *Dinemasporium americana* (GenBank MH864432, 96% identity), *D. pseudodecipens* (GenBank NR_155039, 96% identity).

Dinemasporium spinificis (Subhedar & V.G. Rao) R. Kirschner & Yu Hung Yeh, Sydowia 68:50, 2016.

≡ Stauronema spinificis Subhedar & V.G. Rao, J. Univ. Poona 48:65, 1976.

Geographical distribution: China (Yeh and Kirschner 2016) and India (Subhedar and Rao 1976).

Description and illustration: Subhedar and Rao (1976); Yeh & Kirschner (2016).

Notes: This is another *Stauronema* species which was transferred to *Dinemasporium*. Its occurrence in Taiwan, China was reported by Yeh and Kirschner (2016).

Dinemasporium strigosum (Pers.) Sacc., Michelia 2: 281, 1881.

 \equiv *Peziza strigosa* Pers.: Fr., Syst. Mycol. 2: 103, 1882.

= Dinemasporium graminum (Lib.) Lév., Ann. Sci. Nat., 3 Sér., 5: 274, 1846.

Other synonyms see Sutton (1980a, b) and Nag Raj (1993).



Fig. 250 *Dinemasporium sinense* (Wu15058). **a** Part of excipulum and setae. **b** Conidiophores and conidiogenous cells. **c-y** Conidia. Scale bar: **a** 10 μm, **b-y** 5 μm

Description on the natural substrate: Mycelium immersed, composed of septate, branched, smooth and brown hyphae. Teleomorph: Not observed. Anamorph: Conidiomata eustromatic, superficial, black, cupulate, ellipsoid to spherical in top view, 150–800 µm in diam; basal stroma of textura angularis composed of hyaline to brown, isodiametric cells; excipulum well-developed, lateral wall of lateral wall of textura prismatica to textura porrecta, formed by dark brown to blackish, thick-walled, longer cells in the outer layer and pale brown to hyaline, thin-walled cells in the inner layers, 90–130 µm high, up to 40 µm thick. Setae brown to black, simple, septate, cylindrical with an acute or obtuse apex, wall thick and smooth, 250-500 µm long, 7-12 µm wide at the base, arising from basal part of conidiomata or sometimes from lateral excipulum. Conidiophores hyaline, septate, branched, or unbranched, cylindrical, wall thin and smooth, up to 30 µm long, 1.5-2.5 µm wide. Conidiogenous cells phialidic, hyaline, cylindrical, apex with narrow channel and an inconspicuous collar, $7-10 \times 1.5-2$ µm. Conidia hyaline, aseptate, wall thin and smooth, naviculate to fusiform, curved or straight, ends rounded, eguttulate or guttulate, $8-10 \times 2-2.2 \,\mu\text{m}$, with a single, unbranched setulae at each end, 6-8 µm long.

Materials examined: UK: Scotland, Newton Steward, Galloway Forestry Park, on dead culm of grass, July 2019, W.P. Wu (Wu16501). Living strains: 76,770 and 76,771 (from Wu16501).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Belgium, Germany, Japan, Netherland, Portugal, South Africa, Sweden, UK and USA (Sutton, 1980a, b; Nag Raj, 1993; Crous et al. 2012).

Description and illustration: Webster (1955); Sutton (1980a, b); Nag Raj (1993); Crous et al. (2012); Hashimoto et al. (2015b); Li et al. (2020).

Notes: A full account of *Dinemasporium strigosum* complex was given by Webster (1955), Sutton and Hodges (1977) and Sutton (1980a; b) and Nag Raj (1993). A comparison between *D. strigosum* and some closely related species including *D. longicapillatum* was given by Yamaguchi et al. (2005). Among the many collections examined by us, only one specimen collected from UK is identified to be true *D. strigosum* as defined by Crous et al. (2012). Duan et al. (2007) recorded *D. strigosum* with many collections from different substrates, but no living strain was studied at that time. Those collections are most likely a mixture of several different species yet to be studied.

Dinemasporium suttonii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 251, MycoBank MB841664.

Etymology: Named after the former CMI mycologist Brian C. Sutton.

Typification: **China**, Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead leaves of bamboo, 16 October 2019, W.P. Wu, Holotype HMAS 3512002 (=Wu16993), ex-type strain CGMCC 3.20802 (=NN 77298).

Teleomorph: Unknown. Anamorph: Conidiomata stromatic, scattered or aggregated, superficial, dark brown to black, cupulate, unilocular, globose, 150-350 µm diam, setose with a central white conidial mass; basal stroma of textura angularis, composed of hyaline to pale brown, irregularly shaped cells, 2-4.5 µm diam; excipulum welldeveloped, lateral wall of lateral wall of textura prismatica to textura porrecta, formed by dark brown to blackish, thickwalled, longer cells in the outer layer and pale brown to hyaline, thin-walled cells in the inner layers, 120-150 µm high, up to 35 µm thick, apical cell not separated and with rounded or obtuse apex. Setae brown to black, simple, septate, subulate with acute apex, unbranched, smooth, thick-walled, septate, $350-500 \times 5-8 \mu m$, $2-3 \mu m$ wide at acute apex, arising from basal stroma or lateral from excipulum. Conidiophores lining the basal stroma, hyaline, septate, sparingly branched, cylindrical, thin-walled, smooth, 17-22×1.8-2.2 µm. Conidiogenous cells determinate, phialidic with periclinal thickening, hyaline, smooth, subcylindrical to lageniform, $6-11 \times 1.8-2.2 \mu m$. Conidia hyaline, aseptate, thin-walled, smooth, naviculate to fusiform or ellipsoid, gently curved or straight, apex obtuse to subobtusely rounded, base truncate, eguttulate, $9.5-13 \times 2-2.5 \mu m$, with a single, unbranched, flexuous, tubular appendage at each end, 7–9 µm; basal appendage excentric.

Culture characteristics: Colonies on PDA effuse, colonies 1.8–2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly grey to pale yellow in the center, reverse yellow to soil brown in the center and becoming paler towards the margins (Figs. 234i, j).

Other material examined: **China**, Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead leaves of bamboo, 16 October 2019, W.P. Wu (Wu16992). Living strain: 77,297 (from Wu16992).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Dinemasporium suttonii* also belongs to the *D. strigosum* group with naviculate to fusiform conidia and polar setulae (Sutton 1980a, b; Nag Raj 1993; Crous et al. 2012; Hashimoto et al. 2015a). Morphologically it can hardly be distinguished from other species, but its ITS sequence is significantly different from other species.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 77,298 include *Dinemasporium cruciferum* (GenBank AB900983, 91% identity), *D. decipiens* (GenBank JQ889275, 92% identity) and *D. parastrigosum* (GenBank MW114342, 91% identity).



Fig. 251 *Dinemasporium suttonii* (Wu16992, holotype). a Conidiomata. b, c Excipulum. d Setae. e-h, j-m Conidia. i Conidiophores and conidiogenous cells. Scale bar: a 100 µm, b, d 20 µm, c, e-m 10 µm

Fig. 252 Dinemasporium tubakii (Wu13446, holotype). a Conidiomata. b, c Setae. d–f Conidia. Scale bar: a 50 μm, b, c 10 μm, d–f 5 μm



Dinemasporium tubakii W.P. Wu & Y.Z. Diao, sp. nov., Figs. 252, MycoBank MB841665.

Etymology: Named after the mycologist Tubaki from Japan.

Diagnosis: Similar to *Dinemasporium longicapillatum* in conidial shape and size, but differs in shorter setulae and the unique ITS sequence.

Typification: **China**, Jiangsu Province, Zhenjiang, Jin Shan Park, on dead culm of grass 23 August 2015, W.P. Wu, Holotype HMAS 352,003 (=Wu13446), ex-type strain CGMCC 3.20798 (=NN71229). Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata stromatic, scattered or aggregated, superficial, dark brown to black, cupulate, unilocular, globose, up to 300 μ m diam, setose with a central buff conidial mass; basal stroma of textura angularis, layer 18–30 μ m thick. Setae brown to black, simple, septate, subulate with acute apex, unbranched, smooth, thick–walled, septate, 140–315×5–7 μ m, 1.5–2 μ m wide at acute apex, arising from basal stroma or lateral from excipulum. Conidiophores lining the basal stroma, hyaline, septate, sparingly branched, cylindrical, thin–walled,



Fig. 253 *Dinemasporium yongnianii* (Wu16535, holotype). a Conidiomata with setae. b Part of excipulum. c, d Part of excipulum with conidiophores and conidiogenous cells. e Conidiophores and conid-

iogenous cells bearing developing conidia. f-j Conidia. Scale bar: a 50 $\mu m,$ b-d 20 $\mu m,$ e-j 10 μm

smooth, $18-35 \times 1.5-2.5 \ \mu\text{m}$. Conidiogenous cells phialidic with periclinal thickening, hyaline, smooth, subcylindrical to lageniform, $10-14 \times 2-2.5 \ \mu\text{m}$. Conidia hyaline, aseptate, thin-walled, smooth, fusiform, gently curved, apex obtuse to subobtusely rounded, base truncate, eguttulate or guttulate, $8-10 \times 2-2.5 \ \mu\text{m}$, with a single, unbranched, flexuous, tubular appendage at each end, 7–10 μ m long; basal appendage excentric.

Other living strain: 71,228 (from Wu13446).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Known distribution: China.

Notes: Morphologically *D. tubakii* is similar to *D. lon-gicapillatum*, but differs in conidia with shorter setulae and different ITS sequence (Hashimoto et al. 2015a).

Dinemasporium yongnianii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 253, MycoBank MB841666.

Etymology: Named after the Chinese mycologist Prof. Yongnian Yu from Institute of Microbiology, The Chinese Academy of Science, Beijing.

Typification: **China**, Shan'Xi Province, Zhouzhi, Qinling mountain, on dead leaf, culm and seed of grass, 2 August 2019, W.P. Wu, Holotype HMAS 3,512,004 (=Wu16535), ex-type strain CGMCC 3.20734 (=NN76866).

Description on the natural substrate: Mycelium immersed, composed of septate, branched, smooth and brown hyphae. Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, black, cupulate, ellipsoid to spherical in top view, 150-400 µm in diam; basal stroma of textura angularis composed of hyaline to brown, isodiametric cells; lateral wall of textura prismatica to textura porrecta formed by brown, septate, thick-walled cells that are hyaline towards the inner layer, 250-290 µm high, 2-3 µm wide. Setae brown to black, simple, septate, cylindrical with an acute or obtuse apex, wall thick and smooth, $150-290 \times 10-12 \,\mu\text{m}$, tapering to 4-6 µm at the apex, arising from basal part of conidiomata or sometimes from lateral excipulum. Conidiophores hyaline, septate, branched, or unbranched, cylindrical, wall thin and smooth, up to 25 µm long, 1.5-3 µm wide. Conidiogenous cells phialidic, hyaline, cylindrical, apex with narrow channel and an inconspicuous collar, $12-15 \times 1.5-2$ µm. Conidia hyaline, aseptate, wall thin and smooth, naviculate, curved, ends rounded, eguttulate or guttulate, $9-12 \times 2-2.3 \,\mu\text{m}$, with a single, unbranched setulae at each end, 6–9 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1.5–2.0 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly yellow, reverse yellow to soil brown in the center and becoming paler towards the margins (Fig. 234k–n).

Other materials examined: **China**, Beijing, Yanqing, Changchengjiaoxia Gongshe, on dead culm of unidentified

grass, 4 November 2013, W.P. Wu (Wu15134, Wu15136); Beijing, Huairou, Beigou Village, on dead stem of unidentified herbaceous plant, 06 April 2012, W.P. Wu (Wu15093, Wu15094, Wu15097, Wu15106, Wu15107, Wu15108); Beijing, Huairou, Beigou Village, on dead stem of unidentified herbaceous plant, 06 April 2012, W.P. Wu (Wu15000); Beijing, Huairou, on dead leaves of Phragmitis sp., 20 July 2003, W.P. Wu (CXQ1); Beijing, Yanging, Songshan, on dead stem of unidentified plant, 06 August 2012, W.P. Wu (Wu15007); Hebei Province, Chengde, Bishushanzhuang, on dead culm of grass, 11 September 2012, W.P. Wu (Wu15051, Wu15053, Wu15054, Wu15061, Wu15063, Wu15075, Wu15076, Wu15064); Ningxia Province, Jingyuan County, Liupan Mountain, Linchang, on dead stems of grass, 23 August 1997, W.P. Wu (Wu1017); Shan'Xi Province, Zhouzhi, Qinling mountain, on dead leaf, culm and seed of grass, 2 August 2019, W.P. Wu (Wu16535, Wu16517, Wu16523, Wu16533, Wu16534, Wu16538, Wu16541); Shan'Xi, Zhouzhi, Qinling mountain, On dead leaf, culm and seed of grass, 22 August 2019, W.P. Wu (Wu16520); Shan'Xi, Zhouzhi, Qinling mountain, on dead culm of Arundo donax, 22 August 2019, W.P. Wu (Wu16531); Shan'Xi, Zhouzhi, Qinling mountain, on dead leaf and culm of grass, 22 August 2019, W.P. Wu (Wu16537, Wu16540); Shan'Xi, Zhouzhi, Qinling mountain, on dead culm of grass, 22 August 2019, W.P. Wu (Wu16539, Wu16543, Wu16544, Wu16545, Wu16548, Wu16549, Wu16557, Wu16558); Shan'Xi, Zhouzhi, Qinling mountain, on dead leaf of Phragmites australia, 22 August 2019, W.P. Wu (Wu16559); Shan'Xi, Zhouzhi, Qinling mountain, on dead branches of Lilium brownii var. viridulum, 22 August 2019, W.P. Wu (Wu6576); Shan'Xi, Zhouzhi, Qinling mountain, on dead leaf of Phragmites australias, 22 August 2019, W.P. Wu (Wu16562); other specimens no. Wu0501, 0502, 0503, 0505, 0506, 0507, 0508, 0509, 0510, 0511, 0513, 0514, 0518, 0519, 0520, 0527, 0530, 0532, 0538, 0539, 0543, 0545, 0548, 0550, 0554, 0557, HMAS33611(S), HMAS01437, HMAS06649, HMAS33255(S) and distributed in Beijing, Fujian, Hebei, Jiangsu, Liaoning, Shaanxi, Yunnan. Living strains: 54422 (from Wu15000), 54596 (from Wu15007), 54673 (from Wu15051), 54654 (from Wu15054), 54657 (from Wu15063), 54658 (from Wu15064), 54660 (from Wu15075), 54661 (from Wu15076), 54968 (from Wu15093), 54969 (from Wu15094), 54970 (from Wu15097), 54981 (from Wu15106), 54982 (from Wu15107), 54983 (from Wu15108), 76,828 (from 16,517), 76,861 (from Wu16523), 76,865 (from Wu16533), 76,893 (from Wu16534), 16,538 (from Wu16538), 76,867 (from Wu16541), 47,605 (from CQX1), 54656 (from Wu15061), 57,357 (from 15,134), 57,359 (from Wu15136), 76,791 (from Wu16520), 76,800 (from Wu16531), 76,803 (from Wu16537), 76,805 (from Wu16540), 76,806 (from Wu16543), 76,807 (from Wu16544), 76,808 and 77,129 (from Wu16545), 76,810 (from Wu16548), 76,811 (from Wu16549), 76,813 (from Wu16557), 76,814 (from Wu16558), 76,815 (from Wu16559), 76,820 (from Wu16576), 76,816, 76,817 and 76,869 (from Wu16562) and 76,804 (from Wu16539).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Dinemasporium strigosum has been known to be a species complex which can only be separated by minor difference on conidial morphology (shape, size, length of setulae), but can be clearly identified by the ITS sequences, as demonstrated by Yamaguchi et al. (2005), Crous et al. (2012), Hashimoto et al. (2015a) and this study. Among the studied specimens and strains from China, a large number of them represent a morphologically similar species to D. strigosum species complex, but differ from them by ITS sequences. Here we name them as a new species D. yongnianii. Morphologically D. yongnianii is very similar to D. americanum, D. morbidum, D. pseudostrigosum and D. strigosum (Nag Raj and Castañeda-Ruiz 1989; Crous et al. 2012; Hashimoto et al. 2015a). Among the many collections studied, most specimens belong to D. yongnianii, while only one strain collected from UK is a true D. strigosum as defined by Crous et al. (2012).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 53,378 include *Dinemasporium cruciferum* (GenBank AB900893, 95% identity), *D. morbidum* (GenBank NR_137788, 98% identity), *D. parastrigosum* (GenBank MW114342, 94% identity) and *D. strigosum* (GenBank NR_121540, 93% identity).

Brunneodinemasporium Crous & R.F. Castañeda, Persoonia 28: 128, 2012.

Teleomorph: Unknown. Anamorph: Conidiomata stromatic, scattered or aggregated, superficial, dark brown to black, cupulate, unilocular, globose, setose; basal stroma of textura angularis. Setae abundant, brown to black, simple, septate, subulate to cylindrical, unbranched, smooth, thickwalled, multi-septate, arising randomly throughout basal stroma. Conidiophores lining the basal stroma in a dense layer, brown, septate, unbranched, cylindrical, thin-walled, smooth. Conidiogenous cells integrated, phialidic with conspicuous periclinal thickening at an attenuated apex, brown, smooth, subcylindrical to lageniform. Conidia hyaline to pale brown, aseptate, thin-walled, smooth, fusiform, gently curved or straight, apex obtuse to subobtusely rounded, base truncate, eguttulate or guttulate, with a single, cellular, unbranched, flexuous, with tubular appendage at each end, separated by a septum, or with without tubular appendage but with mucilaginous droplet at both end (Adapted from Crous et al. 2012; Lu et al. 2016).

Type species. *Brunneodinemasporium brasiliense* Crous & R.F. Castañeda.

Ecology/Substrate/Host: Saprobe on dead material of plant, especially on leaves and culm of various grasses and bamboo, but also found on rotten wood.

Geographical distribution: Brazil, China.

Description and illustration: Crous et al. (2012).

The genus *Brunneodinemasporium* was introduced by Crous et al. (2012) to accommodate a *Dinemasporium*–like species with randomly distributed setae throughout the basal stroma, tightly aggregated brown conidiogenous cells and pale brown conidia, which differs from *Dinemasporium*. Except for the type species *B. brasiliense*, the second species *B. jonesii*, was added into the genus from China (Lu et al. 2016). On the phylogenetic tree generated by using the combined ITS and LSU sequence data (Fig. 3), all *Brunneodinemasporium* species are clustered together, aligned with other report (Li et al. 2020).

Key to accepted species of Brunneodinemasporium.

Brunneodinemasporium jonesii Y.Z. Lu, J.K. Liu & K.D. Hyde, Mycosphere 7: 1326, 2016.

Typification: **China**, Guangxi Province, Fang Cheng Gang, on decaying wood in a freshwater stream, 15 May 2016, Yong-Zhong Lu, JHC17–1 (GZAAS 16–0062, holo-type); ex-type living culture, GZCC 16–0050.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China (Lu et al. 2016).

Description and illustration: Lu et al. (2016).

Notes: *Brunneodinemasporium jonesii* was described as a novel species based on morphological distinctions and phylogenetic analysis for the fungus collected from China (Lu et al. 2016). Morphologically, *B. jonesii* and *B. brasiliense* are similar in conidiophores and setae, but they differ from each other by shape of conidia and form of appendages. *Brunneodinemasporium brasiliense* have a single, unbranched, flexuous, tubular appendage at each end, but *B. jonesii* lacks this feature and instead, the conidia are connected by mucilaginous balls (Crous et al. 2012; Lu et al. 2016).

Brunneodinemasporium sinense W.P. Wu & Y.Z. Diao, sp. nov., Fig. 254, MycoBank MB841667.



Fig. 254 *Brunneodinemasporium sinense* (Wu13294, Holotype). **a–c** Conidiomata with setae. **d** Excipulum and setae. **e–h** Conidiophores and conidiogenous cells with narrow sporulating loci and inconspicuous collarettes. **i–r** Coniai. Scale bar: **a–c** 100 μm, **d** 20 μm, **e–r** 5 μm

Etymology: refers to the locality where this fungus was discovered.

Typification: **China**, Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of *Cyclobalanopsis glauca*, 12 June 2015, W.P. Wu, Holotype HMAS 351963 (= Wu13294a), ex-type strain CGMCC 3.20659 (= NN58989, = NN58990).

Description on the natural substrate: Mycelium immersed, composed of pale brown, branched, smooth, septate hyphae. Teleomorph: Unknown. Anamorph: Conidiomata sporodochia, scattered, punctiform, pulvinate, dark brown to black, setose, up to 1000 µm in diam. Setae sterile, arising from the lower cells of the stroma, subulate, acutely pointed, mid to dark brown, becoming paler towards the apex, smooth, simple, erect, straight or slightly curved, 5–10-septate, $450-1000 \times 8-13 \mu m$, acute at apex. Conidiophores macronematous, formed a close palisade over the surface of the stroma, straight or flexuous, pale brown to brown, becoming subhyaline towards the apex, smooth, 1-4-septate, $150-180 \times 2.5-3.5 \,\mu$ m. Conidiogenous cells integrated, terminal or discrete, monophialidic, cylindrical, lageniform, $13-16 \times 2.5-3$ µm, with a very small apical collarette. Conidia holoblastic, solitary, hyaline, aseptate, curved, fusiform, apex acute, base slightly truncate, $20-23 \times 2-2.5 \mu m$, furnished with a setula at each end, $6-7 \mu m \log$.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.4 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, yellow brown, reverse soil brown in the center and becoming paler towards the margins, with purple colored pigment diffused into agar (Figs. 236a–d).

Other material examined: **China**, Zhejiang Province, Hangzhou, Hangzhou Botanical Garden, on dead leaves of *Cyclobalanopsis glauca*, 12 June 2015, W.P. Wu (Wu13295). Living strains: 58990 (from 13294b) and 59053 (from Wu13295).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Brunneodinemasporium sinense* resembles *B. brasiliense* (18–19×2.5–3 μ m), but differs in producing smaller conidia in the latter species (Crous et al. 2012).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 58989 include *Brunneod-inemasporium brasiliense* (GenBank NR_137785, 95% identity) and *Brunneodinemasporium jonesii* (GenBank NR_66384, 94% identity).

Pseudodinemasporium A. Hashim. & Kaz. Tanaka, Mycology 107: 390, 2015.

Teleomorph: Unknown. Anamorph: Conidiomata stromatic, acervular, cupulate, setose, mostly scattered to grouped, superficial, globose, or ellipsoid, dark brown to black; basal stroma well developed, composed of subglobose cells; excipulum composed of rectangular or subglobose, brown cells. Setae arising from excipulum, curved, septate, brown but pale at the apex, smooth, unbranched, thick-walled; inconspicuous setae pale brown, multiseptate. Conidiophores lining the basal stroma, cylindrical, septate, smooth, hyaline, simple or branched. Conidiogenous cells phialidic, cylindrical, hyaline, smooth. Conidia ovoid to ellipsoidal, obtuse at the apex, slightly truncate at the base, unicellular, hyaline, smooth, guttulate, bearing an appendage at each end (Adapted from Hashimoto et al. 2015a).

Type species. *Pseudodinemasporium fabiforme* A. Hashim., G. Sato & Kaz. Tanaka.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Japan.

Description and illustration: Hashimoto et al. (2015a).

Notes: The genus Pseudodinemasporium was established to include P. fabiforme, a Dinemasporium-like species. Three genera including Brunneodinemasporium, Dendrophoma Sacc. and Dinemasporium resemble Pseudodinemasporium on setose conidiomata and one-celled conidia with a single appendage at each end. Among these genera, Dendrophoma is phylogenetically close to Pseudodinemasporium, but differs from the latter in that it has conidiomata with a stipe-like basal excipulum composed of dense textura intricata (Crous et al. 2012; Hashimoto et al. 2015a, b). Brunneodinemasporium is characterized by a densely aggregated layer of brown conidiogenous cells, hyaline to pale brown conidia, and the conidial appendage is apparently separated from the conidial body by a septum (Crous et al. 2012); these features are absent in *Pseudodinemasporium*. Dinemasporium has conidiomata with a poorly developed lateral excipulum (Hashimoto et al. 2015a, b), unlike Pseudodinemasporium, which has relatively large conidiomata with a well-developed peridial wall. The genus has not been reported from China and here we described two new species. These three accepted species in the genus are morphologically difficult to be distinguished from each other, but their ITS sequences are with low identify.

Pseudodinemasporium elegans W.P. Wu & Y.Z. Diao, sp. nov., Fig. 255, MycoBank MB841668.

Etymology: *elegans* (L), beautiful, refers to its conidiomata and conidia.

Typification: **China**, Guangdong Province, Shaoguan, Danxiashan, on dead branches of unidentified tree, 25 December 2012, W.P. Wu, Holotype HMAS 352,041 (=Wu12464), ex-type strain CGMCC 3.20655 (=NN55372).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, scattered or aggregated, blackish, closed, becoming



Fig. 255 *Pseudodinemasporium elegans* (Wu12464, holotype). **a** Conidiomata with setae. **b**, **c** Not well-developed excipulum with setae. **d**, **e** Conidiophores and conidiogenous cells. **f–n** Conidia. Scale bar: **a** 50 μ m, **b–n** 5 μ m

cupulate, up to 350 µm diam.; basal wall of textura angulari composed of brown, thick-walled cells but the inner layer tend to be hyaline, thin-walled, lateral wall of textura porrecta composed of brown, thick-walled, long, septate, branched hyphae, inner layer pale brown to hyaline, thinwalled. Setae arising from outside layer of lateral wall, dark brown to black, erect, tapering towards the apex, acute, wall thick and smooth, arising from lateral wall, septate, 210–300 μ m long, 4–8 μ m wide at the base, 2–3 μ m at the apex. Conidiophores pale brown at the base, becoming hyaline towards the apex, 1–3-septate, branched, or unbranched, cylindrical, formed by the inner layer of both base and lateral walls, $23-30 \times 1.5-2.5$ µm. Conidiogenous cells phialidic, terminal, hyaline, cylindrical, straight, wall thin and smooth, $10-13 \times 1-0.5$ µm. Conidia hyaline, aseptate, naviculate to botuliform, wall thin and smooth, $3-4(-5) \times 1-1.5 \mu m$, bearing an unbranched cellular appendage at each end, 1-2 µm long.

Colonies on PDA effuse, colonies 0.8–1.0 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium welldeveloped, white, slightly grey to pale brown in the center, reverse brown in the center and becoming paler towards the margins (Figs. 236i, j).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Pseudodinemasporium elegans* differs from *P. fabiforme* (conidia reniform, ovoid to ellipsoidal, $3-5 \times 1-2.5 \mu m$; appendage $0.5-1.5 \mu m$ long) by broader conidia and shorter appendages in the latter species (Hashimoto et al. 2015a). Morphologically it is also very similar to *Brunneodinemasporium brasiliense* and *Dinemasporium neottiosporoides* but can be distinguished by conidial morphology and ITS sequence (Agnihothrudu 1962a, b; Sutton 1965, 1969, 1980a, b; Nag Raj 1993; Duan et al. 2007; Crous et al. 2012).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 55372 include *Pseudodinemasporium fabiforme* (GenBank NR_154275, 96% identity)), *Neopseudolachnella magnispora* (GenBank NR_154224, 91% identity), *N. acitospora* (GenBank NR_154223, 90% identity)), *N. uniseptata* (GenBank NR_154225, 90% identity) and *Pseudolachnea hispidula* (GenBank MN700937, 90% identity).

Pseudodinemasporium minimum W.P. Wu & Y.Z. Diao, sp. nov., Fig. 256, MycoBank MB841669.

Etymology: Refers to its small conidia.

Typification: **China**, Guangxi Province, Damingshan, on dead leaves of ?*Cinnamomum* sp., 18 December 1997, W.P. Wu, Holotype HMAS 352,042 (=Wu1382I), ex-type strain CGMCC 3.20702 (=NN43192).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, scattered or aggregated, blackish, closed, becoming cupulate, up to 300 µm diam.; basal wall of textura angulari composed of brown, thick-walled cells but the inner layer tend to be hyaline, thin-walled, lateral wall of textura porrecta composed of brown, thick-walled, long, septate, branched hyphae, inner layer pale brown to hyaline, thinwalled. Setae dark brown to black, erect, tapering towards the apex, acute, wall thick and smooth, arising from lateral wall, up to 7-septate, 130-250 µm long, 4-8 µm wide at the base, $2-3.2 \mu m$ at the apex. Conidiophores pale brown at the base, becoming hyaline towards the apex, 1-3-septate, branched, or unbranched, cylindrical, formed by the inner layer of both base and lateral walls, up to 15 µm long, 1.5-2.5 µm wide. Conidiogenous cells phialidic, hyaline, cylindrical, straight, wall thin and smooth, $4-5 \times 1.5-2 \mu m$. Conidia hyaline, aseptate, naviculate to botuliform, wall thin and smooth, guttulate, $2.7-3.8 \times 1-1.5 \mu m$, bearing an unbranched cellular appendage at each end, 1-1.5 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 0.7–1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey, reverse pale brown in the center and becoming paler towards the margins (Figs. 236k, 1).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Pseudodinemasporium minimum* is morphologically very similar to *P. elegans* (conidia naviculate to botuliform, 3-4 (-5)×1-1.5 µm, setulae 1-2 µm long) and *P. fabiforme* (conidia reniform, ovoid to ellipsoidal, $3-5\times1-2.5$ µm; appendage 0.5-1.5 µm long), but differs from the latter by producing thinner conidia and longer setulae (Hashimoto et al. 2015a, b). It is also similar to *Brunneodinemasporium brasiliense* and *Dinemasporium neottiosporoides*, but differs by longer conidia in these two species (Agnihothrudu 1962a, b; Sutton 1965, 1969, 1980b; Nag Raj 1993; Duan et al. 2007; Crous et al. 2012).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 43192 include *Neopseudolach-nella magnispora* (GenBank NR_154224, 90% identity), *N. acitospora* (GenBank NR_154223, 89% identity), *N. uniseptata* (GenBank NR_154225, 89% identity) and *Pseudodine-masporium fabiforme* (GenBank NR_154275, 96% identity).

Neopseudolachnella A. Hashim. & Kaz. Tanaka, Mycology 107: 385, 2015.

Teleomorph: Unknown. Anamorph: Conidiomata stromatic, acervuloid, mostly scattered, superficial, ellipsoid, dark brown to black, setose; basal stroma composed of globose to subglobose cells; excipulum absent. Setae marginal or interspersed, arising from basal stroma, straight to



Fig. 256 Pseudodinemasporium minimum (Wu1382i, holotype). a, b Pat of excipulum. c-g Conidia. Scale bar: 5 µm

slightly curved, septate, brown but pale at the apex, smooth, unbranched, thick–walled. Conidiophores absent or lining the basal stroma, cylindrical, smooth, hyaline, or pale brown, simple. Conidiogenous cells cylindrical to lageniform, smooth, hyaline, or pale brown. Conidia cylindrical to subcylindrical, acute or obtuse at the apex, truncate at the base, septate, smooth, hyaline, bearing a single to multiple appendages at each end; apical appendage central; basal appendage excentric (Adapted from Hashimoto et al. 2015b).

Type species: *Neopseudolachnella acutispora* A. Hashim., Sat. Hatak. & Kaz. Tanaka.

Ecology/Substrate/Host: Saprobe on dead material of bamboo.

Geographical distribution: China and Japan.

Description and illustration: Hashimoto et al. (2015b).

Notes: The genus *Neopseudolachnella* was established to accommodate three *Pseudolachnella*-like fungal species, *N. acutispora*, *N. magnispora* and *N. uniseptata*, which formed a fully supported phylogenetic clade and is distantly related to other lineages of known genera in the phylogenetic tree (Hashimoto et al. 2015b). *Neopseudolachnella* is mostly similar to *Pseudolachnea* and *Pseudolachnella* in producing hyaline, cylindrical, uni- to multi-septate, conidia with bipolar appendages. It is also clearly separated from the latter two genera by the acervuloid conidiomata lacking a peridial wall compared with the acervular conidiomata with a prominent lateral excipulum present in *Pseudolachnea* and *Pseudolachnella* (Hashimoto et al. 2015b). The flattened setose conidiomata of *Neopseudolachnella* superficially resemble those present in *Rattania*, but *Rattania* has sporodochial conidiomata and holoblastic conidiogenous cells sometimes extending sympodially (Prabhugaonkar and Bhat 2009; Bhat 2010). Under the genus Neopseudolachnella, two new species were discovered from China and are described in this paper. An identification key for all Pseudolachnea, Pseudolachnella and related fungi is provided as well.

Key to species of Calvolachnella, Neopseudolachnella (N.), Pseudolachnea (P.) and Pseudolachnella (Ps.)

1.	Conidiomata without setae; conidia septate, pale brown, with 1 setulae at each end
1.	Conidiomata with setae: conidia hvaline
2.	Conidiomata eustromatic, without lateral excipulum (<i>Neonseudolachnella</i>)
2.	Conidiomata cupulate, with lateral excipulum
3	Conidia fusiform to allantoid $0-1$ -sentate 4
3.	Conidia cylindrical, with more than 3 septa
4.	Conidia aseptate, $9.4-12.5 \times 1.8-2 \ \mu\text{m}$; setulae $2-4 \ \mu\text{m}$ in length <i>N. moganshanensis</i>
4.	Conidia 1-septate
5.	Conidia 10.5–19.5×1.5–2.5 µmN. uniseptata
5.	Conidia $11-12 \times 2-2.5 \ \mu\text{m}$; setulae $3-5 \ \mu\text{m}$ in length N microsperma
6.	Conidia subcylindrical to fusiform, apex acute, $3-6$ septate, $19-40 \times 2-3$ µm,, <i>N. acutispora</i>
6.	Conidia cylindrical to subcylindrical, $3-7$ septate, $35-62 \times 2-3$ µm N magnispora
7.	Conidia 1-septate (<i>Pseudolachnea</i>)
7	Conidia with 3 or more septa (<i>Pseudolachnella</i>) 10
8.	Macroconidia 1-septate, setulae; microconidia aseptate
8	Only macroconidia produced <i>P hispidula</i>
9. 9	Conidia $17-30 \times 2-3$ µm: setulae 4 5-6 µm in
	length
10.	Conidial with more than 1 branched or unbranched setulae at each end
10.	Conidial with only one unbranched setulae at each
	end16
11.	Conidia 3-septate, fusiform to oval, $15-20 \times 4-6.5 \mu m$; bearing 2-4 branched or unbranched setulae at each and 2.5 11 um in length
11.	Conidia 4–11-septate, cylindrical to subcylindrical
12.	Conidia 4–7-septate, < 50 µm long13
12.	Conidia 7–11-septate, $> 50 \mu\text{m}$ in length
13.	Conidia $(5-)$ 7-septate, $22-28 \times 3.5-7 \mu m$, with 1-2
	apical and 3–6 basal unbranched setulae
13.	Conidia 4–6-septate, 30–40 µm in length14

 Conidia bearing 2–5 unbranched setulae at each end, 1–4 µm in length		
 Conidia bearing 1 basal unbranched and 2–3 apical dichotomously branched setulae, 3–6 μm in length	14.	Conidia bearing 2–5 unbranched setulae at each end, 1–4 um in length Ps. vakushimensis
length. <i>Ps. ryukyuensis</i> 15.Conidia 7-11-septate, 70-110×2.5-3 μm, bearing a single branched or unbranched basal setulae and 2-4 dichotomously branched apical setulae, 7-11 µm in length at the apex, 5-8 µm in length at the base.15.Conidia 7-10-septate, 62-90×2-3 µm, bearing 2-3 unbranched or branched setulae at each end, 5-15.5 µm in length at the apex, 2-5.5 µm at the base.16.Conidia subcylindrical, slightly curved, 3-septate.17.Conidia subcylindrical, slightly curved, 3-septate.18.Conidia 35 µm in length.19.Conidia 235 µm in length.19.Conidia 28-35×1.5-2.2 µm; setulae 2-4 µm in 	14.	Conidia bearing 1 basal unbranched and 2–3 api- cal dichotomously branched setulae, $3-6 \ \mu m$ in
15. Condula 7-11-septate, 76-110 × 2.5-5 µm, bearinga single branched or unbranched basal setulae and 2-4dichotomously branched apical setulae, 7-11 µm inlength at the apex, 5-8 µm in length at the base	15	lengthPs. ryukyuensis
length at the apex, $3-8 \ \mu m$ in length at the base	13.	conduct 7–11-septate, 70–110 x 2.5–5 µm, bearing a single branched or unbranched basal setulae and 2–4 dichotomously branched apical setulae, 7–11 µm in
15.Conidia 7–10-septate, $62-90 \times 2-3$ µm, bearing 2–3 unbranched or branched setulae at each end, 5–15.5 µm in length at the apex, 2–5.5 µm at the base		length at the apex, $5-8 \ \mu\text{m}$ in length at the base
2-3 unbranched or branched setulae at each end, 5-15.5 µm in length at the apex, 2-5.5 µm at the base	15.	Conidia 7–10-septate, $62-90 \times 2-3 \mu m$, bearing
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16.Conidia subcylindrical, signity curved, 5-septate1716.Conidia more than 3-septate17.Conidia $<35 \ \mu m$ in length	16	basePs. brevicoronata
10.Conidia $<35 \ \mu m$ in length.1817.Conidia $>35 \ \mu m$ in length.1918.Conidia $19-25 \times 1.5-2.5 \ \mu m$; setulae $2-4 \ \mu m$ in19.Conidia $28-35 \times 1.5-2 \ \mu m$; setulae $2-4 \ \mu m$ in19.Conidia $38-56 \times 2.5-3 \ \mu m$; setulae $2-3 \ \mu m$ in19.Conidia $28-44 \times 2-3 \ \mu m$; setulae $2-4 \ \mu m$ in19.Conidia $28-44 \times 2-3 \ \mu m$; setulae $2-4 \ \mu m$ in19.Conidia $7-17$ -septate, $45-83 \times 2.5-3.5 \ \mu m$; apical10.Conidia $7-17$ -septate, $45-83 \times 2.5-3.5 \ \mu m$; apical11.setulae $10-47 \ \mu m$ in length, basal setulae $8-22 \ \mu m$ in12.Conidia $5-7$ -septate; setulae $<10 \ \mu m$ in length.21.Conidia $5-7$ -septate; setulae $<10 \ \mu m$ in length.22.Conidia fusiform to allantoid, $(3-)7$ -septate, $26-40 \times 2-3 \ \mu m$; setulae $1-2 \ \mu m$ in length.22.Conidia bearing setulae longer than $2 \ \mu m$.23.Conidia $3-7 \ \mu m$ wide, fusiform to allantoid .24.Conidia $30-44 \times 2.5-3 \ \mu m$; setulae $2.5-7 \ \mu m$ in24.Conidia $30-44 \times 2.5-3 \ \mu m$; setulae $2.5-7 \ \mu m$ in25.Conidia $38-57 \times 2-2.5 \ \mu m$; setulae $2.5-7 \ \mu m$ in26.Conidia $38-57 \times 2-2.5 \ \mu m$; setulae $2-3 \ \mu m$; setulae $4.8 \ 6.5 \ \mu m$ in length.25.Conidia $(6-)7$ -septate, $35-45 \times 3.2-5 \ \mu m$; setulae $4.8 \ 6.5 \ \mu m$ in length.26.Conidia $3-5 \ \mu m$ wide.27.Conidia $(6-)7$ -septate, $22-35 \times 4-6 \ \mu m$, setulae $2-8 \ \mu m$ 28.Conidia $(6-)7$ -septate, $22-35 \times 3-5 \ \mu m$; setulae $2-8 \ \mu m$ 29.Conidia $(6-)7$ -se	10. 16	Conidia subcylindrical, slightly curved, 3-septate1/
 Conidia > 35 µm in length	10.	Conidia < 35 um in length
 Conidia 19–25×1.5–2.5 μm; setulae 2–4 μm in length	17.	Conidia > 35 µm in length
length.Ps. minima18.Conidia 28-35 × 1.5-2 μm; setulae 4-6 μm in19.Conidia 38-56 × 2.5-3 μm; setulae 2-3 μm in19.Conidia 28-44 × 2-3 μm, 3-septate; setulae 2-4 μm in19.Conidia 28-44 × 2-3 μm, 3-septate; setulae 2-4 μm in19.Conidia 7-17-septate, 45-83 × 2.5-3.5 μm; apicalsetulae 10-47 μm in length, basal setulae 8-22 μm in19.Conidia 5-7-septate; setulae <10 μm in length.	18.	Conidia $19-25 \times 1.5-2.5$ µm; setulae 2-4 µm in
 Conidia 28–35 × 1.5–2 μm; setulae 4–6 μm in length		lengthPs. minima
19.Conidia $38-56 \times 2.5-3$ μm; setulae $2-3$ μm in length	18.	Conidia $28-35 \times 1.5-2$ µm; setulae $4-6$ µm in length
lengthPs. scolecospora19.Conidia 28–44 × 2–3 μm, 3-septate; setulae 2–4 μm in length20.Conidia 7–17-septate, 45–83 × 2.5–3.5 μm; apical setulae 10–47 μm in length, basal setulae 8–22 μm in length20.Conidia 5–7-septate; setulae < 10 μm in length	19.	Conidia $38-56 \times 2.5-3 \ \mu\text{m}$; setulae 2-3 $\ \mu\text{m}$ in
 Conidia 28–44×2–3 μm, 3-septate; setulae 2–4 μm in length		lengthPs. scolecospora
 20. Conidia 7–17-septate, 45–83×2.5–3.5 μm; apical setulae 10–47 μm in length, basal setulae 8–22 μm in length<i>Ps. longicilicia</i> 20. Conidia 5–7-septate; setulae < 10 μm in length21 21. Conidia 5-septate<i>Ps. antillana</i> 21. Conidia fusiform to allantoid, (3–)7-septate, 26–40× 2–3 μm; setulae 1–2 μm in length<i>Ps. complanata</i> 22. Conidia bearing setulae longer than 2 μm23 23. Conidia 2–3 μm wide, subcylindrical to fusiform	19.	Conidia 28–44 × 2–3 μ m, 3-septate; setulae 2–4 μ m in
20. Conidia 7–17-septate, 43–83 × 2.5–5.5 µmi, aprear setulae 10–47 µm in length, basal setulae 8–22 µm in length <i>Ps. longicilicia</i> 20. Conidia 5–7-septate; setulae < 10 µm in length21 21. Conidia usually 7-septate <i>Ps. antillana</i> 21. Conidia fusiform to allantoid, (3–)7-septate, 26–40× 2–3 µm; setulae 1–2 µm in length 22. Conidia bearing setulae longer than 2 µm23 23. Conidia 2–3 µm wide, subcylindrical to fusiform 24. Conidia 30–44 × 2.5–3 µm; setulae 2.5–7 µm in length	20	Conidio 7, 17 contato 45, 82 × 2,5, 2,5 vm conicol
length	20.	condua $7-17$ -septate, $43-85 \times 2.5-5.5 \text{ µm}$; apreal setulae $10-47 \text{ µm}$ in length basal setulae $8-22 \text{ µm}$ in
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21.Conidia 5-septate.Ps. antillana21.Conidia usually 7-septate.2222.Conidia fusiform to allantoid, (3–)7-septate, 26–40 ×2–3 μ m; setulae 1–2 μ m in length23.Conidia bearing setulae longer than 2 μ m23.Conidia 2–3 μ m wide, subcylindrical to fusiform24.Conidia 30–44 × 2.5–3 μ m; setulae 2.5–7 μ m in24.Conidia 38–57 × 2–2.5 μ m; setulae 2–3 μ m in length.25.Conidia (6–)7-septate, 35–45 × 3.2–5 μ m; setulae 4.8–6.5 μ m in length.26.Conidia 5–7-septate, 22–35 × 4–6 μ m, setulae 2–8 μ m27.Conidia 3–5 μ m wide27.Conidia 3–5 μ m wide27.Conidia 3–5 μ m wide27.Conidia 6–)7-septate, 20.5–34 × 3–5 μ m; setulae28.Mm in length.29.September 20.5–34 × 3–5 μ m; setulae29.September 20.5–34 × 3–5 μ m20.Conidia (6–)7-septate, 20.5–34 × 3–5 μ m; setulae27.Conidia (6–)7-septate, 25–35 × 3–5 μ m; setulae29.Mm in length.29.Septate, 25–35 × 3–5 μ m; setulae	20.	Conidia 5–7-septate; setulae < 10 μ m in length21
21. Conidia usually 7-septate.2222. Conidia fusiform to allantoid, (3–)7-septate, 26–40 ×2–3 μm; setulae 1–2 μm in length.23. Conidia bearing setulae longer than 2 μm23. Conidia 2–3 μm wide, subcylindrical to fusiform24. Conidia 3–7 μm wide, fusiform to allantoid25. Conidia 30–44 × 2.5–3 μm; setulae 2.5–7 μm in24. Conidia 38–57 × 2–2.5 μm; setulae 2–3 μm in length.25. Conidia (6–)7-septate, 35–45 × 3.2–5 μm; setulae 4.8–6.5 μm in length.26. Conidia 5–7 -septate, 22–35 × 4–6 μm, setulae 2–8 μm27. Conidia 3–5 μm wide26. Conidia 3–5 μm wide27. Conidia 3–5 μm wide27. Conidia (6–)7-septate, 20.5–34 × 3–5 μm; setulae28. μm in length.29. Conidia 3–5 μm wide20. Conidia 4–9 μm21. Conidia (6–)7-septate, 25–35×3–5 μm; setulae 4–9 μm22. Conidia (6–)7-septate, 25–35×3–5 μm; setulae 4–9 μm	21.	Conidia 5-septatePs. antillana
 Conidia fusiform to allantoid, (3–)7-septate, 26–40× 2–3 μm; setulae 1–2 μm in length <i>Ps. complanata</i> Conidia bearing setulae longer than 2 μm23 Conidia 2–3 μm wide, subcylindrical to fusiform	21.	Conidia usually 7-septate
2-3 µm; seturae 1-2 µm in rength Ps. complanata 22. Conidia bearing setulae longer than 2 µm23 23. Conidia 2-3 µm wide, subcylindrical to fusiform 24. 23. Conidia 30-44 × 2.5-3 µm; setulae 2.5-7 µm in length	22.	Conidia fusiform to allantoid, $(3-)7$ -septate, $26-40 \times$
 Conidia bearing setulae longer than 2 μm		$2-3 \mu \text{m}$; seturae $1-2 \mu \text{m}$ in rengin Ps complanata
23. Conidia 2–3 µm wide, subcylindrical to fusiform	22.	Conidia bearing setulae longer than 2 um23
23. Conidia 3–7 µm wide, fusiform to allantoid	23.	Conidia 2–3 µm wide, subcylindrical to fusiform
 Conidia 3–7 μm wide, fusiform to allantoid		
 24. Conidia 30–44 × 2.5–3 μm; setulae 2.5–7 μm in length	23.	Conidia 3–7 µm wide, fusiform to allantoid 25
length	24.	Conidia $30-44 \times 2.5-3 \ \mu\text{m}$; setulae 2.5-7 $\ \mu\text{m}$ in
 24. Conidia 38–57 × 2–2.5 μm; setulae 2–3 μm in length 	24	lengthPs. pachyderma
25. Conidia (6–)7-septate, $35-45 \times 3.2-5 \mu m$; setulae 4.8– 6.5 µm in length	24.	Conidia $38-57 \times 2-2.5 \mu\text{m}$; setulae $2-3 \mu\text{m}$ in length
 6.5 μm in length	25.	Conidia (6–)7-septate. $35-45 \times 3.2-5$ um: setulae 4.8–
 Conidia < 35 μm in length		6.5 μm in lengthPs. tengii
 Conidia 5–7-septate, 22–35×4–6 μm, setulae 2–8 μm in lengthPs. botulispora Conidia 3–5 μm wide27 Conidia (6–)7-septate, 20.5–34×3–5 μm; setulae 3–8 μm in lengthPs. asymmetrica Conidia (6–)7-septate, 25–35×3–5 μm; setulae 4–9 μm in lengthPs. ampylospora 	25.	Conidia $< 35 \mu\text{m}$ in length26
 in lengthPs. botulispora 26. Conidia 3–5 μm wide27 27. Conidia (6–)7-septate, 20.5–34×3–5 μm; setulae 3–8 μm in lengthPs. asymmetrica 27. Conidia (6–)7-septate, 25–35×3–5 μm; setulae 4–9 μm in lengthPs. ampylospora 	26.	Conidia 5–7-septate, $22-35 \times 4-6 \mu m$, setulae 2–8 μm
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 27. Conidia (6–)7-septate, 25–35×3–5 μm; setulae 4–9 μm in length	21.	Contaita $(0-)/-$ septate, 20.3-34 × 3-5 µm; setulae
in lengthPs. ampylospora	27	Conidia (6_)7-septate 25_35 × 3_5 um setulae 4_9 um
		in lengthPs. ampylospora



Fig.257 Neopseudolachnella microsperma (a-g, i-r Wu15057, holotype; h Wu16980). a Conidiomata. b Setae. c-f Conidiophores and conidiogenous cells. g Part of conidiomata showing origin of

setae and conidiophores. **h** Basal stroma from which setae and conidiophores are formed. **i–r** Conidia. Scale bar: **a** 40 μ m, **b** 20 μ m, **g** 10 μ m, **c–f**, **h–r** 5 μ m

Neopseudolachnella microsperma W.P. Wu & Y.Z. Diao, sp. nov., Fig. 257, MycoBank MB841670.

Etymology: Refers to its small conidia.

Typification: **China** Hebei Province, Chengde, Bishushanzhuang, on dead culm of unidentified grass, 11 September 2012, W.P. Wu, Holotype HMAS 352,028 (= Wu15057), extype strain CGMCC 3.20649 (= NN54767).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata stromatic, acervuloid, mostly scattered or sometimes 2-3 grouped, superficial to subcuticular, ellipsoid or irregular, 200-400 µm in length, 150–300 µm wide, up to 500 µm high, dark brown to black, with white conidial mass in center, setose; basal stroma 10-15 mm thick, composed of globose to subglobose, 2.5–4 µm diam cells; excipulum medium brown, 70–90 µm high, lateral wall of textura porrecta composed of brown, thick-walled, long, septate, branched, 1-2.2 µm wide hyphae, inner layer pale brown to hyaline, thin-walled. Setae arising from basal stroma, straight or slightly curved, 7–14-septate, brown but pale at the apex, smooth, unbranched, thickwalled, 170-325 µm long, 5-7 µm wide at the lower part, basal cells swollen and 8-11 µm wide, tapering gradually toward the obtuse or acute at the apex, 2-4 µm wide at the apex. Conidiophores lining the basal stroma, cylindrical, smooth, pale brown, simple, 45-60×1-2.2 µm. Conidiogenous cells monophialidic, cylindrical, lageniform, pale brown to hyaline, smooth, 8-14×1.7-2 µm, collarette inconspicuous. Conidia fusiform to allantoid, obtuse at both ends, 1-septate, smooth, hyaline, guttulate, $11-12 \times 2-2.5 \mu m$, bearing a setula at each end, 3–5 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 0.8–1.1 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly grey, reverse pale brown (Figs. 236e–h).

Other materials examined: **China**, Hebei Province, Chengde, Bishushanzhuang, on dead culm of unidentified grass, 11 September 2012, W.P. Wu (Wu15077); Zhejiang Province, Deqing, Moganshan, Luhuadang, on dead culms of unidentified grass, 16 October 2019, W.P. Wu (HMAS 352,029 (=Wu16980)). Living strain: 54768 (from Wu15077), CGMCC 3.20675 (=NN 77,759) and 77,634 (from Wu16980).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes. Neopseudolachnella microsperma is morphologically very similar to N. uniseptata in producing uniseptate conidia, and distinct from the two known species with subcylindrical to fusiform and multiseptate conidia, N. acutispora and N. magnispora (Hashimoto et al. 2015b). The two species with uniseptate conidia can be distinguished by size of conidia ($10.5-19 \times 1.5-2.5 \mu m$ in N. uniseptata vs. $11-12 \times 2-2.5 \ \mu m$ in *N. microsperma*) and the ITS sequences.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 54767 include *Neopseudolachnella acitospora* (GenBank NR_154223, 92% identity), *N. magnispora* (GenBank NR_154224, 92% identity) and *N. uniseptata* (GenBank NR_154225, 91% identity).

Pseudolachnea Ranoj., Annls Mycol. 8: 393, 1910.

= Dinemasporiella Bubák & Kabát, Hedwigia 52: 358. 1912; non *Dinemasporiella* Speg., Annals. Mus. Nac. Hist. Nat. Buenos Aires 20: 366. 1910 (nom. dub.).

= Dinemasporiopsis Bubák & Kabát, nom. nov. apud Died., Krypt.-Fl. Brandenburg 9: 750. 1915.

= Chaetopatella Hino & Katum., J. Jap. Bot. 33: 238. 1958.

Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, scattered or aggregated, blackish, cupulate, basal wall of textura angulari composed of brown, thick-walled cells but the inner layer tend to be hyaline, thin-walled, lateral wall of textura porrecta composed of brown, thick-walled, long, septate, branched hyphae, inner layer pale brown to hyaline, thin-walled. Setae dark brown to black, erect, tapering towards the apex, wall thick and smooth, arising from the base and also lateral wall. Conidiophores hyaline, septate, branched, or unbranched, cylindrical, formed by the inner layer of both base and lateral walls. Conidiogenous cells enteroblastic, phialidic, determinate, discrete, hyaline, cylindrical, straight, wall thin and smooth. Conidia hyaline, 1-septate, navilicate to fusiform, curved of straight, wall thin and smooth, bearing one setulae at each end (Adapted from Sutton 1980b; Nag Raj 1993).

Type species: *Pseudolachnea hispidula* (Schrad.: Fries) B. Sutton.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Widely distributed.

Description and illustration: Sutton (1980a, b); Nag Raj (1993); Crous et al. (2012); Hashimoto et al. (2015b).

Notes: *Pseudolachnea* is a coelomycetous genus typified by *P. hispidula*. This genus is characterized by acervular or cupulate conidiomata surrounded by numerous black setae and one-septate conidia with an appendage at both ends, and the constituent species occur on twigs or wood of various angiosperms (Ranojevic 1910; Sutton 1980b; Nag Raj 1993; Hashimoto et al. 2015b). Morphologically it differs from *Pseudolachnella* in multiseptate scolecospore in the latter genus. In the phylogenetic tree generated by the combined ITS and LSU data, the two genera are clustered as two distinct groups with strong support. *Pseudolachnea* is more closed to *Pseudolachnella*. Most species described under the genus *Pseudolachnela* were transferred to *Pseudolachnella*,



Fig. 258 Colony of *Pseudolachnella* species on PDA after 20 days at 25 °C. **a**, **b** *Pseudolachnella minima* (ex-type strain 55219). **c**, **d** *P. tengii* (ex-type strain 47882). **e**–**g** *P. yunnanensis* (**e**, **f** ex-type strain 58842. **g** 45671). **h** *P. scolecospora* (54233)

which left *Pseudolachnea* as a small genus with only 2 accepted species, *Pseudolachnea hispidula* and *Pseudolachnea fraxini*. Here we add another species into the genus. Living strains of the studied species were also studied on PDA (Fig. 258), some characters such as growth rate, pigments etc. can be used as additional characters to delimit the species.

Pseudolachnea hispidula (Schrad.) B. Sutton, Mycol. Pap. 141: 167, 1977.

= Peziza hispidula Schrad., Syst. Mycol. 2: 98, 1923.

= Dinemasporium hispudulum (Schrad.) Curtis, Geological and National History Survey of North Carolina 3: 120, 1867.

=*Pseudolachnea bubakii* Ranoj., Annls Mycol. 8: 393, 1910.

Other synonyms see Sutton (1980a, b) and Nag Raj (1993).

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, scattered or aggregated, blackish, cupulate, up to 900 μ m diam., basal wall of textura angulari composed of brown, thick-walled cells but the inner layer tend to be hyaline, thin-walled, lateral wall of textura porrecta composed of brown, thick-walled, long, septate, branched hyphae, inner layer pale brown to hyaline, thin-walled. Setae dark brown to black, erect, tapering towards the apex, wall thick and smooth, 120–450×5–8 μ m, arising from the base and also lateral wall. Conidiophores hyaline, septate, branched, or unbranched, cylindrical, 10–30×1.5–3 μ m, formed by the inner layer of both base and lateral walls. Conidiogenous cells phialidic, discrete, hyaline, cylindrical, straight, wall thin and smooth, $8-20 \times 1.5-3$ µm. Conidia hyaline, aseptate, navilicate to fusiform, curved of straight, wall thin and smooth, $12-18 \times 1.5-2.5$ µm, bearing one setula of less than 2 µm long at each end.

Materials examined: **China**, Ningxia Province, Liupan Monutain, Erlonghe, on dead stem of *Berberis* sp., 24 August 1997, W.P. Wu (1092c); and other specimens on many different dead plant materials found in Hebei, Shan'Xi, Beijing, specimens no.0515, 0516, 0517, 0524, 0531, 0534, 0538a, 0540, 0542, 0544, 0549, HMAS33304(S) and HMAS30399(S).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China, Czechoslovakia, Eire, Great Britain, Germany, Japan, Pakistan, U.S.A. and U.S.S.R (Sutton 1980b; Nag Raj 1993).

Description and illustration: Sutton (1980b); Nag Raj (1993).

Notes: *Pseudolachnea hispidula* is widely distributed in Europe (Nag Raj 1993) and was also found to be common in north China. Morphological features of the specimens collected from China agree with the description of *P. hispidula* provided by Nag Raj (1993) and Hashimoto et al. (2015b). This species is distinguished from *Pseudolachnea fraxini* by the smaller conidia compared with those of the latter (14–21 vs 31.5–42.5 µm long) (Crous et al. 2012). **Fig. 259** *Pseudolachnea macrospora* (IMI34705, holotype). **a** Vertical section of a conidioma. **b** Conidiophores and conidiogenous cells. **c** Conidia. **a** 50 μm, **b–c** 10 μm



Pseudolachnea macrospora W.P. Wu & Y.Z. Diao, sp. nov., Fig. 259, MycoBank MB841672.

Etymology: Refers to its large conidia in this fungus.

Typification: **UK**, Petit Port, Guerssey, C.I's, on *Sarothaumus scoparius*, 16 September 1948, M.B. & J.P. Ellis, Holotype IMI34705.

Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, scattered or rarely aggregated, setulate, 300–350 um diam and 250–350 µm deep, basal wall of textura angulari, composed of pale brown to brown, thickwalled cells, but inner layer pale brown to hyaline, wall thin; lateral wall of textura porrecta formed by long, dark-colored and thick–walled cells, also the inner layers of hyaline,

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thin-walled cells. Setae erect, black, wall thick and smooth, septate, simple, tapered towards the apex, apex acute or obtuse, $120-250 \times 5-9 \mu m$. Conidiophores hyaline, septate, branched at the base or not, cylindrical, $10-30 \times 1.5-3 \mu m$, formed from inner layer of both basal and lateral wall; Conidiogenous cells enteroblastic, phialidic, determinate, discrete, hyaline, cylindrical, wall thin and smooth, apex wide and with a minor channel and collar, $5-15 \times 1.5-2.5 \mu m$. Conidia hyaline, 1-septate, fusiform, curved or straight, ends acute, $17-30 \times 2-3 \mu m$, setulae 3–8 μm long, and arising from both ends.

Other material examined: UK, on straw of undet, 1 March 1951, P.K.C. Austwick (66), IMI44944; IMI57018; IMI33978. Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: UK.

Notes: *Pseudolachnea macrospora* differs from *P. hispidula*, *P. microsperma* and *P. fraxini* in its longer conidia and setulae. Teng and Ling (1933) described a variety of *P. bubakii* var. *longispora* with conidia of $15-22 \times 2-2.5 \mu m$ and setulae of $2.5-3 \mu m$ long. The type specimen of this variety could not be located in HMAS (personal communication) or BPI (Nag Raj 1993), where most of Teng's specimens were hold.

Pseudolachnella Teng, Sinensia 7: 775, 1936.

= *Chaetopatella* I. Hino & Katum., J. Jap. Bot. 33: 238, 1958.

Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, scattered or aggregated, blackish, cupulate, basal wall of textura angulari composed of brown, thick-walled cells but the inner layer tend to be hyaline, thin-walled, lateral wall of textura porrecta composed of brown, thick-walled, long, septate, branched hyphae, inner layer pale brown to hyaline, thin-walled. Setae dark brown to black, erect, tapering towards the apex, wall thick and smooth, arising from the base and also lateral wall. Conidiophores hyaline, septate, branched, or unbranched, cylindrical, formed by the inner layer of both base and lateral walls. Conidiogenous cells phialidic, hyaline, cylindrical, straight, wall thin and smooth. Conidia hyaline, multiseptate, navilicate to fusiform, cylindrical, vermiform, curved of straight, wall thin and smooth, bearing 1 to several unbranched or branched setulae at each end (Adapted from Sutton 1980b; Nag Raj 1993).

Type species: *Pseudolachnella scolecospora* (Teng & C.I. Shen) Teng.

Ecology/Substrate/Host: Saprobe on dead material of plant, especially dead culm of various bamboo species.

Geographical distribution: Widely distributed where bamboo grows.

Description and illustration: Sutton (1980a, b); Nag Raj (1993); Hashimoto et al. (2015b).

Notes: *Pseudolachnella* was segregated from *Pseudolachnea* to accommodate a species with multiseptate conidia, *Pseudolachnea scolecospora* (Teng and Ling 1933; Teng 1936). Historical reviews on taxonomy and nomenclature for the genus and other related genera including *Pseudolachnea* and *Chaetopatella* were provided by Sutton and Hodges (1977) and Sutton (1980b), Nag Raj (1993), Crous et al. (2012) and Hashimoto et al. (2015b). Recent molecular phylogenetic study further validated the separation of *Pseudolachnella* and several related genera including *Brunneodinemasporium, Neopseudolachnella, Pseudolachnea* and *Pseudodinemasporium* (Crous et al. 2012; Hashimoto et al. 2015b). Under the genus *Pseudolachnella*, a total of

17 species are accepted and for many of them the DNA bar codes with ITS and LSU are available. In our study of chaetosphaeriaceous fungi from China, we found 2 new species and they are described here together with several known species.

Pseudolachnella indica (V.G. Rao & Varghese) Nag Raj, The Coelomycetous Anamorph with Appendage-Bearing Conidia: 725, 1993.

 \equiv *Chaetopatella indica* V.G. Rao & Varghese, Norw. J. Bot. 24: 45, 1977.

= Chaetopatella indica R.C. Rajak & Soni, Curr. Sci. 47: 136, 1978.

Material examined: **India**, on dead stem of *Bambosa* sp., 23 March 1977, R.C. Rajak (S–6), IMI212440 (Type).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: India (Nag Raj 1993).

Description and Illustration: Rao and Varghese (1977); Rajak and Soni (1978); Nag Raj (1993).

Notes: For comparison and identification of related Chinese collections, the type collection of *P. inidca* in IMI was examined. In this specimen (IMI212440), the conidia are cylindrical and curved, with a rounded apex and truncated base, 3-septate, $28-35 \times 1.5-2 \mu m$, bearing a single unbranched setula of 4–6 μm long at each end.

Pseudolachnella longiciliata (I. Hino & Katum.) Nag Raj, The Coelomycetous Anamorph with Appendage-bearing Conidia: 725, 1993.

 \equiv *Chaetopatella longiciliata* I. Hino & Katum., J. Jap. Bot. 33: 238, 1958.

 \equiv *Pseudolachnea longiciliata* (I. Hino & Katum.) B. Sutton, The Coelomycetes: 461, 1980.

Description on the natural substrate: Caulicolous. Teleomorph: Unknown. Anamorph: Conidiomata stromatic, cupulate, oval to elongate in outline, 400–650 μ m wide, setose, black. Setae dark brown to black, septate, smooth, acute, 100–280 μ m long, 4–6 μ m wide below, tapering to 3–3.5 μ m at the apex. Conidia hyaline, narrow clavate to fusiform, with a tapering apex and a truncate base, straight or slightly curved, 11–14-septate, 60–72×3.5–4.5 μ m, 1.5–2 μ m at the base; apical appendage single, unbranched, filiform, flexuous, 20–42 μ m long; basal appendage single, unbranched, filiform, flexuous, excentric, 10–16 μ m long.

Materials examined: **China**, Taiwan, Kaohsiung, Yako, Liyuan, on *Miscanthus floridulus*, 29 January 1988, A. Sivanesan, IMI323938; **Japan**, prov. Ugo., Mt. Nyutozan, on *Sasa kurilensis* Makino & Shibata, 4 August 1957, H. Muroi, IMI110665 (A portion of type specimen).

Ecology/Substrate/Host: Saprobe on dead material of plant.



Fig. 260 *Pseudolachnella minima* (**a**, **b**, **f**, **g** Wu12378, holotype; **c**–**e** Wu12374; **h**, **i** Wu12933)) **a** Part of conidiomata. **b**, **c** Conidiophores and conidiogenous cells with developing conidia. **d**–**i** Conidia. Scale bar: **a** 20. **b**–**I** 5 μm

Geographical distribution: China, Kunashir Island, India, Japan and Russia (Sutton 1980b; Nag Raj 1993; Hashimoto et al. 2015b).

Description and Illustration: Hino and Katumoto (1958); Sutton (1980b); Nag Raj (1993); Hashimoto et al. (2015b).

Notes: This species is readily distinguished from others in *Pseudolachnella* by its mucronate to ampliform conidiomata

up to 490 mm high and the 8–18-septate conidia with longer apical and shorter basal appendages (Sutton 1980a, b; Nag Raj 1993; Hashimoto et al. 2015b). The above description is based on the collection IMI323938 from Taiwan. It is slightly different from the type specimens of *P. longiciliata* in having more fusiform or clavate conidia (Hino and Katumoto 1958; Sutton 1980a, b; Nag Raj 1993; Hashimoto et al. 2015b). Zhao et al. (2004) recorded its occurrence on living twigs of *Yuchania vigens* from Yunnan, but no description was provided.

Pseudolachnella minima W.P. Wu & Y.Z. Diao, sp. nov., Figs. 260, MycoBank MB841673.

Etymology: Refers to the small conidia in this fungus.

Diagnosis: Similar to *Pseudolachnella scolecospora*, but differs in smaller conidia.

Typification: **China**, Guangdong Province, Guangzhou, Orchard Garden, on dead culm of bamboo, 29 December 2012, W.P. Wu, Holotype HMAS 352,043 (=Wu12378), ex-type strain CGMCC 3.20714 (=NN55219).

Description on the natural substrate: Caulicolous. Mycelium immersed, brown, septate, branched. Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, separate, black, at first closed then opening to become flattened or conical, $150-300 \times 100-250 \mu m$; periclinal wall pseudoparenchymatous, composed of brown textura angularis towards the inside, extending into textura porrecta at the periphery. Setae brown to black, simple, straight, or slightly curved, 1-4-septate, tapering towards the apex, apex acute or obtuse, wall thick and smooth, $(50-)70-260 \times 3-5 \mu m$. Conidiophores hyaline, branched at the base, sparingly septate at the base, wall thin and smooth, cylindrical, $10-25 \times 2.5-3 \mu m$. Conidiogenous cells phialidic, discrete or integrated, hyaline, wall thin and smooth, cylindrical with a minute collarette and narrow channel, $10-15 \times 2.5-3 \mu m$. Conidia hyaline, 3(-4)-septate, wall thin and smooth, cylindrical, straight or curved irregularly, guttulate, apex and base obtuse, $19-25 \times 1.5-2.5 \mu m$, with a single and unbranched setula at each end, 2–4 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1-1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly grey in the central part, reverse yellow to soil brown (Figs. 258a, b).

Materials examined: **China**, Guangdong Province, Guangzhou, Orchard Garden, on dead culm of bamboo, 29 December 2012, W.P. Wu (Wu12374, Wu12375, Wu12372, Wu12373, Wu12432, Wu12433); Guangdong Province, Shaoguan, Danxiashan, on dead culm of bamboo, 26 December2012, W.P. Wu (Wu12384, Wu12378, Wu12382); Guangdong Province, Guangzhou, Yuexiu Park, on dead leaf shelf of bamboo, 2 March 2012, W.P. Wu (Wu12227); Guangdong Province, Guangzhou, Yuexiu Park, on dead culm of bamboo, 2 March 2012, W.P. Wu (Wu12595); Guangxi Province, Damingshan, on dead culm of Miscanthus sp., 20 Dec 1997, W.P. Wu (1467a); Shanghai, Shanghai Botanical Garden, on dead culm of bamboo, 22 May 2012, W.P. Wu (Wu13005); Zhejiang, Hangzhou, Longjing, on dead culm of bamboo, 30 September 2013, W.P. Wu (Wu13004, Wu13005, Wu13006, Wu13007); Guangxi, Nanning, Nanning Subtropical Botanical Garden, on dead culm of bamboo, 15 November 2013, W.P. Wu (Wu13160); Yunnan Province, Kunming, Kunming Botanical Garden, on dead culm of bamboo, 10 April 2015, W.P. (Wu12914, Wu12916, Wu12917, Wu12931, Wu12933); Yunnan Province, Kunming, on dead culms of Phyllostachys sp., 09 March 1994, Wu W.P. (0559); Yunnan, Baoshan, Tengchong, Gaoligongshan, on dead culm of bamboo, 17 Oct 2003, W.P. Wu (Wu7025); Zhejiang Province, Deqing, Moganshan, Luhuadang, on rotten wood, W.P. Wu (Wu17066). Living strain: 44,098 (from Wu1467a), 55,220 (from Wu12384), 55,226 (from Wu12383), 55,227 (from Wu12375), 55,244 (from Wu12373), 55,267 (from 12,374), 55,276 (from Wu12432), 55,279 (from Wu12433), 57,319 (from Wu13004), 57,320 (from Wu13005), 57,321 (from Wu13006), 57,345 (from Wu13007), 57,480 and 57,481 (from Wu13160), 58,854 and 58,856 (from Wu12916), 58,889 (from Wu12917), 58,871 and 58,871 (from Wu12931), 58,873 (from Wu12933), 58,874 (from Wu12914), 58928 (from Wu13005), 58942 (from Wu13031); 58949 (from Wu13005) and 77,468 (from Wu17066).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Pseudolachnella minima is morphologically similar to P. asymmetrica (conidia (6-)7-septate, $20.5-34 \times 3-5 \mu m$; appendages 3-7.5 μm long), D. falcatispora (conidia 3-septate, $28-44 \times 2-3 \mu m$; appendages 2–4 µm long), P. inidca (conidia 3-septate, 24-38×2-2.5 µm; appendage 3-4 µm long), and P. scolecospora (conidia 3(-5)-septate, 30-44.5×2-3 µm; appendages 1.5-3.5 µm long). All these species have longer conidia than those in *P. minima*. In addition, the conidia in P. scolecospora and P. asymmetrica have more than 3 septa. Some variations on conidiomata, setae and conidia were seen from different specimens studied., For example in the specimen Wu7025: the conidiomata are 200-300 µm diam; setae 0–2-septate, $50-70 \times 3-4 \mu m$; conidia cylindrical, curved, 3–4-septate, $20-24 \times 1.7-2.0$ µm; conidial appendages 2-4 µm long; In the specimen Wu1381a: setae are $100-265 \times 5-7$ µm, tapering to 3-4 µm wide at the apex; conidia cylindrical, curved or straight, 3-septate, $19-22 \times 2.5-3 \mu m$, basal appendage 2.5-4 μm long, apical appendage 4-5 µm long.

Pseudolachnella scolecospora (Teng & Shen) Teng, Sinensia 7: 775, 1936. Figures 258h, 261



Fig. 261 *Pseudolachnella scolecospora* (Wu12227). a Part of conidiomata. b Conidiophores and conidiogenous cells with developing conidia. c Setae. d–i Conidia. Scale bar: a 20 μm, c 10 μm, b, d–i 5 μm

≡ Pseudolachnea scolecospora Teng & Shen, Contr. Biol. Lab., Sci. Soc. China Bot. 8: 277, 1933.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata stromatic, acervular, setose, shallow cupulate, oval in outline, 400–700 μ m long, 300–450 μ m wide, 100–150 μ m high; basal stroma 7–12 mm thick; excipulum 15–35 mm thick, poorly developed. Setae 100–155 μ m long, acute and 2–3 mm wide at the apex, 3–4 μ m wide at the base. Conidiophores 10–23 × 2–2.5 μ m. Conidiogenous cells 5–8 × 2–3 μ m. Conidia 26–34 × 1.8–2 μ m, 3 (–5)-septate, subcylindrical, hyaline, slightly curved, smooth, bearing an unbranched appendage at each end, setulae $1-3 \ \mu m \log n$.

Materials examined: **China**, Guangdong Province, Guangzhou, Yuexiu Park, on dead culm of bamboo, 2 March 2012, W.P. Wu (Wu12227); Shanghai, Shanghai Botanical Garden, on dead culm of bamboo, 22 May 2012, W.P. Wu (Wu12967, Wu12975, Wu12979, Wu12984, Wu12986, Wu12987, Wu12999, Wu129681; Wu13031); Zhejiang Province, Deqing, Moganshan, Luhuadang, on rotten wood, 16 October 2019, W.P. Wu (Wu17066); Zhejiang Province, Deqing, Moganshan, Luhuadang, on rotten wood, 16 October 2019, W.P. Wu (Wu17065); Zhejiang, Huaian County, Qiandaohu, on dead culm of bamboo, 18 October 2018, W.P. Wu (Wu16094); Living strains: 77,468 (from Wu17066), 54,233 (from Wu12227); 54,233 (from Wu12227), 58938 (from Wu12986), 58902 (from Wu12967), 58909 (from Wu12999), 58910 (from Wu12979), 58911 (from Wu12984), 58912 (from Wu12975), 58940 (from Wu12968), 76,322 (from Wu16094), 77,487 (from Wu17065).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Japan (Sutton 1980b; Nag Raj 1993; Hashimoto et al. 2015b).

Notes: *Pseudolachnella asymmetrica*, *D. falcatispora*, *P. inidca* and *P. scolecospora* are a few species with similar morphology and in fact they can hardly be distinguished on conidial morphology. The ITS sequences of *P. scolecospora* and *P. asymmetrica* are identical, but they can be distinguished by wider conidia in *P. asymmetrica* (Hashimoto et al. 2015b).

Pseudolachnella tengii W.P. Wu & Y.Z. Diao, sp. nov., Fig. 262, MycoBank MB841674.

Etymology: Named after the Chinese mycologist Shuqun Teng, who described the genus *Pseudolachnella*.

Typification: **China**, Yunnan Province, Kunming, Botanical Garden, on dead culm of *Phyllostachys* sp., 21 August 2003, W.P. Wu, Holotype HMAS 352,045 (=Wu7544), extype culture CGMCC 3.20791 (=NN47882).

Description on the natural substrate: Caulicolous. Mycelium immersed, brown, septate, branched. Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, separate, black, at first closed then opening to become flattened or conical, $150-500 \times 100-300 \mu m$; periclinal wall pseudoparenchymatous, composed of brown textura angularis towards the inside, extending into textura porrecta at the periphery. Setae brown to black, simple, straight, or slightly curved, septate, tapering towards the apex, apex acute or obtuse, wall thick and smooth, 120-250×4-6 µm. Conidiophores hyaline, branched at the base, sparingly septate at the base, wall thin and smooth, cylindrical, $15-30 \times 2.5-4.5 \,\mu\text{m}$. Conidiogenous cells phialidic, discrete or integrated, hyaline, wall thin and smooth, cylindrical with a minute collarette and narrow channel, 10-20×2.5-4.5 µm. Conidia hyaline, 7-septate, rarely 6 septate, wall thin and smooth, cylindrical, straight or curved irregularly, guttulate, apex and base obtuse, $35-45 \times 3.2-5 \mu m$, with a single and unbranched setula at each end and measured 4.8–6.5 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1.0–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, reverse pale brown in the center and becoming paler towards the margins (Fig. 258c, d).

Other materials examined: China, Yunnan Province, Kunming, Kunming Botanical Garden, on dead culm

of *Phyllostachys* sp., 09 March 1994, W.P. Wu (Wu623, Wu0560); Yunnan Province, Kunming, Botanical Garden, on dead culm of *Phyllostachys* sp., 22 October 1999, W.P. Wu and Yan Huang (Wu2607). Living strain: 45,726 (from Wu2607).

Ecology/Substrate/Host: Saprobe on dead culm of *Phyllostachys* sp..

Geographical distribution: China.

Notes: *Pseudolachnella tengii* differs from all other species in the genus by its broader verm-like conidia with one setula at each end. Among the known species, several species produce multiseptate and verm–like conidia with setulae at both ends, and they are *Pseudolachnella asymmetrica*, *P. botulispora* (conidia 5–7-septate, 22–35×4–6 µm, appendages 2–8 µm long), *P. campylospora* (conidia 6–7-septate, 25.5–35.5×3–5 µm, appendages 4–9 µm long), *P. complanata* (conidia (3–)7-septate, 26–40×2–3 µm, appendages 1–2 µm long), *P. vermospora* (conidia (5–)7-septate, 22–28×3.5–7 µm, 3–6 appendages 5–13 µm). These species can be distinguished from *P. tengii* by conidial septation, number of appendage and size of conidia (Sutton 1980b; Nag Raj 1993; Zhao et al. 2004; Sato et al. 2008; Hashimoto et al. 2015b).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 47882 include *Pseudolach-nella fusiformis* (GenBank NR_154280, 95% identity), *P. falcatispora* (GenBank NR_154279, 94% identity).

Pseudolachnella vermospora R.L. Zhao, Y.M. Yang & G.C. Zhao, Fungal Divers. 15: 256, 2004.

Description on the natural substrate: Caulicolous. Teleomorph: Unknown. Anamorph: Conidiomata 257–772 µm diam., 200–330 µm high. Excipulum absent. Setae marginal, up to 310 µm long, 3.5-5 µm wide. Conidiophores $25-36 \times 1.2-2$ µm, filiform, bearing 1–2 conidiogenous cells on the apex. Conidiogenous cells $5-10 \times 2-3$ µm. Conidia vermicular, fusiform, acerose, colorless, (5–)7-septate, $22-28 \times 3.5-7$ µm, bearing appendages at both ends. Appendages filiform, flexuous, colorless, unbranched, basal appendages 3–6, eccentric and discrete; apical appendages 1–2, scarcely 3–4, same length or not, 5–13 µm long (Zhao et al. 2004).

Typification: **China**, Yunnan Province, Gaoligong Mountain Nation Natural Reserve, altitude 3400 m, on living twigs of *Yushania vigens* Yi, May 2001, G.C. Zhao, R.L. Zhao and Y.M. Yang and S.B. Tan, deposited in Plant Pathology Herbarium of Southwest Forestry College Kunming, Yunnan, China (Holotype: HSFC 010,534).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China (Zhao et al. 2004).

Description and illustration: Zhao et al. (2004); Zhao and Zhao (2012).

Fig. 262 *Pseudolachnea tengii* (Wu7544, holotype). **a** Vertical section of a conidioma. **b** Setae. **c** Basal stroma and conidiophores. **d** Conidiophores and conidiogenous cells. **e** Conidia. Scale bar: **a** 50 µm, **b–e** 10 µm



Notes: *Pseudolachnella vermospora* differs from other known species in number of septa, setulae, and length/ width ratio of conidia. Among the known species, *P. brevicoronata* (conidia 7–10 septate, $62–90 \times 2-3 \mu m$; 2–4 unbranched or branched setulae), *P. yakushimensis* (conidia 3 septate, $15–33 \times 2-3 \mu m$, 2–4 setulae of 1–4 μm long), and *P. fusiformis* (conidia 3-septate, $15–20 \times 4-6.5 \mu m$, 2–4 unbranched setulae) produce conidia with more than one appendage at each end of the conidia, they can be distinguished from *P. vermospora* by the length/width ratio which is 5:1 in *P. vermospora* and smaller than that of other species. The conidia of *P. vermospora* have three to six unbranched basal appendages. The only other species with several appendages is *P. coronate*, but the appendages in this species are branched, and the conidia are considerably longer (Sutton 1980a, b; Nag Raj 1993; Zhao et al. 2004; Sato et al. 2008; Hashimoto et al. 2015b).



Fig. 263 *Pseudolachnella yunnanensis* (a–e Wu12930; f–m Wu12902, holotype) a Part of conidiomata. f Conidiophores and conidiogenous cells with developing conidia. b–e, g–m Conidia. Scale bar: a 20 µm; b–m 5 µm

Pseudolachnella yunnanense W.P. Wu & Y.Z. Diao, sp. nov., Figs. 263, MycoBank MB841675.

Etymology: Refers to the location, Yunnan Province in China, where the species was originally found.

Diagnosis: Similar to *Pseudolachnella scolecospora* but differs in ITS sequence.

Typification: China, Yunnan, Kunming, Kunming Botanical Garden, on dead culm of bamboo, 10 April 2015, W.P. Wu, Holotype HMAS 352,046 (= Wu12902), ex-type strain CGMCC 3.20720 (= NN58842).

Description on the natural substrate: Caulicolous. Mycelium immersed, brown, septate, branched. Teleomorph: Unknown. Anamorph: Conidiomata eustromatic, superficial, separate, black, at first closed then opening to become flattened or conical, $150-450 \times 100-250 \,\mu\text{m}$; periclinal wall pseudoparenchymatous, composed of brown textura angularis towards the inside, extending into textura porrecta at the periphery, apical cell separated and with acute or rounded apex. Setae brown to black, simple, straight, or slightly curved, 2-4-septate, tapering towards the apex, apex acute or obtuse, wall thick and smooth, 110-250×2-4.5 µm. Conidiophores hyaline, branched at the base, sparingly septate at the base, wall thin and smooth, cylindrical, $15-25 \times 2-3 \mu m$. Conidiogenous cells phialidic, discrete or integrated, hyaline, wall thin and smooth, cylindrical with a minute collarette and narrow channel, $6-12 \times 2-2.5 \mu m$. Conidia cylindrical, straight or curved irregularly, hyaline, 3-5-septate, wall thin and smooth, guttulate, slightly tapering towards the obtuse apex and truncated base, $(25-)30-38(-40) \times 1.8-2.5 \mu m$, with a single and unbranched setula at each end and measured 2-4 µm long.

Culture characteristics: Colonies on PDA effuse, colonies 1.3–1.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, white, slightly grey, reverse yellow to soil brown in the center and becoming paler towards the margins (Figs. 258e–g).

Other materials examined: **China**, Yunnan Province, Kunming, Kunming Botanical Garden, on dead culm of bamboo, 10 April 2015, W.P. Wu (Wu12918, Wu12930); China: Yunnan Province, Shilin, on dead culm of bamboo, 24 October 1999, W.P. Wu and Yan Huang (Wu2555b). Living strains: 45,671 (from Wu2555b), 58,858 (from Wu12918) and 58,870 (from Wu12930).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: *Pseudolachnella yunnanensis* resembles *Pseudolachnella falcatispora* (conidia 28–44×2–3 μ m), *P. indica* (conidia 24–38×2.5–5 μ m) and *P. scolecospora* (conidia 30–43×1.6–2.0 μ m) in 3-septate and falcate conidia with one unbranched appendage at both ends, but they can be distinguished by the size of conidia and also ITS sequences (Sutton 1980a, b; Nag Raj 1993; Hashimoto et al. 2015b; Fig. 3).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 58,842 include *Pseudolachnella asymmetrica* (GenBank NR_154276, 98% identity), *P. pachyderma* (GenBank NR_154282, 98% identity) and *P. falcatispora* (GenBank NR_154279, 95% identity). *Conicomyces* R.C. Sinclair, Eicker & Morgan-Jones, Mycologia 75: 1100, 1983.

Teleomorph: Unknown. Anamorph: Conidiomata stromatic, seemingly superficial and synnematous, more or less cornute with a long dark brown to black stalk and a slightly swollen head bearing a concave conidial hymenium, setose, with a terminal, white glocoid mass of conidia; basal stroma of an intraperidermal, lower texturea globulosa of dark brown, thick-walled cells, and an upper, thin textura epedermoidea of similar cells; stalk composed of textura intricate, elements moderately thick-walled, brown to pale brown, often giving rise to peripheral setae. Conidiomatal setae profuse, unbranched, straight, or variously curved, acuminate at the apex, septate, thick-walled, and often with a narrow lumen, smooth, dark brown in the middle part, paler toward the extremities. Conidiophores lining the cavity of the conidioma, arising from the inner textura intricate of the apical part of the stalk, unbranched or irregularly branched, euseptate, pale brown to colorless, smooth, invested in mucus. Conidiogenous cells discrete or integrated, subcylindrical to cylindrical or clavate, hyaline, smooth, phialidic, with annellidic proliferation. Conidia acerose with a narrow truncate base, multiseptate, hyaline, smooth, bearing an apical appendage; appendage cellular, narrow, and attenuated, unbranched, flexuous, separated from the conidium body by a septum, and invested (at least in one species) in a thin, persistent layer of mucus (Adapted from Nag Raj 1993).

Type species: *Conicomyces transvaalensis* R.C. Sinclair, Eicker & Morgan-Jones.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Canada, China, Japan, South Africa.

Description and illustration: Sinclari et al. (1983); Nag Raj (1993).

Notes: The genus *Conicomyces* was created to accommodate a synnematous hyphomycetes with synnematous conidiomata with a long dark brown to black stalk and a slightly swollen head bearing a concave conidial hymenium, setose, with a terminal, white glocoid mass of conidia, phialidic conidiogenous cells and hyaline, septate and acerose conidia with apical cellular appendages (Sinclair et al., 1983; Nag Raj 1993; Seifert et al. 2011). Four species are known in the genus: *C. contortus, C. nassensis, C. pseudotransvaalensis* and *C. transvaalensis*, which can be distinguished by conidial morphology (Sinclair et al., 1983; Illman and White 1984, 1985a, b; Seifert 1999; Liu et al. 2015).

Key to species of Conicomyces.

- Conidia 63-90×3.5-4.5 μm, with the appendage 20-30 μm long......C. contortus
 Conidia > 100 μm long.
- 1. Conidia > 100 μ m long......2
- 2. Conidia 11–21-septate, 96–116×4–5 μm, apical appendage 48–66 μm long.....C. nassensis
- 3. Conidia 19–29-septate, 122–200×5.5–7.3 μm; appendage 30–84 μm.....*C. transvaalensis*
- 3. Conidia 15–22-septate, 105–170×7.5–10 μm; appendage 40–80 μm.....*C. pseudotransvaalensis*

Conicomyces transvaalensis R.C. Sinclair, Eicker & Morgan-Jones, Mycologia 75: 1100, 1983.

Description on the natural substrate: Caulicolous. Teleomorph: Unknown. Anamorph: Conidiomata up to 1200 µm high, 120-200 µm wide at the base, up to 350 µm wide at the apex, setose, with a terminal, white glocoid mass of conidia. Conidiomatal setae profuse, unbranched, straight or variously curved, acuminate at the apex, up to 350 µm long, up to 8 µm wide at the base, 2–2.5 µm wide at the apex, septate, thick-walled. Conidiophores lining the cavity of the conidioma, arising from the inner textura intricate of the apical part of the stalk, unbranched or irregularly branched, septate, pale brown to colorless, smooth, invested in mucus. Conidiogenous cells discrete or integrated, subcylindrical to cylindrical or clavate, hyaline, smooth, phialidic, with annellidic proliferation, $20-35 \times 2-2.5 \,\mu\text{m}$. Conidia acerose with a narrow truncate base, 16-19-septated, hyaline, smooth, $98-140 \times 4.5-5.5 \,\mu$ m, bearing an apical cellular appendage; appendage cellular, narrow and attenuated, unbranched, flexuous, 10–50 µm long, separated from the conidium body by a septum.

Materials examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead branch of unidentified plant, 2 January 1997, W.P. Wu (Wu1248a).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and South Africa (Sinclair et al., 1983; Nag Raj 1993; Liu et al. 2015).

Description and illustration: Sinclair et al. (1983); Nag Raj (1993); Liu et al. (2015).

Notes: *Conicomyces transvaalensis* can be distinguished from other known species in the genus by a combination of setose synnemata and conidial morphology (septa, size, and appendage) (Sinclair et al., 1983; Illman and White 1985a, b; Seifert 1999; Liu et al. 2015).

Hoehneliella Bres. & Sacc., Verh. Zool.-Bot. Ges. Wien 52: 437, 1902.

= *Klebahnopycnis* Kirchstein, Annls Mycol. 37: 120, 1939.

Teleomorph: Unknown. Anamorph: Conidiomata stromatic, erumpent, cornute to cupulate, unilocular, setose, black; with a moderately developed basal textura epidermoidea, merging with a textura intricate at a higher level; excipulum well developed, of textura intricate in the outer layers giving rise to conidiomatal setae and merging toward the interior with an inner textura prismatica. Conidiomatal setae subulate, unbranched, septate, thick-walled, dark brown below. Conidiophores lining the cavity of the conidiomata, septate, branched, hyaline to very pale brown, smooth, invested in a thin layer of mucus. Conidiogenous cells discrete or integrated, subcylindrical to obclavate, monophialidic, hyaline, smooth. Conidia cylindrical, fusiform or ellipsoidal, euseptate, pale brown to almost colorless, smooth, bearing cellular appendages at both ends; appendages polar, arising as cellular extensions of the conidium body and separated from the latter by septa, branched or unbranched, attenuated, flexuous; basal appendage excentric (Adapted from Nag Raj 1993).

Type species: Hoehneliella perplexa Bresadola & Sacc.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Australia and China.

Description and illustration: Rao and Sutton (1976); Nag Raj (1993).

Notes: *Hoehneliella* was treated as member of both hyphomycetes and coelomycetes in literature due to different understanding of its conidiomata (Nag Raj 1993). Rao and Sutton (1976) redescribed the type species and concluded that the conidiomata of the fungus are cupulate and with brown setae, and the conidiophores arise from cells lining the wall. Nag Raj (1993) also examined the type specimen of the type species and described a bit more complex wall structure of conidiomata. *Paramenisporopsis*, typified by *P. undulisetulata*, has very similar conidiomata, conidiogenesis and conidial morphology and it might belong to the same genus as *Hoehneliella* (Matsushima 2003). Two species were discovered from China, and they can be distinguished by size and septation of conidia.

In the phylogenetic analysis, *Hoehneliella perplaxa*, the type species of the genus *Hoehneliella*, forms a distinct linkage which is basal to Clades 1–8 and other genera in Clade 9 and well assigned to the Chaetosphaeriaceae. On the conidiomatal structure, *H. perplaxa* resembles *Conicomyces*, producing synnematous conidiomata with setae and well-developed excipulum (Nag Raj 1993; Seifert et al. 2011).

Key to known species of Hoehneliella.

- 1. Conidia 1-septate, $7-11 \times 2-2.5 \,\mu\text{m}$H. perplexa
- 1. Conidia 3-septate, 18–23×4–6 µm......H. triseptata

Hoehneliella perplexa Bres. & Sacc., Verh. Zool.-Bot. Ges. Wien 52: 437, 1902. Figure 264

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata up to $250-500 \mu$ m high, $100-200 \mu$ m wide. Conidiomatal setae $180-300 \times 2.5-3.5 \mu$ m. Conidiophores lining the cavity of



Fig. 264 *Hoehneliella perplexa* (Wu13238). a Synnematous conidiomata with cupulate fertile region and setae. b Setae. c Low part of conidiomata with filamentous hyphae. d Subhyaline hyphae sur-

rounding the fertile region in the upper part of conidiomata. e Conidiophores and conidiogenous cells. f-q Conidia. Scale bar: a, b 20 µm, c 10 µm, d-q 5 µm

the conidiomata, septate, branched, hyaline to very pale brown, smooth, up to 100 μ m long, 1.5–2 μ m wide, invested in a thin layer of mucus. Conidiogenous cells discrete or integrated, subcylindrical to obclavate, monophialidic, hyaline, smooth-and thin-walled, 7–30×1.5–2 μ m. Conidia formed in black and wet spore mass, cylindrical, fusiform or ellipsoidal, 1-septate, pale brown to almost colorless, smooth, 7–11×2–2.5 μ m, bearing cellular appendages at both ends; appendages polar, arising as cellular extensions of the conidium body and separated from the latter by septa, branched or unbranched, attenuated, flexuous, 3–6 μ m long; basal appendage excentric.

Materials examined: **China**, Sichuan Province, Ya An, Wanguan County, Bifengxia, on dead stem of unidentified tree, 15 December 2013, W.P. Wu (Wu13238); Guangdong Province, on dead branches of unidentified plant, 9 October 1998, W.P. Wu (Wu2251a). Living strain: 57,688 (from Wu13238).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Australia and China (Nag Raj 1993).

Description and illustration: Rao and Sutton (1976); Nag Raj (1993).

Notes: The fungus collected from China seems to have smaller conidia $(9-15 \times 2.5-3.5 \ \mu\text{m})$ compared to those from the type specimen (Nag Raj 1993), otherwise it is very similar. The ITS sequence for this fungus was for the first time obtained from the strain 57688. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 57688 include *Pseudolachnea fraxini* (GenBank NG057956, 96% identity) and *Dendrophoma cytosporoides* (GenBank NG059108, 96% identity).

Hoehneliella triseptata W.P. Wu & Y.Z. Diao, sp. nov. Fig. 265, MycoBank MB841748

Etymology: Refers to its 3-septate conidia.

Typification: **China**, Guangdong Province, on dead branches of unidentified plant, 9 October 1998, W.P. Wu, Holotype Wu2252.

Description on the natural substrate: Teleomorph: Unknown. Anamorph: Conidiomata stromatic, erumpent, cornute to cupulate, unilocular, setose, black, 150–400 μ m high, 100–200 μ m wide; with a moderately developed basal textura epidermoidea, merging with a textura intricate at a higher level; excipulum well developed, of textura intricate in the outer layers giving rise to conidiomatal setae and merging toward the interior with an inner textura prismatica, hyphae 1.5–2 μ m. Conidiomatal setae arising from the excipular textura intricate, subulate, unbranched, straight or curved, 3–6-septate and hardly seen in basal part, smooth- and thick-walled, dark brown to black, apex rounded, 130–230×4–5.5 μ m. Conidiophores lining the cavity of the conidiomata, septate, branched, hyaline to very pale brown, smooth, up to 100 μ m long, 1.5–2 μ m wide. Conidiogenous cells discrete or integrated, subcylindrical to obclavate, monophialidic, hyaline, smooth– and thin–walled, 7–25 × 1.5–2 μ m. Conidia formed in black and wet spore mass, cylindrical, fusiform or ellipsoidal, 3-septate, pale brown to brown, smooth- and thick-walled, 18–23 × 4–6 μ m, bearing cellular appendages at both ends; appendages polar, arising as cellular extensions of the conidium body and separated from the latter by septa, branched or unbranched, attenuated, flexuous, 3–6 μ m long; basal appendage excentric.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Morphologically *Hoehneliella triseptata* fits well to the generic concept of *Hoehneliella*, such as cupshaped conidiomata with setae, phialidic conidiogenous cells forming from conidiophores arising from inner layer of the cup, and pale brown, and septate conidia with mucilaginous appendage. It differs from *H. perplaxa* in producing 3-septate and larger conidia (Rao and Sutton 1976; Nag Raj 1993). No strain was obtained for molecular study.

Excluded species from Chaetosphaeriaceae

Plectosphaerellaceae W. Gams, Summerbell & Zare (Glomerellales).

Plectosphaerellaceae, typified with *Plectosphaerella*, was erected by Zare et al. (2007). Hyde et al. (2017) updated the phylogeny of this family and accepted eleven genera. *Acremoniisimulans*, typified by *A. thailandensis* was recently introduced to the genus (Zare et al. 2007; Tibpromma et al. 2018).

Several *Chloridium*-like fungi with pigmented conidiophores and pale brown conidia were studied from the fresh collection made in China. Morphologically they are similar to *Chloridium phaeophorum*, and phylogenetically they belong to Plectosphaerellaceae rather than Chaetosphaeriaceae where most other *Chloridium* species including the type species belong to. Furthermore, based on their morphology and phylogeny, no existing genus can accommodate these fungi, thus 2 new genera are created for these 3 fungal species.

Phaeochloridium W.P. Wu & Y.Z. Diao, gen. nov., Myco-Bank MB841742.

Etymology: Refers to its similarity with *Chloridium* but with colored spore.

Type species: *Phaeochloridium geniculata* (Van Emden) W.P. Wu & Y.Z. Diao (≡ *Phialophora geniculata* Van Emden, Acta Bot. Neerl. 24:194, 1975).



Fig. 265 *Hoehneliella triseptata* (Wu2252). a Synnematous conidiomata with setae and wet spore mass. b Basal part of setae. c-h Conidia. Scale bar: a 50 μm, b-h 5 μm

Mycelium composed of hyaline or pigmented hyphae. Teleomorph: Unknown. Anamorph: Lignicolous. Conidiophores pale brown, unbranched, macronematous, septate, terminated with conidiogenous cell, often with sympodial proliferation. Conidiogenous cells phialidic, integrated, subcylindrical, proliferating sympodially, geniculate, irregularly widened at the proliferations, dark brown and paler toward the tip, tapering slightly toward the collarette; collarettes funnel-shaped. Conidia oblong, ellipsoid, pale to medium brown, aseptate, truncate at the base, obtuse at the apex, arranged in wet spore heads.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China, Surinam and USA.

Notes: The new genus *Phaeochloridium* is characterized by solidary, brown conidiophore with or without percurrent or sympodial proliferation, phialidic conidiogenous cells with funnel-shaped collarettes, and pale brown, ellipsoidal, Fig. 266 Colony of non chaetosphaeriaceous fungal species on PDA after 20 days at 25 °C. **a**, **b** *Phaeochloridium* gamsii (ex-type strain 78202). **c**, **d** *Sinochloridium* bambusicola (ex-type strain 76961). **e**, **f** *Xyladictyochaeta* eucalypti (43979). **g**, **h** *Xylolentia* matsushimae (43170). **i**, **j** *Tubulicolla* cylindrospora (43188). **k**, **l** *Rhopalophora* hainanensis (ex-type strain 78512)



cylindrical conidia with a darker hilum at the base. Morphologically it is similar to several genera such as *Phialophora*, *Chloridium*, *Phaeoacremonium*, but phylogenetically they belong to different families.

Phaeochloridium gamsii W.P. Wu & Y.Z. Diao, sp. nov. Figures 266a, b and 267, MycoBank MB841749.

Etymology: Named after the former CBS mycologist W. Gams who contributed significantly for this group of fungi.

Typification: **China**, Guangdong Province, Shenzhen, Lianhuashan Park, on dead leaves of *Musa* sp., 18 October 2020, W.P. W, Holotype HMAS 352,039 (=Wu17434), extype strain CGMCC 3.20755 (=NN78203).

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, $1.5-3 \mu m$ wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or 2–3 in group, cylindrical, erect, unbranched, straight or slightly flexuous, 2–6-septate, pale to medium brown, dark brown at the base, becoming paler towards the apex, smooth, thick-walled at the basal part, thin-walled towards the upper part, $45-108 \times 3-4$ µm, basal cell 7–10 µm. Conidiogenous cells integrated, terminal, monophialidic, pale brown, smooth, thin-walled, $25-30 \times 3-4$ µm; collarette funnel-shaped, 2–2.5 µm wide, 1-1.5 µm deep, slightly darker than other part of the conidiogenous cells. Conidia produced singly, aggregated in a brown slimy masses, oblong, ellipsoidal, rounded at both ends, distinctly with a dark hilum at one or both ends, 6.5–8 $(-10) \times 3-3.5$ µm.

Culture characteristics: Colonies on PDA effuse, colonies 0.7–0.9 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, dark brown, with pale colored margin, reverse pale brown to brown (Fig. 266a, b).



Fig. 267 Phaeochloridium gamsii (Wu17434, holotype). a-g Conidiophores and conidiogenous cells. h-r Conidia. Scale bar: 5 µm

Other materials examined: **China**, Guangdong Province, Shaoguan, Danxiashan, on dead leaves of *Monstera deliciosa*, 25 December 2012, W.P. Wu (Wu12504); Guangdong Province, Shaoguan, Danxiashan, on dead leaves of *Musa* sp., 25 December 2012, W.P. Wu (Wu12587); Guangdong Province, Shenzhen, Lianhuashan Park, on dead leaves of *Ananas* sp., 11 November 2019, W.P. Wu (Wu17074); Guangdong Province, Shenzhen, Lianhuashan Park, on dead leaves of *Musa* sp., 18 October 2020, W.P. Wu (Wu17435). Living strains: 55347 (from Wu12504), 55401 (from Wu12587), 77412 (from Wu17055), 77730 (from Wu17074) and 78204 (from Wu17435).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: Our phylogenetic analysis by using the combined data set of ITS and LSU clearly showed that *Phaeochloridium gamsii* is closely related to *Phialophora geniculata* and *Chloridium phaeophorum*. Morphologically these three fungi also shared similarity on pigmented conidiophores, monophialidic conidiogenous cell with funnel-shaped collarette often percurrently proliferating, and pale brown, aseptate and oblong conidia with a dark hilum. They can be distinguished by much bigger conidia in *P. gamsii* ($6.5-8 \times 3-3.5 \mu m$ vs. $3-6 \times 2-2.5 \mu m$ in *P. geniculata*; $4-5 \times 1.7-2.2 \mu m$ in *C. phaeosporum*).

The ITS sequences were determined from several strains obtained from the fresh collections in China. The ITS sequences from Wu12587 and Wu17434 are identical, while they differ with 7 bps from the one obtained from Wu12504. Morphologically the fungus from these different specimens are almost identical. In the specimen Wu17434, the fungus forms well-developed basal stroma from which up to 15 conidiophores are formed, and biguttulate and slightly larger conidia $(7.5-10 \times 2.5-3 \,\mu\text{m})$.

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 78,202 include *Phialophora geniculata* exotype strain CBS562.73 (GenBank MH860773, 93% identity), *Phialophora geniculata* IFM50532 (GenBank AB190395, 93% identity) and *Gibellulopsis nigrescens* (GenBank KR014364, 93% identity).

Phaeochloridium geniculatum (Van Emden) W.P. Wu & Y.Z. Diao, comb. nov. Figure 268, MycoBank MB841747.

≡ Phialophora geniculata Van Emden, Acta Bot. Neerl. 24: 194, 1975.

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1.5–2.5 µm wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or in group, cylindrical, erect, unbranched or occasionally irregularly branched, straight or slightly flexuous, tapering gradually towards the apex, 2–4-septate, brown, dark brown at the base, becoming paler towards the apex, smooth- and thin-walled, $45-85 \times 2.3-3 \mu m$, with 0–2 sympodial proliferations. Conidiogenous cells integrated, terminal, monophialidic, pale brown, smooth, 20–25 × 1.5–2.2 µm; collarette funnelshaped or subcylindrical, darker, 1–1.3 µm wide, up to 1 µm deep. Conidia produced singly, aggregated in a brown slimy masses, ellipsoidal, cylindrical, rounded at both ends, distinctly with a dark scar at base, guttulate, 4.5–5.5 (–6)×(1.8) 2–2.2 µm.

Materials examined: **China**, Yunnan Province, Xishuangbanna, on dead leaves of unidentified plant, 16 October 1999, W.P. Wu & Yan Huang (Wu2735b). Living strain: 46,009 (from Wu2735b).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China, Surinam and USA (Van Emden 1975; Gams and Holubová-Jechová 1976; Morgan-Jones et al. 1992).

Description and illustration: Van Emden (1975); Gams and Holubová-Jechová (1976); Morgan-Jones et al. (1992).

Notes: The genus Phialophora, typified by P. verrucosa, includes structurally simple, dematiaceous hyphomycetes with pigmented conidiophores, flask-shaped phialides often with a flaring collarette, and one-celled conidia (Medlar 1915; Gams and Holubová-Jechová 1976). A total of 99 valid names were listed in Mycobank (23 March 2021) and these species are highly pleomorphic in different ascomycete groups (Gams 2000) as demonstrated by the phylogenetic analysis (Gams 2000; Réblová et al. 2011a, b, 2013, 2017). The type species of the genus, P. verrucosa, together with several other species, belongs to the Herpotrichiellaceae (Chaetothyriales, Eurotiomycetes), while many other species have been reassigned to several different genera (for example Hyphodiscus, Rhopalophora, Lasiosphaeris, Cyphellophora etc.) (Gams 2000; Li et al. 2017a, b; Réblová et al. 2013, 2017).

Phialophora geniculata was originally described with geniculate conidiophores and aseptate, light colored, oblong conidia with a darker hilum $(4-5 \times 2-2.5 \,\mu\text{m})$ (Van Emden 1975). It was compared on the conidiophores with those of Phialogeniculata and Codinaea, but the conidia in this species are different from the other two genera by lack of septation and of appendages. The DNA sequences are available for several strains including the ex-type strain of P. geniculata. Our phylogenetic analysis shows it clearly belongs to a different genus in Plectosphaerellaceae. Based on both molecular phylogeny and morphological characters, the new genus Phaeochloridium is introduced to accommodate this fungus. Morphologically it resembles Acremoniisimulans, and some species with dark spore in Chloridium and Phialophora, but can be distinguished by pale brown conidia with dark hilum (Medlar 1915; Gams and Holubová-Jechová



Fig. 268 Phaeochloridium geniculata (Wu2735b). a-g Conidiophores, conidiogenous cells and conidia. h, i Conidia. Scale bar: 5 µm



Fig. 269 Phaeochloridium phaeosporum (Wu12504). a–d Conidia. e–h Conidiophores, conidiogenous cells and conidia. Scale bar: h 20 μ m, a–g 5 μ m

1976; Gams 2000; Seifert et al. 2011; Li et al. 2017a, b; Réblová et al. 2013, 2017).

Morphologically the fungus from the Chinese specimen fits well to the original description from the type specimen, except for the more sympodial proliferations in the original description (from pure culture).

The ITS sequence obtained from the Chinese collection is only 6 bp difference from those reported in the GenBank including the ex-type strain CBS562.73. Based on ITS blast in NCBI's GenBank, the closest matches to the strain 46009 include *Phialophora geniculata* exotype strain CBS562.73 (GenBank MH860773, 98% identity), *Phialophora geniculata* IFM50532 (GenBank AB190395, 98% identity) and *Gibellulopsis nigrescens* (GenBank KR014364, 96% identity).

Phaeochloridium phaeosporum (W. Gams & Hol.-Jech.) W.P. Wu & Y.Z. Diao, comb. nov., Fig. 269, MycoBank MB842078.

 \equiv Chloridium phaeosporum W. Gams & Hol.-Jech., Stud. Mycol. 13: 27, 1976.

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1.5–2.5 µm wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or in group, cylindrical, erect, unbranched, or occasionally irregularly branched, straight or slightly flexuous, 3–11-septate, brown, dark brown at the base, becoming paler towards the apex, smooth, $50-100 \times 2.5-3$ µm. Conidiogenous cells integrated, terminal, monophialidic, pale brown, smooth, $18-22 \times 3-3.5$ µm, with 1–2 irregular percurrent proliferation. Conidia produced singly, aggregated in a brown slimy masses, ellipsoidal, rounded at both ends, distinctly with a dark scar at base, $5-6 \times 2-2.5$ µm.

Materials examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead culm of bamboo, 2 January 1997, W.P. Wu (Wu1300d).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and USA (Gams and Holubová-Jechová 1976; Morgan-Jones et al. (1992).

Description and illustration: Gams and Holubová-Jechová (1976); Morgan-Jones et al. (1992).

Notes: Chloridium phaeosporum and Phialophora geniculata are very similar on conidiophores, conidiogenous cells and conidia (Emden 1975; Gams and Holubová-Jechová 1976). The difference is that in *P. geniculata*, the conidiophores have sympodial proliferation, and the conidia are slightly wider ($4-5 \times 2-2.5 \mu m$); while in *C. phaeosporum*, the conidiophores are with percurrent proliferation and the conidia are narrower ($4-5 \times 1.7-2.2 \mu m$). No molecular data is available for *C. phaeosporum*. *Sinochloridium* W.P. Wu & Y.Z. Diao, gen. nov., MycoBank MB841743.

Etymology: Refers to its similarity to *Chloridium* and the location where this fungus was discovered.

Type species: *Sinochloridium bambusicola* W.P. Wu & Y.Z. Diao sp. nov.

Mycelium composed of hyaline or pigmented hyphae. Teleomorph: Unknown. Anamorph: Lignicolous. Conidiophores pale brown, unbranched, macronematous, septate, terminated with conidiogenous cell. Conidiogenous cells monophialidic, integrated, subcylindrical, dark brown and paler toward the tip, tapering slightly toward the collarette, with a single sporulating locus; collarettes inconspicuous. Conidia oblong, ellipsoid, hyaline, aseptate, arranged in wet spore heads.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Sinochloridium bambusicola W.P. Wu & Y.Z. Diao, sp. nov., Figs. 266c, d, 270, MycoBank MB841948.

Etymology: Refers to its occurrence on bamboo.

Typification: **China**, Guangdong Province, Guangzhou, Nansha, on dead culm of bamboo, 18 August 2019, W.P. Wu, Holotype HMAS 352,053 (= Wu16678), ex-type strain CGMCC 3.20735 (= NN76961).

Description on the natural substrate: Lignicolous. Colonies effuse, hairy. Mycelium composed of hyaline or pigmented hyphae, 2-3.5 µm. Teleomorph: Unknown. Anamorph: Conidiophore macronematous, single or 2-3 in clusters, cylindrical, unbranched, 5-9-septate, straight, or slightly flexuous, dark brown at base, paler towards the apex, smooth-walled, $55-105 \times 3-4 \mu m$, basal cell swollen and 6-9 µm wide, terminated with a conidiogenous cell. Conidiogenous cells monophialidic, integrated, subcylindrical, lageniform, tapering towards apex, $23-25 \times 2-3 \mu m$, pale brown at the base, becoming subhyaline towards the apex, smooth- and thin-walled; collarette inconspicuous, $0.8-1.2 \mu m$ wide, with a single sporulating locus. Conidia oblong, ellipsoid, hyaline, aseptate, biguttulate, $4.5-5.5 \times 2.0-2.3$ µm, slightly tapering towards ends, arranged in wet spore heads.

Culture characteristics: Colonies on PDA effuse, colonies 1–1.3 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey in the central part, reverse brown to dark brown (Fig. 266c, d).

Other living strain: 78,253 and 76,962 (from Wu16678). Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Notes: This dematiaceous microfungus on dead culm of bamboo is similar to some *Chloridium* species in producing macronematous, pigmented and septate conidiophores, terminal phialidic conidiogenous cells, and hyaline and aseptate conidia aggregated into wet spore head (Gams and Holubová-Jechová 1976; Seifert et al. 2011). However, our phylogenetic analysis based on the integrated dataset of ITS and LSU showed that it represents another genus in Plectosphaerellaceae W, thus a new genus is created here. Morphologically it resembles *Phaeophialophora*, *Acremoniisimulans*, and some species in *Chloridium* and *Phialophora*, but can be distinguished by a combination of macronematous conidiophores, terminal and monophialidic conidiogenous cells, and hyaline, ellipsoid and aseptate conidia (Medlar 1915; Gams and Holubová-Jechová 1976; Gams 2000; Seifert et al. 2011; Li et al. 2017a, b; Réblová et al. 2013, 2017; Tibpromma et al. 2018).

Based on ITS blast in NCBI's GenBank, the closest matches to the ex-type strain 76,961 include unclassified Plectosphaerellaceae (GenBank MW619966, 98% identity), *Acremonium furcatum* (GenBank MG250388, 90%) and *Acremonium antarcticum* (GenBank MG250387, 90%).

Rhamphoriaceae Réblová, Mycologia 11: 754, 2018. (Sodariomycetidae)

The family Rhamphoriaceae was introduced for two new genera with *Phaeoisaria*- and *Idriella*-like anamorphs. *Xylolentia* is one of the genera (Réblová and Štěpánek 2018). Based on morphological comparison and phylogenetic analysis, *Chloridium reniforme* Matsush. is transferred into the genus *Xylolentia*, and a new species is also added into the genus.

Xylolentia Réblová, Mycologia 11: 754, 2018.

Type species: Xylolentia brunneola Réblová.

Description and illustration: Réblová and Štěpánek (2018).

Xylolentia matsushimae W.P. Wu & Y.Z. Diao, nom. nov., MycoBank MB841949

 \equiv Chloridium reniforme Matsush., Icon. Microfung. Mats. Iect., Kobe: 28, 1975.

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1.5–3 µm wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or in group, cylindrical, erect, unbranched, straight, or slightly flexuous, 6–9-septate, brown, dark brown to black at the base, becoming paler towards the apex, smooth, $60-160 \times 3.5-5$ µm, swollen up to 7 µm wide at the base. Conidiogenous cells integrated, terminal, phialidic, pale brown, becoming paler towards the apex, smooth, $15-30 \times 2.5-3$ µm, inflated to 3.5-4.5 µm near the tip, but strongly constricted at the hardly visible collarette. Conidia produced singly, aggregated in a slimy mass, more or less reniform, $3-4 \times 2-2.5$ µm. Culture characteristics: Colonies on PDA effuse, colonies 0.6–1.4 cm diameter in 20 days, circular, flat, margin entire or irregular, aerial mycelium well-developed, grey, with pale colored margin, reverse brown in the center and becoming paler towards the margins (Fig. 266g, h).

Materials examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead culms of bamboo, 2 January 1997, W.P. Wu (Wu1266f); Hain Province, on rotten wood, 20 December 2000, W.P. Wu (Wu5554); Hunan Province, Mangshan, on rotten wood, 15 April 2002, W.P. Wu (Wu6108). Living strain: 43170 (from 1266f).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China and Japan (Matsushima 1975).

Description and illustration: Matsushima (1975); Gams and Holubová-Jechová (1976).

Notes: This fungus was originally described as *Chloridium reniforme* and it is unique in producing terminal monophialidic conidiogenous cell with multisporulating loci within the collarette, and reniform conidia (Matsushima 1975; Gams and Holubová-Jechová 1976). Our phylogenetic analysis with the combined ITS and LSU sequences shows that it belongs to *Xylolentia* in *Rhamphoriaceae* Réblová (Réblová and Štěpánek 2018; Yuan et al. 2020), and should be excluded from the genus *Chloridium* (Chaetosphaeriaceae). Since *Xylolentia reniformis* C.G. Lin, K.D. Hyde & Jian K. Liu already exists for a different species, a new name *Xylolentia matsushimae* is proposed for *Chloridium reniforme* Matsush.

Morphologically it is indistinguishable from *Xylolentia reniformis* C.G. Lin, K.D. Hyde & Jian K. Liu, both are with terminal conidiogenous cell with slightly swollen subapical region, multisporulating loci within the inconspicuous collarette, and hyaline and reniform conidia with similar size $(3-4.5 \times 1.8-3 \ \mu\text{m})$ (Matsushima 1975; Yuan et al. 2020). However, their ITS sequences are with significant difference (98% identity).

Xylolentia palmicola W.P. Wu & Y.Z. Diao, sp. nov., Fig. 271, MycoBank MB841984.

Etymology: Refers to its host plant as palm.

Typification: **China**, Guangdong Province, Shaoguan, Danxiashan, on dead leaves of palm, 25 December 2012, W.P. Wu, Holotype Wu12519, ex-type strain NN55349.

Description on the natural substrate: Colonies effuse, brown, hairy. Mycelium mostly immersed in the substrate, composed of brown, septate, subhyaline to pale brown, smooth, 1.5–3 μ m wide hyphae. Teleomorph: Unknown. Anamorph: Conidiophores solitary or in small group, cylindrical, erect, unbranched, straight, or slightly flexuous, 8–12-septate, brown, dark brown at the base, becoming paler towards the apex, smooth, 100–175 × 3.5–4.5 μ m; basal cell



Fig. 270 Sinochloridium bambusicola (Wu16678, holotype). a-f Conidiophores and conidiogenous cells. g-j Conidia. Scale bar: 5 µm



Fig. 271 *Xylolentia palmicola* (Wu12519, holotype). **a–o** Conidiophores, conidiogenous cells and conidia. **p**, **q** Conidia. Scale bar: 10 μ m for **a–x**. Scale bar: 5 μ m for **d–q**

swollen and lobbed, 7–10 μ m wide. Conidiogenous cells integrated, terminal, monophialidic, brown, becoming paler towards the apex, smooth, 23–29×2.5–2.7 μ m, inflated to 3–4.2 μ m near the tip, but strongly constricted at the hardly visible collarette. Conidia produced singly, aggregated in a slimy mass, more or less reniform, 4–5×1.7–2 μ m.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Description and illustration: Matsushima (1975); Gams and Holubová-Jechová (1976).

Notes: Morphologically *X. palmicola* is indistinguishable from *Xylolentia matsushimae* and *X. reniformis*, both are with terminal conidiogenous cell with slightly swollen subapical region, multisporulating loci within the inconspicuous collarette, and hyaline and reniform conidia with similar size $(3-4.5 \times 1.8-3 \mu m$ (Matsushima, 1975; Yuan et al. 2020). The conidia in *X. palmicola* are slightly longer and narrower, and its ITS sequence is with significant difference with the other two species.

Xylolentia reniformis C.G. Lin, K.D. Hyde & Jian K. Liu, Fungal Divers. 104: 93, 2020.

Description on the natural substrate: Teleomorph: Not observed. Anamorph: Conidiophores 65–160 μ m long, 3–9.5 μ m thick at the base, slightly tapering towards the conidiogenous cells just below the apex then swelling again. Conidiogenous cells polyblastic, integrated, sympodial, terminal, clavate, subhyaline to pale brown, 14–40×3–4.5 μ m. Conidia aggregated in slimy masses, acropleurogenous, simple, smooth, aseptate, reniform, hyaline, 3.2–4.6 μ m long, 1.8–3.0 μ m thick in the broadest part (Yuan et al. 2020).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China.

Description and illustration: Yuan et al. (2020).

Notes: As noticed above, morphologically *X. reniformis* can hardly be distinguished from *X. matsushimae*. Their ITS sequences are with 98% identity (Matsushima 1975; Yuan et al. 2020).

Xyladictyochaetaceae Crous & Hern.-Restr. Fungal Systematics & Evolution (FUSE) 1: 212, 2018.

(Xylariales).

Mycelium consisting of medium brown, smooth, septate, branched hyphae, forming globose, intercalary, brown, smooth, chlamydospore-like structure. Conidiophores erect, brown, smooth, subcylindrical, flexuous, multiseptate. Conidiogenous cells terminal and intercalary, polyphialidic; phialidic opening lacking flared collarettes. Conidia solitary, aggregating in slimy mass, hyaline, smooth, fusoid-ellipsoid, slightly curved, apex subacute, base truncate, medianly 1-septate; each end with flexuous, unbranched appendage. Type genus: *Xyladictyochaeta* Hern.-Restr., R.F. Castañeda & Gené.

Xyladictyochaeta Hern.-Restr., R.F. Castañeda & Gené, Stud. Mycol., 86: 93, 2017.

Type species: *Xyladictyochaeta eucalypti* (Sutton & Hodges) W.P. Wu & Y.Z. Diao.

The genus Xyladictyochaeta was recently created for a microfungus on Eucalyptus sp. collected from Portugal (Hernández-Restrepo et al. 2017) and shortly after also found in Australia (Crous et al. 2018a, b). Apart from the type species, the second species X. tristaniopsidis Crous was added into the genus (Crous et al. 2020). Morphologically, Xyladictyochaeta is mostly similar to Dictyochaeta in having similar conidiophores appearance, producing wet spore mass and hyaline conidia with setulae, but differs in having setiform conidiophores with intercalary and terminal polyblastic and sympodial conidiogenous cells. Moreover, Xyladictyochaeta phylogenetically belongs to Xylariales, while members of Dictyochaeta are phylogenetically associated with Chaetosphaeriaceae (Ellis 1971, 1976; Réblová et al. 1999; Réblová 2000, 2004; Fernández and Huhndorf 2005; Fernández et al. 2006; Seifert et al. 2011; Hernández-Restrepo et al. 2017; Crous et al. 2018a, b).

During an examination of Eucalyptus leaf litter collected in China, one fungus similar to Codinaea eucalypti B. Sutton & Hodges was often seen from a number of collections. They are very similar on conidiophores and conidial appearances, and also collected from the same host genus (Eucalyptus spp.), and can only be distinguished by conidiogenous cells, ie. monophialidic in C. eucalypti and polyphialidic and sympodial in the Chinese collection (same as in Xyladictyochaeta eucalypti) (Sutton and Hodges, 1975; Hernández-Restrepo et al. 2017; Crous et al. 2018a, b). This brought our attention to reexamine the type specimen of *Codinaea* eucalypti in hebarium IMI, and from this it was confirmed that the conidiogenous cells from this type specimen are morphologically identical to what we observed in the Chinese collection and also what was described in X. eucalypti. Instead of phialidic conidiogenous cells with collarettes in Codinaea and Dictyochaeta, the conidiogenous cells in these species are found to be with polyblastic and sympodial denticles as found in Dactylaria and Idriella. Furthermore, it was also concluded that these fungus from Brazil, China and Portugal are identical, and this was further confirmed by ITS sequence comparison. Thus, the following new combination Xyladictyochaeta eucalypti (Sutton & Hodges) W.P. Wu & Y.Z. Diao (\equiv *Codinaea eucalypti* B. Sutton & Hodges) is made here as the type species of the genus *Xyladictyochaeta*.

Xyladictyochaeta eucalypti (Sutton & Hodges) W.P. Wu & Y.Z. Diao, comb. nov., Figs. 266f, 272, MycoBank MB841738.

Fig. 272 *Xyladictyochaeta eucalypti*. **a** Conidiophores, conidiogenous cells and attached conidia. **b** Conidia. Scale bar: 10 μm



 \equiv *Codinaea eucalypti* B. Sutton & Hodges, Nova Hedwigia 26: 517, 1975.

≡ Dictyochaeta eucalypti (B. Sutton & Hodges) Aramb. & Cabello, Mycotaxon 34: 682, 1989.

= *Xyladictyochaeta eucalypti* Hern.-Restr., R.F. Castañeda & Gené, Stud. Mycol. 86: 93, 2017.

Description on the natural substrate: Colonies effuse, spreading, diffuse, brown. Mycelium partly immersed and partly superficial, sparse, formed of smooth, septate, branched, pale brown, thin- and smooth-walled hyphae, 2-4 µm wide. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, scattered or occasionally aggregated at the base, erect, straight, or slightly flexuous, simple, unbranched, cylindrical, medium to dark brown, up to 20 septate, smooth, up to 170 µm long and 7-8 µm wide, the distance between septa averaging 6-7 µm. Conidiogenous cells integrated, indeterminate, terminal and intercalary, polyblastic, cylindrical, pale brown to brown, smooth, conidiogenous loci unthicken, flattened, and closely aggregated on an ejection from the conidiogenous cells just below septa except the apical conidiogenous cells where the conidiogenous loci distributed on the apical regions, ejection hyaline to pale brown, up to 3 µm long and 1.5 µm wide. Conidia holoblastic, solitary, aggregated at the base, hyaline, 0-1-septate, falcate, tapering towards both ends, $11-13.5 \times 2-2.5 \mu m$, with an unbranched setulae at each end, 3.5-7.5 µm.

Culture characteristics: Colonies on PDA effuse, colonies 0.7–1.2 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, dark grey to pale brown in the central part, becoming paler toward the margins, reverse yellow to soil brown in the center and becoming paler towards the margins (Fig. 266e, f).

Typification: **Brazil**, Sao Paulo: Nr. Bauru, on dead leaves of *Eucalyptus saligna*, 15 January 1973, I.A.S. Gibson, IMI 173094a (Holotype).

Materials examined: Brazil, Espirito Santo, Viana, 11 December 1973, C.S. Hodges, IMI 181532b; Espirito Santo, Aracruz, 10 December 1973, C.S. Hodges, IMI 181531b; Espirito Santo, Aractuz, on dead leaves of Eucalyptus citriodora, 30 May 1973, C.S. Hodges, IMI 176988d; Minas Gerais, Vicosa, C.S. Hodges, on dead leaves of E. paniculata, 18 December 11,973, C.S. Hodges, IMI 181534a; Sao Paulo, Assis, 10 June 1973, C.S. Hodges, IMI 176991a; Sao Paulo, Nr. Bauru, on dead leaves of Eucalyptus saligna, 15 January 1973, I.A.S. Gibson, IMI 173094a (Holotype); Sao Paulo, Itepetininga, on dead leaves of Eucalyptus saligna, 9 June 1973, C.J. Hodges, IMI 176992a; Sao Paulo. Rio Claro, 6 June 1974, C.S. Hodges, IMI 186981 g; Sao Paulo. Nr. Franca, on dead leaves of *Eucalyptus* sp., 14 January 1973, I.A.S. Gibson, IMI 173093c; Sao Paulo, Rio Claro, 6 June 1974, C.S. Hodges, IMI 186980b, 186979b, 186978b, 186976b, 186977a; China, Yunnan Province: Kunming:

Fungal Diversity (2022) 116:1–546

Kunming Botanical Garden, on dead leaves of *Eucalyptus* sp., 24 November 1995, W.P. Wu (Wu993b); China: Yunnan Province: Kunming: Kunming Botanical Garden, on dead leaves of undetermined tree, 24 November 1995, W.P. Wu (Wu960b); Guangxi Province, Shiwandashan, on dead leaves of *Eucalyptus* sp., 31 December 1997, W.P. Wu (Wu1603b); Guangxi Province, Shiwandashan, on dead leaves of *Eucalyptus* sp., 31 December 1997, W.P. Wu (Wu1607 d); Guangxi Province, Nangning, on dead leaves of *Eucalyptus* sp., 3 January 1998, W.P. Wu (Wu1646b). Living strains: 43959 (from Wu1646b) and 43979 (from Wu1603b).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Australia, Brazil, China and Portugal.

Description and illustration: Sutton and Hodges (1975); Hernández-Restrepo et al. (2017); Crous et al. (2018a, b).

Notes: Morphologically, the fungus collected from China fits well to *Codinaea eucalypti* as reported from Australia, Brazil, and Portugal. Based on ITS blast in NCBI's Gen-Bank, the closest matches to the strain 43959 include *X. lusitanica* (GenBank NR_154542, 100% identify), *X. trisetaniopsis* (GenBank NR_171761, 97% identify) and *Castanediella eucalyptigena* (GenBank NR_156384, 91%).

Vermiculariopsiellaceae Hern.-Rest., J. Mena, Gené & Crous.

(Sordariomycetes, Vermiculariopsiellales Hern.-Rest., J. Mena, Gené & Crous).

Tubulicolla Réblová & Hern.-Restr., Mycologia 113: 420, 2021.

Type species: *Tubulicolla cylindrospora* (Morgan-Jones & E.G. Ingram) Réblová & Hern.-Restr.

Ecology/Substrate/Host: Saprobe on decaying leaves.

Geographical distribution: China, North American, South American and Carribean (Morgan-Jones and Ingram 1976; Réblová et al. 2021c).

Description and illustration: Réblová et al. (2021c).

Notes: The genus *Tubulicolla* is a recently described genus for *Codinaea cylindrospora* Morgan-Jones & E.G. Ingram, which is phylogenetically distinct from other known *Codinaea* and *Dictyochaeta* species in the phylogenetic analysis from the combined LSU and ITS sequences (Réblová et al. 2021c). Morphologically the fungus is unique in producing several short conidiophores clustered together with one long fertile setiform conidiophores, and both are ended with a single clavate phialide bearing a apical, funnel-shaped, stalked collarette (Morgan-Jones and Ingram 1976; Hernández-Restrepo et al. 2017; Réblová et al. 2021c).

As pointed by Réblová et al. (2021c), the tubular neck between the funnel-shaped collarette and the body of the conidiogenous cell is the prominent character of *Tubulicolla*.

Apart from *Codinaea cylindrospora*, presence of the tubular neck between the funnel-shaped collarettes and the body of conidiogenous cells are also found in 2 other described *Dictyochaeta* species, *Dictyochaeta microcylindrospora* (conidia subcylindrical, $4.8-7.2 \times 1-1.5 \mu$ m) (Whitton et al. 2000) and *D. stipitocolla* (conidia spear-shaped with basal protuberances, $12.7-17.5 \times 2.6-4 \mu$ m) (Kuthubutheen and Nawawi 1991b). They are also transferred to the genus *Tubulicolla* and their phylogenetic relationship with *Tubulicolla* needs to be further studied when fresh specimens are recollected.

Tubulicolla cylindrospora (Morgan-Jones & E.G. Ingram) Réblová & Hern.-Restr., Mycologia 113: 420, 2021.

 \equiv *Codinaea cylindrospora* Morgan-Jones & E.G. Ingram, Mycotaxon 4: 504, 1976.

=Dictyochaeta cylindrospora (Morgan-Jones & E.G. Ingram) Aramb. & Cabello, Mycotaxon 34: 681, 1989 (Invalid).

= Dictyochaeta cylindrospora (Morgan-Jones & E.G. Ingram) Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 137, 2000.

Description on the natural substrate: Colonies hypophyllous, effused, dark brown to almost black. Mycelium composed of immersed, semi-immersed or superficial, branched, septate, subhyaline to pale brown hyphae, 1.5–2.5 µm wide, aggregated to form small stromata at the bases of setae and conidiophores. Stromatic cells globose or angular, thick-walled, brown, up to 7 µm wide. Teleomorph: Unknown. Anamorph: Setae arising from dark brown, swollen basal cells, erect, straight, smooth, up to 6-septate, dark brown and thick-walled in the lower part, paler above, fertile, terminating in a single, narrowly clavate phialide, $105-125 \times 3-4 \mu m$, $6-7 \mu m$ wide at the bulbous base. Conidiophores macronematous, mononematous, arising in groups of up to four near the base of each seta, cylindrical, with a somewhat swollen basal cell, simple, septate, smooth, $30-60 \times 2$. $5-4 \mu m$, terminating in a single conidiogenous cells. Conidiogenous cells narrowly clavate, monophialidic, pale brown to subhyaline, each phialide bearing a single apical, funnel shaped, stalked cellarette. Conidia extruded in s limy colorless droplets, continuous, hyaline, cylindrical, straight, or very lightly curved, obtuse at each end, $8-11 \times 2-2.5 \,\mu\text{m}$.

Culture characteristics: Colonies on PDA effuse, colonies 0.3–0.5 cm diameter in 20 days, circular, flat, margin entire, aerial mycelium well-developed, grey, reverse brown (Figs. 266i, j).

Materials examined: **China**, Guangxi Province, Shangsi, Shiwandashan, Wangle, on dead leaves of ?*Quercus* sp., 2 January 1997, W.P. Wu (Wu1323d). Living strain: 43188 (from Wu1323d). Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China, Cuba Malaysia, Mexico and USA (Morgan-Jones and Ingram 1976; Castañeda-Ruiz and Kendrick, 1990a, b; Kuthubutheen and Nawawi 1991a, b, c, d, e; Heredia et al. 2000).

Description and illustration: Morgan-Jones (1976); Castañeda-Ruiz and Kendrick (1990a, b); Kuthubutheen and Nawawi (1991a, b, c, d, e); Heredia et al. (2000); Réblová and Seifert (2007), Réblová et al. (2021c).

Notes: *Tubulicolla cylindrospora* seems to be a rather common fungus and recorded on decaying leaves of *Pinanga* sp., *Pinus* sp. and *Quercus* spp. from broad geographic areas. The conidia $(6-7.5 \times 1.5-2 \mu m)$ from the specimen collected in Mexico are significantly smaller than the type specimen (Heredia et al. 2000).

Tubulicolla microcylindrospora (Whitton, McKenzie & K.D. Hyde) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841739.

≡ Dictyochaeta microcylindrospora Whitton, McKenzie & K.D. Hyde, Fungal Divers. 4: 141, 2000.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Brazil and China.

Description and illustration: Whitton et al. (2000).

Notes: *Dictyochaeta microcylindrospora* fits well to concept of the recently described genus *Tubulicolla* on presence of cylindrical neck between collarette and conidiogenous cells, and cylindrical, aseptate conidia without setulae.

Tubulicolla stipitocolla (Kuthub. & Nawawi) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841740.

≡ Dictyochaeta stipitocolla Kuthub. & Nawawi, Mycol. Res. 95: 1214, 1991.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Malaysia (Kuthubutheen and Nawawi 1991a, b, c, d, e).

Description and illustration: Kuthubutheen and Nawawi (1991a, b, c, d, e).

Notes: *Dictyochaeta stipitocolla* resembles *Tubulicolla cylindrospora* on presence of sterile setae, clustered conidiophores with setae, terminal and monophialidic conidiogenous cells with a cylindrical neck below the funnel-shaped collarette, and aseptate and asetulate conidia. Its conidia have broad base and is similar to those in *Vermiculariopsiella*.

Doubtful species in Chaetosphaeriaceae

Bahusutrabeeja Subram. & Bhat, Can. J. Bot. 55: 2204, 1977.

Based on the phylogenetic study, *Bahusutrabeeja dwaya*, the type species of the genus *Bahusutrabeeja*, is recently

transferred to Codinaea Maire and Bahusutrabeeja becomes one of the synonyms for Codinaea. The remaining known species under the genus need to be revised for reclassification. These species are *B. angularis*, *B. bunyensis*, *B. dwaya*, B. dubhashii, B. exappendagiculata, B. globosa and B. manoharacharii. These species can be distinguished by their conidial morphology, including shape and size, of conidia and appendages (Subramanian and Bhat 1977; Rao and de Hoog 1986; Bhat and Kendrick 1993; Bhat 1994; McKenzie 1997; Pratibha and Bhat 2005; Li et al. 2012). Morphologically two other Bahusutrabeeja species, B. bunyensis and B. globosa, closely resemble C. dwaya in having globose to subglobose, multi-setulate conidia. The conidia of B. angularis have an angular outline and should be compared with Nawawia. Other species differ in conidial shape and lack setulae. Their taxonomic treatment needs to be resolved using phylogenetic analysis in future study (Réblová et al. 2021e).

Under the genus *Bahusutrabeeja*, three species, *B. angularis*, *B. dwaya* and *B. exappendagiculata*, were recently reported from China (Chang 1990; Wu and McKenzie 2003; Li et al. 2014; Gao et al. 2015). Their systematic position remains to be studied.

Key to all known species under Bahusutrabeeja.

1.	Conidia globose, without appendage
	B. exappendagiculata
1.	Conidia with short or long setulae appendage0.2
2.	Conidia angular or obpyriform to obclavate3
2.	Conidia spherical
3.	Conidia obpyriform, obclavate, $15-20 \times 5-8 \mu m$, with
	4 basal and 2 apical setulae up to 18 µm long
	B. dubhashii
3.	Conidia angular less than 15 µm diam4
4.	Conidia 8.5–11.5×7.5–10 μ m, with 4 setulae up to
	4.5 μm longB. manoharacharii
4.	Conidia angular, 7–8 μ m, with 3–5 setulae up to 4 μ m
	longB. angularis
5.	Conidia 7.5–10.5 μm setulae 5–9 μm long
	B. bunyensis
5.	Conidia more than 10 µm diam in average7
6.	Conidia 12-19 µm diam, with 8-16 setulae of 4.5-12 µm
	longCodinaea dwaya
6	
0.	Conidia 18–22 μ m diam, with 9–12 setulae of 6.5–
0.	Conidia $18-22 \ \mu\text{m}$ diam, with $9-12$ setulae of $6.5-12.5 \ \mu\text{m}$ longB. globosa

Bahusutrabeeja angularis V. Rao & de Hoog, Stud. Mycol. 28: 67, 1986.

Description on the natural substrate: Saprobe on dead branches. Teleomorph: Unknown. Anamorph: Conidiophores cylindrical, $145-290 \times 4.5-7.5 \mu m$. Conidiogenous cells 4.8–6.5 μm wide at the widest part, 2 μm wide just below the collarette; collarette funnel-shaped, 2–2.5 μm

long, 3.5–4.5 μ m wide at the opening. Conidia roundedcubical to polygonal, aseptate, hyaline, smooth, thick-walled, 7.5–10 μ m diam, one corner being the basal scar, each corner provided with a thin, hyaline appendage, 5–8 μ m long, accumulating in a slimy head at the tips of the conidiogenous cells (Gao et al. 2015).

Materials examined: **China**, Hainan Province, tropical forest of Jianfengling, on dead branches of unidentified broad leaf tree, 18 April 2014, J.M. Gao (HMAS243459).

Ecology/substrate/host: Saprobe on dead branch.

Geographical distribution: China and India (Rao and de Hoog 1986; Chang 1990; Gao et al. 2015).

Description and illustration: Rao and de Hoog (1986); Chang (1990); Gao et al. (2015).

Notes: Bahusutrabeeja angularis differs from other species in the genus by round-cubical to polygonal conidia with several appendages, while in all other species they are somewhat globose or subglobose (Rao and de Hoog 1986; Chang 1990; Gao et al. 2015). The specimen preserved in HMAS was examined in this study and it bears this fungus with slightly bigger conidia than those in original description $(7-8 \mu m \text{ diam.})$, aligned with the description by Gao et al. (2015). Its occurrence (conidia 6.3–7.2 µm diam) on decaying twig from Taiwan was also reported by Chang (1990). Chang (1990) also studied the living strain and observed the ellipsoidal microconidia $(4.5 \times 1 \ \mu m)$ with one end sharper and no appendage formed on autoclaved corn leaf. No living strain is available for phylogenetic analysis by us, thus its phylogenetic relationship with the type species of the genus remains to be studied.

Bahusutrabeeja exappendiculata Xiao X. Li & X.G. Zhang, Mycotaxon 126: 228, 2013.

Saprobe on dead branches. Teleomorph: Unknown. Anamorph: Conidiophores cylindrical, up to 14-septate, $161-275 \times 5-6.5 \mu m$. Conidiogenous cells monophialidic, cylindrical, with a broad sporulating loci and collarette, up to 7.5 µm wide at the widest part; collarette prominent, up to 1 µm long, 3-4 µm wide at the opening. Conidia holoblastic, globose, aseptate, hyaline, smooth, thick-walled, $10.5-16 \mu m$ diam, no appendage, accumulating in a slimy head at the tips of the conidiogenous cells.

Typification: **China**: Guangxi Province, Dayaoshan Nature Reserve, on dead branches of unidentified broad leaf tree, 10 November 2012, Ciao X. Li (HMAS243429, isotype).

Ecology/substrate/host: Saprobe on dead branch.

Geographical distribution: China (Li et al. 2012).

Description and illustration: Li et al. (2012).

Notes: Bahusutrabeeja exappendiculata differs from other species in the genus by globose conidia without appendage, while all other known species in the genus produce conidia with setulae in different number (Rao and de Hoog 1986; Chang 1990; Li et al. 2012; Gao et al. 2015). The isotype specimen preserved in HMAS was examined by us. No living strain is available for molecular study, its phylogenetic relationship with the type species of the genus remains to be studied.

Pseudofuscophialis Sivan. & H.S. Chang, Mycol. Res. 99: 711, 1995.

Colonies effuse, sparse, causing no discoloration on the wood. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, straight, simple, rarely branched, smooth, multiseptate, brown to dark brown. Conidiogenous cells mono- or polyphialidic, integrated, rarely discrete, intercalary, and terminal, sympodial. Phialides terminated by a funnel-shaped collarette. Conidia proliferation at the conidiogenous locus is enteroblastic. Conidia holoblastic, endogenous, acropleurogenous, simple, straight to slightly curved, smooth apex obtuse or acute, truncate at the base, transversely multiseptate, with large, pale brown central cells and smaller, subhyaline to very pale brown end cells (Sivanesan and Chang 1995).

Type species: *Pseudofuscophialis lignicola* Sivan. & H.S. Chang.

Ecology/substrate/host: Saprobe on dead branches.

Geographical distribution: China (Sivanesan and Chang 1995; Cai and Hyde 2007).

Description and illustration: Sivanesan and Chang (1995); Cai and Hyde 2007).

Notes: This genus was described for a fungus found in Taiwan, China and is characterized by dark brown conidiophores terminated with a phialides bearing a funnel-shaped collarette from which the conidia are produced (Sivanesan and Chang 1995). The genus has been remaining to be monotypic so far. Cai and Hyde (2007) reported its occurrence in mainland China.

Pseudofuscophialis lignicola Sivan. & H.S. Chang, Mycol. Res. 99: 711, 1995.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China (Sivanesan and Chang 1995; Cai and Hyde 2007).

Description and illustration: Sivanesan and Sutton (1985); Cai and Hyde (2007).

Notes: No specimen was examined by us. This species has been known only from two collections and its funnel-shaped collarette and fusiform, versicolored, and 3-septate conidia easily distinguishes it from other hyphomycetes (Sivanesan and Chang 1995; Cai and Hyde 2007; Seifert et al. 2011). Stratiphoromyces Goh & K.D. Hyde, Mycol. Res. 102: 1149, 1998.

Description on the natural substrate: Colonies on natural substratum effuse, hairy, dark brown to black. Mycelium mainly immersed in the substratum. Stroma not developed. Setae and hyphopodia absent. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, solitary, erect, unbranched, straight, or slightly flexuous, multiseptate, dematiaceous, smooth, regenerating percurrently. Conidiogenous cells integrated, terminal, with crowded repeating percurrent proliferations. Conidia holoblastic, acrogenous, solitary, euseptate, curved, dematiaceous, setulate, usually aggregated in a mass. Conidial secession rhexolytic (Goh and Hyde 1998a, b).

Type species: *Stratiphoromyces brunneisporus* Goh & K.D. Hyde.

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Brunei, China and India.

Description and illustration: Goh and Hyde (1998a, b).

Notes: Goh and Hyde (1998a, b) created the new genus Stratiphoromyces for S. brunneisporus, and differentiated it from other dematiaceous hyphomycetes by its unique combination of morphological characters: solitary conidiophores which regenerate percurrently like those in some species of Chloridium and Cacumisporium; conidiogenous cells which repeatedly proliferate to produce a crop of solitary, rhexolytically seceding conidia; and brown, uniseptata, curved, setulate conidia. Morphologically Chloridium and Dictyochaeta in Chaetosphaeriaceae are closely related genera but differ from Stratiphoromyces by the septate asymmetrical conidia. The genus is with two described species, S. brunneisporus and S. raghukumarensis D'Souza, S.K. Singh & Bhat (Goh and Hyde 1998b; D'Souza et al. 2002; Seifert et al. 2011). No NDA sequence data are available for phylogenetic analysis, in phylogenetic relationship with Chaetosphaeriaceae remains to be studied.

Stratiphoromyces brunneisporus Goh & K.D. Hyde, Mycol. Res. 102: 1149, 1998. Figure 273

Description on the natural substrate: Colonies on natural substratum effuse, hairy, dark brown to black, sparsely aggregated. Mycelium mainly immersed in the substratum. Teleomorph: Unknown. Anamorph: Conidiophores macronematous, mononematous, solitary, erect, stout, unbranched, straight or slightly flexuous, 100–450 μ m long, more or less cylindrical to attenuated, nodulate along the length due to results of multiple regenerations of conidiogenous regions, with a conical base 25–30 μ m, and gradually tapering towards the apex which is 4–5 μ m wide, black and opaque near the base, dark brown to medium brown at the upper portions, pale brown near the apex, thick–walled, smooth, multiseptate, regenerating percurrently, bearing at



Fig. 273 *Stratiphoromyces brunneisporus* (Wu5509). **a** Conidiophores and conidiogenous cells with developing conidia. **b**, **c** Upper part of conidiophores with terminal conidiogenous cells. **d–h** Conidia. Scale bar: **a** 10 μm, **b–h** 5 μm

the apex a dark brown, globular mass of conidia which is $25-40 \mu m$ diam. Conidiogenous cells integrated, terminal, with crowded repeating percurrent proliferations. Conidia produced singly at the apex of the conidiogenous cells, usually aggregated in a mass, overall shape more or less ellipsoidal, slightly curved, $12-15 \times 4.5-5.5 \mu m$, medium brown, smooth, with one setulae at each end, with a single, central

euseptum, not constricted at the septum, distal cell more or less triangular, proximal cell more or less rhomboid, with a slightly protruding, obtuse hilum, bearing minute frills of wall remnants resulting from rhexolytic conidial secession. Setulae thin, $(5-)8 \mu m \log$, straight to curved, hyaline, slightly swollen at the tip. Materials examined: **China**, Hainan Province, on dead branches of palm, 20 December 2000, W.P. Wu and Yan Huang (Wu5508, Wu5509).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: Brunei, China and India (Goh and Hyde 1998b; D'Souza et al. 2002).

Description and illustration: Goh and Hyde (1998b); D'Souza et al. (2002).

Notes: As the type species of the genus, *Stratiphoromyces brunneisporus* is characteristics in conidiogenous proliferation and conidial morphology. Fully description and illustration were provided by Goh and Hyde (1998b) and D'Souza et al. (2002). Attempt to isolate the fungus from fresh material was failed and the conidia did not germinate under the normal isolation method.

Stratiphoromyces multifimbriatus (R. Kirschner & C.J. Chen) W.P. Wu & Y.Z. Diao, comb. nov., MycoBank MB841741.

≡ Dictyochaeta multifimbriata R. Kirschner & C.J. Chen, Mycol. Prog. 1: 287, 2002.

Description on the natural substrate: Colonies effuse, velvety, brown. Setae absent. Teleomorph: Unknown. Anamorph: Conidiophores solitary, septate, 120–450 μ m long, 7–11 μ m wide at the base, 6–7 μ m wide at the apex. Conidiogenous cell monophialidic, terminal, integrated, cylindrical, with an apical, flaring collarette, 20–35×6–7 μ m. Conidia aggregated in a white slimy head at the top of the conidiophore, hyaline, one-celled, reniform, guttulate when fresh or with 1–2 large and several minute drops after drying and subsequent mounting in KOH, 11–13×6–7 μ m, with a truncate, 1 μ m wide abscission scar, (2)3–6 (mostly 4) sub-basal setulae and with 2–4 (mostly 3) apical setulae, setulae slightly flexuous, 8–12(15) μ m long and not exceeding 0.5 μ m in diam.

Typification: **China**, Taiwan, Kaohsiung, Chu Yun Shan Lin Dao, on dead twig on ground, associated with *Tetraploa aristate*, 28 Apr. 2001, R. Kirschner & C.J. Chen (HAST 832).

Ecology/Substrate/Host: Saprobe on dead material of plant.

Geographical distribution: China (Kirschner and Chen 2002).

Description and illustration: Kirschner and Chen (2002).

Notes: *Dictyochaeta multifimbriata* is unique in producing reniform conidia with excentric basal scars and several setulae at each end. The reniform-shaped conidia with 3–6 setulae at each end easily distinguish it from others (Lunghini et al. 1982; Kuthubutheen and Nawawi 1991a, b, c, d, e; Whitton et al. 2000). *Dictyochaeta multifimbriata* is very similar to *Stratiphoromyces brunneisporus* Goh & K.D. Hyde on conidiophores, conidiogenous cells and conidia, except for the hyaline and broader conidia with multisetulae at each end, thus it is transferred into the genus. No living strain can be located for phylogenetic study.

Discussion

Based on and morphological study and phylogenetic analysis, the family Chaetosphaeriaceae is further expanded to accommodate 89 accepted genera, including 24 new genera and 10 newly assigned genera. It is expected that the family will be further expanded with more genera from revision of the polyphyletic genus Chaetosphaeria, availability of molecular data and phylogenetic analysis for existing genera, and diversity exploration from subtropical and tropical areas. For future study of chaetosphaeriaceous fungi, several potential interesting areas could be explored: a). phylogenetic analysis by using the whole genome sequencing and with inclusion of all representatives from different linkages might further elucidate the phylogenetic relationships of these fascinating fungi; b). molecular phylogenetic analysis and revision of several polyphyletic genera will support to establish a natural classification system for these fungi; these polyphyletic genera are Ellisembia, Stanjehughesia, Cacumisporium, Chaetosphaeria, Chloridium, Craspedodidymum, Cryptophiale, Cryptophialoidea, Dictyochaetopsis, Minimidochium, and many published species of Codinaea and Dictyochaeta; c). biodiversity exploration of these fungi, especially in subtropical and tropical areas, could lead to further expansion of the family and also help to obtain more living strains for molecular phylogenetic study.

Non-phialidic anamorphs of Chaetosphaeriaceae

The chaetosphaeriaceous fungi with non-phialidic anamorphs are polyphyletic, majority of them are *Sporidesmium*like fungi in anamorphs and with holoblastic conidiogenous cells, multiseptate and versicolor ascospores in teleomorphs. Based on the morphological and phylogenetic analysis, ten monophyletic genera are proposed for these fungi: *Aunstrupia, Ellisembia, Falholtia, Linkosia, Lomaantha, Morrisiella, Paliphora, Riisgaardia, Stanjehughesia,* and *Zanclospora.* Most of these genera are well defined monophyletic genera in both morphology and phylogeny. However, the two relatively large genera, *Ellisembia* and *Stanjehughesia*, are probably polyphyletic and need to be further studied towards a monophyletic generic concept and revision of the established species.

Inclusion of *Ellisembia* in Chaetosphaeriaceae is still doubtful and needs to be further confirmed when the DNA sequence data will be available from fresh collection of the type species *E. coronata*. This will also support to redefine the concept of the genus and revision of the over 70 known species. For *Stanjehughesia*, the type species is included in the phylogenetic analysis and the genus is well defined. However, most of other known species (15/17) in *Stan-jehughesia* have not been studied with living strains and DNA sequences, their systematic positions still remain to be studied.

Chaetosphaeria is still polyphyletic and revision needed

The large genus with both anamorph and teleomorphs known and diverse on morphology, Chaetosphaeria, is polyphyletic and problematic, which is aligned with what was reported already (Réblová 2000; Fernández and Huhndorf 2005; Fernández et al. 2006; Lin et al. 2019; Luo et al. 2019; Hyde et al. 2020; Réblová et al. 2020, 2021a, b, c). The species included in the analysis are distributed in many different clades on the ML tree. Some of these species have been revised and a number of species are transferred to some already established or new monophyletic genera, including Cacumisporium, Catenularia, Chloridium, Dictyochaeta, Ellisembia, Exserticlava, Thozetella and Zanclospora. However, still many other known species are phylogenetically distinct from the type species of the genus and other established genera, and they need to be reclassified. Based on our phylogenetic analysis, several published Chaetosphaeria species are revised here.

Several Chaetosphaeria species are grouped together with Chloridium and Gonytrichum species, including type species of the two asexually typified genera, Chloridium virescens for Chloridium and Gonytrichum caesium for Gonytrichum. These Chaetosphaeria species are always with *Chloridium* or *Gonytrichum* anamorphs, including C. chloroconia (anamorph: G. chlamydosporum), C. inaequalis (anamorph: G. caesium), C. vermicularioides (anamorph: C. virescens) and Melanopsammella gonytrichii (anamorph: Chloridium gonytrichii). Morphologically, the conidiogenous cells of these species are monophialidic, occasionally with percurrent proliferation, and often with meristematic tip protruding beyond the collarette and producing several hyaline and aseptate conidia side by side from successively formed conidiogenous loci (Gams and Holubová-Jechová, 1976). Now these species are excluded from Chaetosphaeria and well resolved with Chloridium names (Réblová et al. 2016, 2021c).

Another clade with inclusion of several *Chaetosphaeria* species is the one with *Zanclospora*, and characterized by lateral phialides on the setiform conidiophores. Except for *Chaetosphaeria minuta*, all these species (*C. jonesii*, *C. lateriphiala*, *C. sylvatica* and *C. tropicalis*) are now transferred into the monophyletic genus *Zanclospora* as emended by Réblová et al. (202a). *Chaetosphaeria minuta* resembles *Zanclospora* in setiform conidiophores bearing lateral phialides but in only one side of the conidiophores, the new genus *Zanclosporiella* is introduced for this fungus.

Chaetosphaeria rivularia is phylogenetically related to members of the genus *Thozetella*, while distinct from other *Chaetosphaeria* species. The relationship between *Chaetosphaeria* and *Thozetella* was suggested by Paulus et al. (2004) and confirmed with *Chaetosphaeria rivularia* (Ariyawansa et al. 2015). *Chaetosphaeria rivularia*, originally described with both teleomorph and *Thozetella*-like anamorph on wood submerged in freshwater in southern France, is the only known *Chaetosphaeria* species with the *Thozetella* anamorph. Based on our phylogenetic analysis, it should be placed under *Thozetella* as an independent species.

Chaetosphaeria luquillensis is phylogenetically distinct from all other known *Chaetosphaeria* species, thus it should be excluded from the genus. Morphologically it resembles species of *Dictyochaeta* s. str. in presence of setae, short conidiophores clustered with setae, and hyaline conidia without setulae. However, in this species, the conidia are aciculate or obclavate, and 3-septate. The anamorphic species *Dictyochaeta aciculata* resembles the anamorph of *Chaetosphaeria luquillensis* (Silva and Gusmão 2013). Here a new genus *Aciculadictyochaeta* is introduced for these two fungal species.

Chaetosphaeria longiseta and several other *Codinaea*like fungal species are grouped together as a strongly supported clade unrelated to other *Chaetosphaeria* species, including the type species. Morphologically these fungi are also unique in producing versicolored sterile setae with darker ultimate or penultimate cells, and multiguttulate asetulate or setulate conidia (Hughes and Kendrick 1968; Kuthubutheen and Nawawi 1991a, 1991e; Fernández and Huhndorf 2005; Cruz et al. 2008). The new genus *Xyladelphia* is recently introduced for this small group of species.

On the ML phylogenetic tree, many known Chaetosphaeria species, including Chaetosphaeria innumera, the type species of Chaetosphaeria with Chloridium botryoideum as anamorph, are grouped together in one of the big branches where several well-known asexually typified genera such as Kionochaeta and Dictyochaeta s. str. are included. The 8 undefined *Chaetosphaeria* species in this big clusters are C. dilabens, C. guttulata (only anamorph known, conidiogenous cells not phialidic, polyblastic with many tiny protuberant conidiogenous loci), C. lentomita (anamorph: Chloridium pachytrachelum), C. mangrovei (no anamorph reported), C. myriocarpa (anamorph: Chloridium clavaeforme), C. pygmaea (anamorph: Phialophora phaeophora), C. preussii (anamorph: Chloridium preussii). Together with some Chloridium species (C. botryoideum, C. clavaeforme, C. lignicola and C. pini and some undescribed species), these species need to be revised in both generic and species level. Except for Chaetosphaeria guttulata and C. mangrovei without known anamorph, the known anamorphs of these species belong to Chloridium section Gongromeriza (proliferation of the conidiophores only percurrent) and *Psilobotrys* (proliferation of the conidiophores mainly sympodial) (Gams and Holubová-Jechová 1976; Constantinescu et al. 1995; Réblová and Seifert 2003; Réblová 2000; Réblová and Winka 2000; Fernández and Huhndorf 2005; Fernández et al. 2006; Lin et al. 2019; Luo et al. 2019; Réblová et al. 2020, 2021a, b, c, d).

On the phylogenetic tree, all other Chaetosphaeria species with various anamorphs classified in *Catenularia*, Cacumisporium, Kylindria-like, Dischloridium, Exserticlava, Obeliospora, Phialophora, Stanjehughesia are grouped together with the Paragaeumannomyces to form a strongly supported clade (99/1) unrelated to the type species of the genus and other Chaetosphaeria species. Some of these species have been revised and transferred to already established or new monophyletic genera, including Cacumisporium, Catenularia, Exserticlava, Paragaeumannomyces, Stanjehughesia. Two new genera are introduced by us for two of these species: Fusichloridium for C. fusiformis and Phaeodischloridium for C. aquatica. While several other phylogenetically distinct species still need to be revised in both generic and species level, these species are C. chalaroides with Fusichalara-like anamorph, C. conirostris and C. curvispora with Dictyochaeta-like anamorph, C. fennica with Chloridium-like anamorph, C. lignomollis with Kylindria-like anamorph (Gams and Holubová-Jechová 1976; Constantinescu et al. 1995; Réblová and Gams 1999, 2000; Réblová 2000; Réblová and Winka 2000; Réblová and Seifert 2003; Fernández and Huhndorf 2005; Fernández et al. 2006; Atkinson et al. 2007; Hyde et al. 2018; Lin et al. 2019; Luo et al. 2019).

Revision of polyphyletic genera *Codinaea* s. lat., *Dictyochaeta* s. lat. and *Tainosphaeria* s. lat.

Species of Codinaea, Dictyochaeta and Tainosphaeria are polyphyletic and phylogenetically located in several different clades in the phylogenetic tree, which is aligned with previous studies (Liu et al. 2016; Perera et al. 2016; Hernández-Restrepo et al. 2017; Tibpromma et al. 2018; Yang et al. 2018a; Lin et al. 2019; Luo et al. 2019; Hyde et al. 2020; Réblová et al. 2020, 2021a, b, c). The genera Codinaea, Dictyochaeta and Tainosphaeria were recently revised with monophyletic generic concept, and several generic names were introduced towards a framework for revision of existing species and assignment of new taxa (Réblová et al. 2021a, b, c, e). Under these three genera, more than 150 species names are known, proximally half of them are revised with available living strains and DNA sequence, while many other species still remained to be studied (Spegazzini 1923; Marie 1937; Index of Fungi).

Based on both morphologic and phylogenetic study, these polyphyletic genera are partly resolved for those studied species by accepting 22 monophyletic genera through: a). redelimitation of *Codinaea*, *Dictyochaeta* and *Tainosphaeria* in narrow concepts, b). acceptance of some established genera (including *Achrochaeta*, *Anacraspedodidymum*, *Codinaeella*, *Flectospora*, *Multiguttulispora*, *Nimesporella*, *Phialogeniculata*, *Phialoturbella*, *Stilbochaeta*, *Tainosphaeriella*, *Xyladelphia*), and finally c). introducing several new genera, including *Aciculadictyochaeta*, *Brachydictyochaeta*, *Calceisporiella*, *Lunatochaeta*, *Neotainosphaeria*, *Oxenbollia*, *Parabahusutrabeeja*, and *Paracodinaea*. These 22 genera are phylogenetically distinct and most of them can also be delimited by a combination of different morphological characters, such as setae, conidiophores, conidiogenous cells, conidia and conidial appendages.

With this framework, all studied species in our analysis are properly assigned to the relevant genera. However, many other species were not covered in our study, mainly due to lacking living strains and DNA sequences data (Kuthubutheen and Nawawi 1991a; Whitton et al. 2000). Future phylogenetic studies on some other published species are needed to provide a full solution to resolve these genera complex. For example, four synnematous species of Codinaea species, including Codinaea delicata, C. obesispora, C. pindobacuensis and Dictyochaeta dendroidea, are with synnamatous conidioma, terminal and monophialidic or polyphilidic conidiogenous cells with funnel-shaped collarette, and hyaline, aseptate conidia with setulae at both ends, none of them is available with living strain and DNA sequence and their taxonomic positions remain to be solved (Hughes and Kendrick 1968; Kuthubutheen 1987a, b, c, d; Almeida et al. 2014; Granados et al. 2014). Many non-setulate species are yet to be resolved, including D. circei, D. curvispora, D. heteroderae, D. illinoensis, D. lilliputiana, D. lunulospora, D. minutissima, D. occidentalis, D. uncinata, D. zapatensis, Codinaea apiculata, C. curvispora and C. setosa (Kuthubutheen and Nawawi 1992; Whitton et al. 2000). In addition, two species with pale colored conidia, D. multifimbriata and D. subfuscospora were placed in the genus Dictyochaeta and their taxonomic positions also remain to be studied (Kuthubutheen and Nawawi 1991a; Hernández-Gutiérrez and Portales 1996; Castañeda-Ruiz et al. 1998; Kirschner et al. 2001; Kirschner and Chen 2002; Cai et al. 2004).

Chloridium is polyphyletic and needs to be revised

Chloridium is polyphyletic and a systematic revision for the genus is needed. The members included in our research are grouped into several different clades in Chaetosphaeriaceae and some species should be excluded from the genus. Based on the phylogenetic analysis, the genus is emended to include those species which are clustered together with the type species of the genus, *Chloridium virescens*. The accepted species under the genus include all species known

as Gonytrichum (including G. caesium (the type species, = Chaetosphaeria inaequalis), G. mirabile, G. chlamydosporium (= Chaetosphaeria chloroconium), and G. macrocladum, Chaetosphaeria vermcularioides, Chloridium aquaticum, and several undescribed Chloridium species (Hughes 1951; Réblová and Winka 2000; Fernández and Huhndorf 2005; Fernández et al. 2006; Crous et al. 2012; Réblová 2000; Réblová et al. 2016).

The other studied *Chloridium* species and some *Chaeto-sphaeria* with *Chloridium*-like anamorphs are found in several different phylogenetic clades. A systematic revision of these species, together with other known species is needed with a holistic view (Réblová 2000; Crous et al. 2018a, b; Luo et al. 2019). Here we also exclude three species from the genus and transfer them to other fungal genera, *C. obclavata* to *Phialogeniculata*, *C. reniformis* to *Xylolentia*, *C. phaeosporum* to a new genus *Phaeochloridium* in Plectosphaerellaceae (Glomerallales) (Gams and Holubová-Jechová 1976; Réblová 2018; Yuan et al. 2020).

Craspedodidymum elatum., the type species of the genus Craspedodidymum, is grouped together with Chaetosphaeria dilabens with strong support. It is the first time that the ITS and LSU sequences are obtained for Craspedodidymum. The genus is characterized with single or branched conidiophores, terminal monophialidic conidiogenous cell with a wide funnel-shaped collarette, and ellipsoidal, brown and aseptate conidia (Holubová-Jechová 1972; Mercado Sierra et al. 1997a, b). The genus was previously assigned to Chaetosphaeriaceae, but that is based on observation of the similar anamorphs obtained for several scolecosporous species of Chaetosphaeria, now known as Paragaeumannomyces (Huhndorf and Fernández 2005; Perera et al. 2016; Réblová et al. 2020). Under the genus, 17 species names are known, and revision is needed with study including of living strain and DNA sequences in future.

Cryptophiale and related genera with lateral or intercalary phialides

The genera with lateral or intercalary phialides in Chaetosphaeriaceae are found in four different phylogenetic groups on the ML tree. The type species of *Codinaeopsis* is clustered together with *Codinaea* with setae and setulate conidia; species of *Gonytrichum* are grouped together with *Chloridium*; species of *Menispora* form sister groups with *Arcuatospora*; species of *Kionochaeta* are closely related to true *Chaetosphaeria* and *Dictyochaeta* species; and all other genera, including *Cryptophiale*, *Cryptophialoidea*, *Paraceratocladium Paracryptophiale*, *Zanclospora*, form an independent phylogenetic group with strong bootstrap support value. The monophyletic genus *Zanclospora* was recently emended and revised by Réblová et al. (2021a).

The distinction between Cryptophiale, Cryptophialoidea and Paracryptophiale is not well supported from the phylogenetic analysis. All studied species under Cryptophiale., Cryptophialoidea and Paracryptophiale are clustered together with Paraceratocladium, Conicomyces and Kionochaeta ivoriensis with good support. This is aligned with the other previous publication (Yang et al. 2018a; Lin et al. 2019). In contrast to result from the molecular phylogenetic analysis, these genera are morphologically well defined and can be easily distinguished. Cryptophialoidea differs from Cryptophiale in having obvious monophialidic conidiogenous cells arranged only on one side of the conidiophore and not covered by a shield of sterile cells (Kuthubutheen and Nawawi 1987; Whitton et al. 2012); Paracryptophiale resembles Cryptophiale in having setiform conidiophores and typical Cryptophiale-like conidiogenous cells aggregated into a fertile region with shield cells, but differs by the dictyosporous conidia by Paracryptophiale (Kuthubutheen and Nawawi 1994a; Wu and Mckenzie 2003). Many species have been already known under these genera, and future molecular study with inclusion of more these species and different marker genes will support to clarify their phylogenetic relationship and delimitation of generic concept (Goh and Hyde 1996b; Delgado et al. 2002, 2005; Marques et al. 2008; Wu and McKenzie 2003; Whitton et al. 2012; Yang et al. 2018a).

The two studied species in the genus Paraceratocladium, P. silvestre and P. polysetosum, are polyphyletic, and the generic name Paraceratocladiella is introduced to accommodate P. polysetosum and P. bacilliforme. Phylogenetically Paraceratocladium, typified by P. silvestre, is closely related to Cryptophiale, Cryptophialoidea and Paracryptophiale. Morphologically all these fungi producing setae or setiform conidiophores, monophialidic or polyphialidic conidiogenous cells with funnel-shaped collarettes, and hyaline, aseptate or septate conidia, but differ in morphology of setae, conidiophores and conidiogenous cells (Pirozynski 1968; Castañeda-Ruiz 1987; Kuthubutheen and Nawawi 1987, 1994a, b, c; McKenzie and Hyde 1997; Dulymamode et al. 1998; Whitton et al. 2001; Seifert et al. 2011; Lin et al. 2019; Luo et al. 2019). The other three known species under the genus Paraceratocladium, including P. malaysianum, P. seychellarum, P. triseptata are morphologically similar to P. silvestre, but remain to be studied for their phylogenetic relationship (Castañeda-Ruiz 1987; McKenzie and Hyde 1997; Dulymamode et al. 1998; Whitton et al. 2001).

Obeliospora, probably an earlier name for *Paragaeumannomyces*

One single spore isolate of *Obeliospora minima* is clustered together with members of *Paragaeumannomyces*, a re-validated genus for several *Chaetosphaeria* species with scolecosporous ascospores, and formed a well-supported group (Réblová et al. 2020). In the study of Chaetosphaeria raciborskii and related genera with scolecospore ascospore, Huhndorf and Fernández (2005) described several Chaetosphaeria species with Obeliospora-like anamorphs in pure culture, although they called them Craspedodidymum-like. On MCA and MA, all these species form poorly developed conidiophores with a few cells from hyphae, flask-shaped to obclavate conidiogenous cells with flared or cup-shaped collarette, and hyaline, aseptate, globose to subglobose conidia with or without setulae. Among them, C. ellisii, C. lapaziana and C. panamensis produce asetulate conidia; C. raciborskii produces the globose to subglobose, asetulate conidia (most strains) or the triangular conidia with 3 setulae (the strain SMH3119); while C. rubicunda produces the globose, subglobose to subangular conidia bearing 3 setulae. The very similar conidiophores, conidiogenous cells and conidia are also reported from the Thailand strain of P. panamensis by Perera et al. (2016). These anamorphs are aligned with the asexually typified genus Obeliospora. Recently these fungi together with several other scolecosporous Chaetosphaeria species are reclassified under Paragaeumannomyces (Réblová et al, 2020). Combined with morphology and molecular analysis, Obeliospora Nawawi & Kuthub. (1990) and Paragaeumannomyces Matsu. (2003) are most likely congeneric, and the earlier name should be Obeliospora. Unfortunately, the strain and DNA sequence data of the type species for the genus Obeliospora, Obeliospora basispira, is not available for analysis. We recommend use the more wellestablished Paragaeumannomyces for these fungi and made transferring of all Obeliospora species. However, these still need to be confirmed by molecular phylogenetic analysis when living strains will be available.

Menisporopsis and related genera with synnematous conidiomata

The synnematous genera in Chaetosphaeriaceae are polyphyletic and found in different phylogenetic groups on the ML tree. These genera include *Arcuatospora*, *Hoehneliella.*, *Menisporopsis Phialoarthrobotryum*, *Polynema* and *Phialosporostilbe*. However, all these genera except for *Menisporopsis*, seem to be well-defined monophyletic genera.

The genus *Menisporopsis*, typified by *M. theobromae*, is polyphyletic and the species are resolved with two very distinct phylogenetic groups. The genus was revised recently by accepting two monophyletic genera to accommodate these fungi, including emending the genus *Menisporopsis* with narrow concept and creating the new genus *Arcuatospora* (Réblová et al. 2021b). Two other synnematous genera with phialidic conidiogenous cells are newly assigned to the family Chaetosphaeriaceae, including *Hoehneliella* and *Phialoarthrobotryum* (Nag Raj 1993; Seifert et al. 2011).

Thozetella and related genera with sporodochial conidiomata

The sporodochial genera in Chaetosphaeriaceae are also polyphyletic and found in different phylogenetic groups on the ML tree. These genera include *Adautomilanezia*, *Eucalyptostroma*, *Eucalyptostromiella*, *Rattania*, *Minimidochium*, *Thozetella* and *Verhulstia*. However, these genera seem to be well-defined monophyletic genera.

All species of Thozetella, typified by T. nivea, are grouped together as a monophyletic clade with strong support value. Morphologically, Thozetella is also unique in forming sporodochial and/or synnematal conidiomata, presence of microawns, and setulate, hyaline and aseptate conidia in wet spore mass (Seifert et al. 2011). The relationship between Chaetosphaeria and Thozetella was suggested by Paulus et al. (2004) and later confirmed with Chaetosphaeria rivularia (Ariyawansa et al. 2015). Chaetosphaeria rivularia, originally described with both teleomorph and Thozetellalike anamorph on wood submerged in freshwater in southern France, is the only known Chaetosphaeria species with the Thozetella anamorph. Phylogenetically C. rivularia is closely related to all members of the genus Thozetella, while very distinct from all other Chaetosphaeria species. We recommend transferring C. rivularia to Thozetella.

Three isolates identified as *Rattania* spp. from China together with *Rattania setulifera*, the type species of the genus, are clustered together and form a distinct clade with strong support. Phylogenetically these fungi show more closer relationship with *Tainosphaeria* and all *Codinaea* s. lat. and *Dictyochaeta* s. lat. with no setae and producing setulate conidia. *Minimidochium*, typified by *M. setosum*, is characterized with sporodochial conidiomata with setae among conidiophores, monophialidic conidiogenous cells, and hyaline, falcate and setulate conidia (Sutton 1970; Bhat 2010). Morphologically it resembles *Rattania*, but phylogenetically it is clustered together with all *Codinaea* and *Dictyochaeta* species with septate conidia and forms a separate branch.

Several isolates representing three different species of *Verhulstia* obtained from China, are clustered together with *V. trisorosrum* (the type species of the genus) and form a distinct clade with strong support. Morphologically this recently described genus *Verhulstia* resembles *Minimidochium* on sporodochial conidiomata with setae among conidiophores and differs by producing ellipsoidal conidia without setulae (Crous et al. 2017). phylogenetically they are also very distinct, the members of *Verhulstia* shows closer

relationship with several Chaetosphaeria species with Chloridium-like anamorph, including Chloridium lignicola and Chloridium pini.

Four species of Eucalyptostroma, E. eucalypti (the type species), E. eucalyptorum, and two undescribed fungi from China, are clustered together and form a distinct group with strong support. The genus, as typified by E. eucalypti, is characteristic in producing tiny orange-brown sporodochial conidiomata without setae, branched conidiophores with terminal monophialidic conidiogenous cells, and hyaline, aseptate, falcate conidia in wet spore mass (Crous et al. 2016, 2019). Several isolates from decaying fruit of *Quercus* sp. collected around Beijing area produce very similar conidiomata, conidiogenous cells and conidia as Eucalyptostroma, but phylogenetically very distinct and the new genus Eucalyptostromiella is created to accommodate this fungus. On the phylogenetic tree, the genus Paliphora, with setiform conidiophores, intercalary or terminal conidiogenous cells, polytretic sporulating loci on the conidiogenous cells as seen in Helminthosporium, and hyaline, aseptate or septate, cylindrical to subfusiform or subacerose conidia in slimy masses, is clustered together with the genus Eucalyptostroma with strong support (Sivanesan and Sutton 1985; Kuthubutheen 1987a, b, c, d; Alcorn 1996; Gusmão et al. 2008; Goh et al. 2014a, b; Malosso et al. 2017).

Coelomycetous genera

Aligned with the previous work, all the coelomycetous genera, Brunnepdinemasporium, Calvolachnella, Dendrophoma, Dinemasporium, Infundibulomyces, Neopseudolachnella, Polynema, Pseudolachnea, Pseudolachnella and Pseudodinemasporium are monophyletic and well-defined (Sutton 1980b; Nag Raj 1993; Crous et al. 2012; Hashimoto et al. 2015a, b; Li et al. 2020). These coelomycetous genera are phylogenetically polyphyletic and distributed among different clades in the ML tree. Infundibulomyces and Calvolachnella are more closely related to some Codinaea species without setae. All species of Dinemasporium formed sister groups with Menispora and Menisporopsis and Codinaea species with septate conidia. All species of other genera, including Brunnepdinemasporium, Dendrophoma, Neopseudolachnella, Polynema, Pseudolachnea, Pseudolachnella are

(*not member of Chaetosphaeriaceae)

- 1. Aciculadictyochaeta W.P. Wu & Y.Z. Diao
- 2. Aunstrupia W.P. Wu & Y.Z. Diao
- 3. Brachydictyochaeta W.P. Wu & Y.Z. Diao
- 4. Calceisporiella W.P. Wu & Y.Z. Diao
- Curvichaeta W.P. Wu & Y.Z. Diao 5.

- 6. Ejnerjensenia W.P. Wu & Y.Z. Diao
- 7. Eucalyptostromiella W.P. Wu & Y.Z. Diao
- 8. Falholtia W.P. Wu & Y.Z. Diao
- 9. Fusichloridium W.P. Wu & Y.Z. Diao
- 10. Kionochaetiella W.P. Wu & Y.Z. Diao
- 11. Kylindrochaeta W.P. Wu & Y.Z. Diao
- 12. Lunatochaeta W.P. Wu & Y.Z. Diao
- 13. Monosporoschisma W.P. Wu & Y.Z. Diao
- 14. Neotainosphaeria W.P. Wu & Y.Z. Diao
- 15. Oxenbollia W.P. Wu & Y.Z. Diao
- 16. Parabahusutrabeeja W.P. Wu & Y.Z. Diao
- 17. Paraceratocladiella W.P. Wu & Y.Z. Diao
- 18. Paracodinaea W.P. Wu & Y.Z. Diao
- 19. Parasporendocladia W.P. Wu & Y.Z. Diao*
- 20. Phaeochloridium W.P. Wu & Y.Z. Diao*
- 21. Phaeodischloridium W.P. Wu & Y.Z. Diao
- 22. Pseudothozetella W.P. Wu & Y.Z. Diao
- Riisgaardia W.P. Wu & Y.Z. Diao 23.
- 24. Sinochloridium W.P. Wu & Y.Z. Diao*
- 25. Zanclosporiella W.P. Wu & Y.Z. Diao

A list of new fungal species

(*not member of Chaetosphaeriaceae)

- 1. Arcuatospora ellisii W.P. Wu & Y.Z. Diao
- 2. Arcuatospora hughesii W.P. Wu & Y.Z. Diao
- 3. Arcuatospora lunata W.P. Wu & Y.Z. Diao
- 4. Arcuatospora septata W.P. Wu & Y.Z. Diao
- 5. Arcuatospora sinensis W.P. Wu & Y.Z. Diao
- 6. Arcuatospora suttonii W.P. Wu & Y.Z. Diao
- 7. Arcuatospora yunnanensis W.P. Wu & Y.Z. Diao
- 8. Brachydictyochaeta bulliformis W.P. Wu & Y.Z. Diao
- 9. Brunneodinemasporium sinense W.P. Wu & Y.Z. Diao
- Calceisporiella sinensis W.P. Wu & Y.Z. Diao 10.
- Catenularia elegans W.P. Wu & Y.Z. Diao 11.
- 12. Chloridium crousii W.P. Wu & Y.Z. Diao
- 13. Chloridium culmicola W.P. Wu & Y.Z. Diao
- Chloridium cylindrosporellum W.P. Wu & Y.Z. Diao 14.
- 15. Chloridium jilinense W.P. Wu & Y.Z. Diao
- 16. Chloridium kirkii W.P. Wu & Y.Z. Diao
- 17. Chloridium proliferatum W.P. Wu & Y.Z. Diao
- 18. Chloridium setosum W.P. Wu & Y.Z. Diao
- 19. Chloridium shangsiense W.P. Wu & Y.Z. Diao
- 20. Chloridium sinense W.P. Wu & Y.Z. Diao
- 21. Chloridium tropicale W.P. Wu & Y.Z. Diao
- 22. Chloridium xishuangbanaense W.P. Wu & Y.Z. Diao
- Codinaea clavatospora W.P. Wu & Y.Z. Diao 23.
- 24. Codinaea dinghushanensis W.P. Wu & Y.Z. Diao
- 25. Codinaea fanglanii W.P. Wu & Y.Z. Diao
- Codinaea kendrickii W.P. Wu & Y.Z. Diao 26.
- 27. Codinaea latispora W.P. Wu & Y.Z. Diao
- Codinaea minima W.P. Wu & Y.Z. Diao 28.

clustered together as one strongly supported group. A list of new fungal genera

- 29. Codinaea oxenbolliae W.P. Wu & Y.Z. Diao
- 30. Codinaea pyriformis W.P. Wu & Y.Z. Diao
- 31. Codinaea simaoensis W.P. Wu & Y.Z. Diao
- 32. Codinaea tengii W.P. Wu & Y.Z. Diao
- 33. Codinaea trisetula W.P. Wu & Y.Z. Diao
- 34. Codinaeella brevissima W.P. Wu & Y.Z. Diao
- 35. Codinaeella cannonii W.P. Wu & Y.Z. Diao
- 36. Codinaeella cinnamomi W.P. Wu & Y.Z. Diao,
- 37. Codinaeella kuthubutheenii W.P. Wu & Y.Z. Diao
- 38. Codinaeella latispora W.P. Wu & Y.Z. Diao
- 39. Codinaeella multisporuloca W.P. Wu & Y.Z. Diao
- 40. Dinemasporium beijingense W.P. Wu & Y.Z. Diao
- 41. Dinemasporium fanglanii W.P. Wu & Y.Z. Diao
- 42. Dinemasporium longisporum W.P. Wu & Y.Z. Diao
- 43. Dinemasporium multisetulum W.P. Wu & Y.Z. Diao
- 44. Dinemasporium suttonii W.P. Wu & Y.Z. Diao
- 45. Dinemasporium tubakii W.P. Wu & Y.Z. Diao
- 46. Dinemasporium yongnianii W.P. Wu & Y.Z. Diao
- 47. Ellisembia reblovae W.P. Wu & Y.Z. Diao
- 48. Eucalyptostroma hongluosiensis W.P. Wu & Y.Z. Diao
- 49. Eucalyptostroma oxenbolliae W.P. Wu & Y.Z. Diao
- 50. Eucalyptostromiella beijingensis W.P. Wu & Y.Z. Diao
- 51. Fuscocatenula bumbsicola W.P. Wu & Y.Z. Diao
- 52. Hoehneliella triseptata W.P. Wu & Y.Z. Diao
- 53. Kionochaeta beijingensis W.P. Wu & Y.Z. Diao
- 54. Linkosia acutispora W.P. Wu & Y.Z. Diao
- 55. Linkosia gelatinosa W.P. Wu & Y.Z. Diao
- 56. Linkosia filiformis W.P. Wu & Y.Z. Diao
- 57. Linkosia rostrata W.P. Wu & Y.Z. Diao
- 58. Linkosia subramanianii W.P. Wu & Y.Z. Diao
- 59. Lunatochaeta shenzhenensis W.P. Wu & Y.Z. Diao
- 60. *Menispora paraciliata* W.P. Wu & Y.Z. Diao
- 61. Menispora paratortuosa W.P. Wu & Y.Z. Diao
- 62. Menisporopsis biformis W.P. Wu & Y.Z. Diao
- 63. Menisporopsis dinemasporioides W.P. Wu & Y.Z. Diao
- 64. Menisporopsis macrospora W.P. Wu & Y.Z. Diao
- 65. Minimidochium dictyochaetum W.P. Wu & Y.Z. Diao
- 66. Minimidochium triseptata W.P. Wu & Y.Z. Diao
- 67. Morrisiella reblovae W.P. Wu & Y.Z. Diao
- 68. Monosporoschisma elegans W.P. Wu & Y.Z. Diao
- 69. Multiguttulispora paratriseptata W.P. Wu & Y.Z. Diao
- 70. Neopseudolachnea microsperma W.P. Wu & Y.Z. Diao
- 71. Neotainosphaeria microsperma W.P. Wu & Y.Z. Diao
- 72. Nimesporella aunstrupii W.P. Wu & Y.Z. Diao
- 73. Nimesporella riisgaardii W.P. Wu & Y.Z. Diao
- 74. Oxenbollia lunatospora W.P. Wu & Y.Z. Diao
- 75. Parabahusutrabeeja minima W.P. Wu & Y.Z. Diao
- 76. Paracodinaea japonica W.P. Wu & Y.Z. Diao
- 77. Paragaeumannomyces asetulus W.P. Wu & Y.Z. Diao
- 78. Paragaeumannomyces nawawii W.P. Wu & Y.Z. Diao
- 79. Phaeochloridium gamsii W.P. Wu & Y.Z. Diao*
- 80. Phaeostalagmus minimus W.P. Wu & Y.Z. Diao
- 81. Pseudodinemasporium elegans W.P. Wu & Y.Z. Diao

531

- 83. Pseudolachnea macrospora W.P. Wu & Y.Z. Diao
- 84. Pseudolachnella minima W.P. Wu & Y.Z. Diao
- 85. Pseudolachnella tengii W.P. Wu & Y.Z. Diao
- 86. Pseudolachnella yunnanensis W.P. Wu & Y.Z. Diao
- 87. Pseudothozetella lunata W.P. Wu & Y.Z. Diao
- 88. Rattania falcata W.P. Wu & Y.Z. Diao
- 89. Rattania intermedia W.P. Wu & Y.Z. Diao
- 90. Riisgaardia longispora W.P. Wu & Y.Z. Diao
- 91. Stilbochaeta ejneri W.P. Wu & Y.Z. Diao
- 92. Stilbochaeta minteri W.P. Wu & Y.Z. Diao
- 93. Stilbochaeta sinensis W.P. Wu & Y.Z. Diao
- 94. Sinochloridium bambusicola W.P. Wu & Y.Z. Diao*
- 95. Sporendocladia beijingensis W.P. Wu & Y.Z. Diao
- 96. Stephembruneria microsperma W.P. Wu & Y.Z. Diao
- 97. Tainosphaeria cupulata W.P. Wu & Y.Z. Diao
- 98. Tainosphaeria microsperma W.P. Wu & Y.Z. Diao
- 99. Tainosphaeria phialogeniculata W.P. Wu & Y.Z. Diao
- 100. Tainosphaeria sivanesanii W.P. Wu & Y.Z. Diao
- 101. Tainosphaeria verrucophora W.P. Wu & Y.Z. Diao
- 102. Thozetella asetula W.P. Wu & Y.Z. Diao
- 103. Thozetella aunstrupii W.P. Wu & Y.Z. Diao
- 104. Thozetella fanglanii W.P. Wu & Y.Z. Diao
- 105. Thozetella guozhongii W.P. Wu & Y.Z. Diao
- 106. Thozetella hunanensis W.P. Wu & Y.Z. Diao
- 107. Thozetella japonica W.P. Wu & Y.Z. Diao
- 108. Thozetella lunata W.P. Wu & Y.Z. Diao
- 109. Thozetella moganshanensis W.P. Wu & Y.Z. Diao
- 110. Thozetella palmicola W.P. Wu & Y.Z. Diao
- 111. Thozetella paragiganitea W.P. Wu & Y.Z. Diao
- 112. Thozetella pseudotocklaiensis W.P. Wu & Y.Z. Diao
- 113. Thozetella suttonii W.P. Wu & Y.Z. Diao
- 114. Thozetella wenyingiae W.P. Wu & Y.Z. Diao
- 115. Xylolentia palmicola W.P. Wu & Y.Z. Diao *
- 116. Verhulstia biformis W.P. Wu & Y.Z. Diao
- 117. Verhulstia elegans W.P. Wu & Y.Z. Diao
- 118. Verhulstia minima W.P. Wu & Y.Z. Diao
- 119. Xyladelphia parapulchriseta W.P. Wu & Y.Z. Diao
- 120. Xyladelphia sinensis W.P. Wu & Y.Z. Diao

A list of new combinations and new name.

(*excluded or new species not in Chaetosphaeriaceae)

- Aciculadictyochaeta aciculata (S.S. Silva & Gusmão) W.P. Wu & Y.Z. Diao (≡ Dictyochaeta aciculata S.S. Silva & Gusmão)
- 2. Aciculadictyochaeta luquillensis (F.A. Fernández & Huhndorf) W.P. Wu & Y.Z. Diao (≡ *Chaetosphaeria luquillensis* F.A. Fernández & Huhndorf)
- 3. Aunstrupia nodipes (Penz. & Sacc.) W.P. Wu & Y.Z. Diao (≡ Helminthosporium nodipes Penz. & Sacc.)
- Brachydictyochaeta antillana (R.F. Castañeda) W.P. Wu & Y.Z. Diao (≡ Dictyochaeta antillana R.F. Castañeda)

- Cacumisporium acutata (Réblová & W. Gams) W.P. Wu & Y.Z. Diao (≡ Chaetosphaeria acutata Réblová & W. Gams)
- 6. Chloridium humicola (S.C. Jong & E.E. Davis) W.P.
 Wu & Y.Z. Diao (≡ Phialocephala humicola S.C. Jong & E.E. Davis, ≡ Phialocephala gabalongii Sivasith.)
- 7. *Chloridium mirabile* (Hol.-Jech.) W.P. Wu & Y.Z. Diao (≡ *Gonytrichum mirabile* Hol.-Jech.)
- Codinaea brachysetula (Y.L. Jiang & T.Y. Zhang) W.P. Wu & Y.Z. Diao (=Dictyochaeta brachysetula Y.L. Jiang & T.Y. Zhang).
- 9. *Codinaea lithocarpi* (R.H. Perera, E.B.G. Jones & K.D. Hyde) W.P. Wu & Y.Z. Diao (≡ *Dictyochaeta lithocarpi* R.H. Perera, E.B.G. Jones & K.D. Hyde)
- Codinaea plovercovensis (Goh and K.D. Hyde) W.P. Wu & Y.Z. Diao (≡ Dictyochaeta plovercovensis Goh and K.D. Hyde)
- 11. Codinaea zhangii W.P. Wu & Y.Z. Diao (≡ Dictyochaeta chinensis Y.L. Jiang & T.Y. Zhang)
- Codinaeella sinensis (D.W. Li, W.B. Kendr. & Jiangyuan Chen) W.P. Wu & Y.Z. Diao (≡ Codinaea sinensis D.W. Li, W.B. Kendr. & Jiangyuan Chen)
- Craspedodidymum carpaticum (Hol.-Jech. & Révay) W.P. Wu & Y.Z. Diao (≡ Chloridium carpaticum Hol.-Jech. & Révay)
- Curvichaeta curvispora (Réblová) W.P. Wu & Y.Z. Diao, (≡ Chaetosphaeria curvispora Réblová)
- 15. *Ejnerjensenia myriocarpa* (Fr.) W.P. Wu & Y.Z Diao (≡ *Sphaeria myriocarpa* Fr.)
- 16. *Ejnerjensenia pygmaea* (P. Karst.) W.P. Wu & Y.Z. Diao, (≡*Chaetosphaeria pygmaea* (P. Karst.) Constant.
- Ellisembia aurantiaca (D. Magyar & R. Shoemaker) W.P. Wu & Y.Z. Diao (≡ Pyrigemmula aurantiaca D. Magyar & R. Shoemaker)
- Exserticlava exserticlavoides (Réblová & Seifert) W.P. Wu & Y.Z. Diao (≡ Chaetosphaeria exserticlavoides Réblová & Seifert)
- Falholtia kaohsiungensis (S.Y. Hsieh, Goh & C.H. Kuo) W.P. Wu & Y.Z. Diao (≡ Stanjehughesia kaohsiungensis S.Y. Hsieh, Goh & C.H. Kuo)
- 20. Fusichloridium fusiformis (W. Gams & Hol.-Jech.)
 W.P. Wu & Y.Z. Diao (≡ Chaetosphaeria fusiformis
 W. Gams & Hol.-Jech.)
- 21. Kionochaetiella ivoriensis (Rambelli & Lunghini) W.P. Wu & Y.Z. Diao (≡ Chaetopsina ivoriensis Rambelli & Lunghini, Giornale Botanico Italiano 110: 253, 1976; ≡ Kionochaeta ivoriensis (Rambelli & Lunghini) P.M. Kirk & B. Sutton, Trans. Br. Mycol. Soc. 85 (4): 713, 1986)
- 22. Kylindrochaeta lignomollis (F.A. Fernández & Huhndorf) W.P. Wu & Y.Z. Diao (≡ Chaetosphaeria lignomollis F.A. Fernández & Huhndorf)

- 23. Lareunionomyces foliicola (P.M. Kirk) W.P. Wu & Y.Z. Diao (≡ Phialocephala foliicola P.M. Kirk, ≡ Sporendocladia folliicola (P.M. Kirk) M.J. Wingf.)*
- 24. Lareunionomyces kionochaetoides (B. Sutton) W.P. Wu & Y.Z. Diao (≡ Sporendocladia kionochaetoides B. Sutton)*
- 25. Nimesporella aliformis (Kuthub. & Nawawi) W.P. Wu
 & Y.Z. Diao (≡ Dictyochaeta aliformis Kuthub. & Nawawi)
- Nimesporella aquatica (R.F. Castañeda, M.S. Oliveira & Malosso) W.P. Wu & Y.Z. Diao (≡Codinaea aquatica R.F. Castañeda, M.S. Oliveira & Malosso)
- 27. Nimesporella daphnioides (Kuthub. & Nawawi) W.P.
 Wu & Y.Z. Diao (≡ Dictyochaeta daphnioides Kuthub.
 & Nawawi)
- Nimesporella leomaiae (M.A. Barbosa, Malosso & R.F. Castañeda) W.P. Wu & Y.Z. Diao (≡Codinaea leomaiae M.A. Barbosa, Malosso & R.F. Castañeda)
- 29. *Nimesporella pulchriseta* (Curr.) W.P. Wu & Y.Z. Diao (≡ *Chaetosphaeria pulchriseta* Curr.)
- Nimesporella queenslandica (Matsush.) W.P. Wu & Y.Z. Diao (≡ Hyphodiscosia queenslandica Matsush.)
- Nimesporella tumidospora (Kuthub. & Nawawi) W.P. Wu & Y.Z. Diao (≡ Dictyochaeta tumidospora Kuthub. & Nawawi)
- Paraceratocladiella polysetosum (R.F. Castañeda) W.P. Wu & Y.Z. Diao (≡ Ceratocladium polysetosum (R.F. Castañeda)
- Paraceratocladiella seychellarum (Whitton, McKenzie & K.D. Hyde) W.P. Wu & Y.Z. Diao
- 34. Paragaeumannomyces basispirus (Nawawi & Kuthub)
 W.P. Wu & Y.Z Diao (≡ Obeliospora basispira Nawawi & Kuthub.)
- 35. *Paragaeumannomyces microappendiculatus* (Cantillo & Gusmão) W.P. Wu & Y.Z Diao (≡ *Obeliospora microappendiculata* Cantillo & Gusmão)
- 36. Paragaeumannomyces minimus (W.P. Wu & McKenzie) W.P. Wu & Y.Z. Diao ≡ Obeliospora minima W.P. Wu & McKenzie)
- Paragaeumannomyces nitidus (Kuthub., G.M. Liew & Nawawi) W.P. Wu & Y.Z. Diao (≡ Obeliospora nitida (Kuthub., G.M. Liew & Nawawi) Cantillo & Gusmão)
- Paragaeumannomyces triappendiculatus (Kuthub. & Nawawi) W.P. Wu & Y.Z. Diao (≡ Obeliospora triappendiculata Kuthub. & Nawawi)
- 39. Parasporendocladia bactrospora (W.B. Kendr.) W.P. Wu & Y.Z. Diao (≡ Phialocephala bactrospora W.B. Kendr., ≡ Sporendocladia bactrospora (W.B. Kendr.) M.J. Wingf.)*
- 40. *Phaeochloridium geniculata* (Emden) W.P. Wu & Y.Z. Diao (= *Phialophora geniculata* Emden)*

- 41. Phaeochloridium phaeosporum (W. Gams & Hol.– Jech) W.P. Wu & Y.Z. Diao (≡ Chloridium phaeosporum W. Gams & Hol.-Jech.)*
- 42. Phaeodischloridium inaequiseptatum (Matsush.) W.P. Wu & Y.Z. Diao (≡ Dischloridium inaequiseptum (Matsush.) Hol.-Jech.)
- 43. Phialogeniculata obclavata (Matsush.) W.P. Wu & Y.Z. Diao (≡ Chloridium obclavata Matsush.)
- 44. Phialoturbella apiculata (Matsush.) W.P. Wu & Y.Z. Diao (≡ Codinaea apiculata Matsush.)
- 45. *Riisgaardia obclavata* (W.P. Wu) W.P. Wu & Y.Z. Diao (≡ *Linkosia obclavata* W.P. Wu)
- 46. *Riisgaardia vermiculata* (W.P. Wu) W.P. Wu & Y.Z. Diao (≡ *Clasterosporium vermiculatum* Cooke)
- Stilbochaeta jianfenglingensis (J.W. Xia & X.G. Zhang) W.P. Wu & Y.Z. Diao (≡ Codinaea jianfenglingensis J.W. Xia & X.G. Zhang)
- Stratiphoromyces multifimbriata (R. Kirschner & C.J. Chen) W.P. Wu & Y.Z. Diao (≡ Dictyochaeta multifimbriata R. Kirschner & C.J. Chen, Mycol. Progress 1(3): 287, 2002)*
- 49. Thozetella rivularis (Réblová & J. Fourn.) W.P. Wu & Y.Z. Diao (≡ Chaetosphaeria rivularis Réblová & J. Fourn.)
- *Xyladelphia intermedia* (Gusmão & S.M. Leão) W.P. Wu & Y.Z. Diao (≡ *Dictyochaeta intermedia* Gusmão & S.M. Leão)
- 51. Xyladelphia plutiguttulata (Kuthub. & Nawawi)
 W.P. Wu & Y.Z. Diao (≡ Dictyochaeta plutiguttulata Kuthub. & Nawawi)
- *Xyladelphia vittata* (Kuthub. & Nawawi) W.P. Wu & Y.Z. Diao (≡ *Dictyochaeta vittata* Kuthub. & Nawawi)
- 53. Xyladictyochaeta eucalypti (B. Sutton & Hodges) W.P. Wu & Y.Z. Diao (≡ Codinaea eucalypti B. Sutton & Hodges)*
- 54. *Xylolentia matsushimae* W.P. Wu & Y.Z. Diao (= *Chloridium reniforme* Matsush.)*
- 55. Zanclosporiella minuta (F.A. Fernández & Huhndorf) W.P. Wu & Y.Z. Diao (≡ Chaetosphaeria minuta F.A. Fernández & Huhndorf)

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Author contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by WW and YD. The first draft of the manuscript was written by WW and YD and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability The datasets generated during and/or analysed during the current study are available in the MycoBank repository (included in the manuscript), GenBank (included in Tables 1 and 2) and Tree-BASE (Submission Number: 29086). And also the datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

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