



## Generic hyper-diversity in *Stachybotriaceae*

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**Abstract** The family *Stachybotriaceae* was recently introduced to include the genera *Myrothecium*, *Peethambara* and *Stachybotrys*. Members of this family include important plant and human pathogens, as well as several species used in industrial and commercial applications as biodegraders and biocontrol agents. However, the generic boundaries in *Stachybotriaceae* are still poorly defined, as type material and sequence data are not readily available for taxonomic studies. To address this issue, we performed multi-locus phylogenetic analyses using partial gene sequences of the 28S large subunit (LSU), the internal transcribed spacer regions and intervening 5.8S nrRNA (ITS), the RNA polymerase II second largest subunit (*rpb2*), calmodulin (*cmdA*), translation elongation factor 1- $\alpha$  (*tef1*) and  $\beta$ -tubulin (*tub2*) for all available type and authentic strains. Supported by morphological characters these data resolved 33 genera in the *Stachybotriaceae*. These included the nine already established genera *Albosynnema*, *Alfaria*, *Didymostilbe*, *Myrothecium*, *Parasarcopodium*, *Peethambara*, *Septomyrothecium*, *Stachybotrys* and *Xepicula*. At the same time the generic names *Melanopsamma*, *Memnoniella* and *Virgatospora* were resurrected. Phylogenetic inference further showed that both the genera *Myrothecium* and *Stachybotrys* are polyphyletic resulting in the introduction of 13 new genera with myrothecium-like morphology and eight new genera with stachybotrys-like morphology.

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## INTRODUCTION

The family *Stachybotriaceae* was established by Crous et al. (2014) in the order *Hypocreales* (*Hypocreomycetidae*, *Sordariomycetes*, *Pezizomycotina*, *Ascomycota*) to accommodate the genera *Myrothecium* (*Myr.*), *Peethambara* (*Pe.*) and *Stachybotrys* (*St.*). These genera include approximately 210 species ([www.mycobank.org](http://www.mycobank.org); [www.indexfungorum.org](http://www.indexfungorum.org)). The majority of these fungi are saprobic or pathogenic to plants and animals, and some pose a serious risk to human health. They are characterised by asexual morphs with mononematous to sporodochial to synnematos conidiomata, usually with phialidic conidiogenous cells that produce 0–1-septate conidia in dark green to black slimy or dry masses. Some are linked to sexual morphs with perithecial ascomata that are either semi or totally immersed in host tissue, bright to dark yellow to orange or black that do not change colour in KOH.

Past phylogenetic studies by Castlebury et al. (2004) and Summerbell et al. (2011) showed that the genera *Myrothecium*, *Peethambara* and *Stachybotrys* formed a well-supported monophyletic lineage distinct from the other families in the *Hypocreales*. Arguing that more sexual morphs are required for these genera, Castlebury et al. (2004) refrained from introducing a

family for these fungi at that time. As the sexual and asexual morphs are now regarded as equal with the abolishment of dual nomenclature for fungi (Hawksworth et al. 2011, Rossman et al. 2013), Crous et al. (2014) introduced the fungal family *Stachybotriaceae* to accommodate these genera.

The asexual genus *Myrothecium*, based on *Myr. inundatum*, was first introduced by Tode in 1790. He described these fungi as cup-shaped fungi surrounded by a sheath with spores slowly becoming sticky, and included five species in the genus (Preston 1943, Tulloch 1972). Link (1809) emended Tode's generic concept of *Myrothecium* and only retained *Myr. inundatum* in the genus, noting for the first time the conidia of this fungus as globose. Ditmar (1813) also described and illustrated *Myr. inundatum* with globose conidia, and included *Myr. verrucaria* (= *Peziza verrucaria*). Both Link (1809) and Ditmar (1813) referred to the woolly margins surrounding the conidial mass of these fungi. Fries (1829) accepted both Link and Ditmar's generic concept of *Myrothecium* and included four species in the genus. Later, Saccardo (1886) introduced the genus *Hymenopsis*, which he distinguished from *Myrothecium* by the absence of a well-defined margin and included six species, which he previously included in *Myrothecium*. Von Höhnelt (1905) compared *Myrothecium* to *Volutella* and *Amerosporium*, and noted that the conidia of *Myr. inundatum* were oblong rod-shaped, and not globose as previously recorded. At the same time, he also noted white setae at the margin of young sporodochia, not previously recognised in *Myrothecium*. Preston (1943, 1948, 1961) recognised six species in *Myrothecium*, and also provided a detailed historical survey. Pidoplichko & Kirilenko (1971) were the first to provide a key to species in the genus, which included 11 species. In the first comprehensive monographic study of *Myrothecium*, Tulloch (1972) recognised 12 species and provided the first link to a sexual morph, *Nectria bactridioides*. Samuels (1988) linked three other nectria-like species, i.e., *N. chlorogloea*, *N. pityrodes* and *N. ralfsii*, to *Myrothecium*

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based on the green conidia produced by the asexual morphs of these species. However, the first phylogenetic study to include *Myr. inundatum* by Rossman et al. (2001), disproved the link between *N. pityrodes* and *Myrothecium*. Nag Raj (1993, 1995) strongly questioned Tulloch's broad generic concept for *Myrothecium* and introduced two genera, *Xepicula* and *Xepiculopsis*, for *Myr. leucotrichum* and *Myr. gramineum*, respectively. Additionally, Nag Raj (1993) also synonymised several *Myrothecium* species under *Hymenopsis*. The treatment of *Myrothecium* by Nag Raj (1993) was reconsidered by Seifert et al. (2003), who regarded both *Xepicula* and *Xepiculopsis* as synonyms of *Myrothecium* based on 28S large subunit rDNA (LSU) sequence data.

Several *Myrothecium* species are well-known for their cellulolytic activity (Pope 1944, White et al. 1948, Whitaker 1953, Grimes et al. 1957, Halliwell 1961, Bollenbacher & Fulton 1963, Updegraff 1971, Okunowo et al. 2010), resulting in their extensive use as standard test organisms in mould proofing textiles (Tulloch 1972) and biodegradation of waste paper (Updegraff 1971, Okunowo et al. 2010). Additionally, *Myrothecium* species are also known to produce a cocktail of secondary metabolites that have strong antifungal and antibiotic activity (Brian & McGowan 1946, Brian 1948, Ôkuchi et al. 1968, Gülay & Grossman 1994, Kobayashi et al. 2004, Liu et al. 2006, Xu et al. 2006, Ruma et al. 2015). Some *Myrothecium* species also produce macrocyclic trichothecenes, biochemical compounds being exploited for their strong cytotoxicity towards human and murine lymphocytic leukaemia and solid tumours (Murakami et al. 2001, Namikoshi et al. 2001, Amagata et al. 2003, Oda et al. 2005, Xu et al. 2006, Liu et al. 2015). Both *Myr. roridum* and *Myr. verrucaria* have also been associated with mycotoxicoses of livestock and humans (Mortimer et al. 1971, Martinovich et al. 1972, Trapp et al. 1998, Abbas et al. 2002). Thus far, only *Myr. roridum* and *Myr. verrucaria* are considered serious plant pathogens associated with dieback and leaf spots of various plant hosts (Tulloch 1972, Yang & Jong 1995, Han et al. 2014, Li et al. 2014, Ben et al. 2015, Fujinawa et al. 2015) resulting in the exploitation of these fungi as bioherbicides of weeds (Boyet et al. 2014a, b, Piyaboon et al. 2014, Weaver et al. 2016).

There have been a limited number of phylogenetic studies done that included the genus *Myrothecium*. Rossman et al. (2001) were able to demonstrate the close phylogenetic relationship between *Myrothecium* and the sexual morph *Peethambara* based on LSU sequence data. This was further supported by Seifert et al. (2003), Castlebury et al. (2004) and Tang et al. (2007), with the latter two studies also providing evidence of a close relationship with *Stachybotrys*. Decock et al. (2008) used internal transcribed spacer regions and intervening 5.8S rDNA (ITS) sequence data to distinguish *Septomyrothecium* from *Myrothecium*. This study also revealed that the genus *Myrothecium* is paraphyletic, but the authors did not contemplate this at that time. Surprisingly, all recent taxonomic studies of this genus (Castañeda-Ruiz et al. 2008, Alves et al. 2010, Jiang et al. 2014, Wu et al. 2014) did not include any sequence data. A general search on NCBI's GenBank ([www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov)) revealed that there are several ITS and LSU sequences available for *Myrothecium*, as well as sequences of gene clusters associated with mycotoxin production and other secondary metabolite pathways. However, no phylogenetic study focused on the genus *Myrothecium* could be located.

The sexual genus *Peethambara*, based on *Pe. sundara*, was introduced by Subramanian & Bhat (1978a) linked to the asexual morph *Putagraivam sundaram* (Subramanian & Bhat 1978b), which was later synonymised under *Didymostilbe* (*Di.*) as *Di. sundara* by Seifert (1985). Rossman et al. (1998, 1999) placed *Peethambara* in the *Bionectriaceae*, allied with other asexual

genera characterised by synnema and green multiseptate conidia. A second species, *Pe. spirostriata* (= *Nectria spirostriata*; Rossman 1983) was later introduced by Rossman et al. (1999) and linked to the asexual morph, *Di. echinofibrosa* (= *Virgatospora echinofibrosa*; Finley 1967) based on its phenotypic similarity to *Pe. sundara*.

*Peethambara* is characterised by yellow, globose perithecial ascomata having a synnematus asexual morph producing thick-walled, 1-septate conidia in green slimy masses (Seifert 1985, Rossman et al. 1999). Little is known of its ecology and it is presumed to be saprobic based on the substrates it has been isolated from (Subramanian & Bhat 1978a, b, Seifert 1985, Rossman et al. 1999).

The asexual morph *Stachybotrys*, based on *St. atra*, was first introduced by Corda (1837), and described as having 2-celled conidia. Bisby (1943) questioned Corda's generic concept and revised the genus to include species with single-celled conidia containing two guttules, which gave it the 2-celled appearance. At the same time, Bisby (1943) also reduced 19 of the known species to synonymy under *St. atra*, while retaining *St. subsimplex* as a second species in the genus. Hughes (1958) studied the type material of *St. atra* and *Stilbospora chartarum* (Ehrenberg 1818) and concluded that these fungi were conspecific and provided the combination *St. chartarum* based on priority.

Bisby (1943) also considered the genus *Memnoniella* (*Mem.*), first introduced by Von Höhnel (1924), based on *Mem. aterrima*, recognising its close relationship to *Stachybotrys*. Galloway (1933) provided a new combination for *Mem. aterrima*, as *Mem. echinata*, based on an earlier description and illustration of a similar fungus by Rivolta (1873). However, Smith (1962), considered both *Memnoniella* and *Stachybotrys* as congeneric, arguing that the conidial disposition in dry chains (*Memnoniella*) or in slimy masses (*Stachybotrys*) are insufficiently important to distinguish between these genera.

This view was largely ignored by Verona & Mazzucchetti (1968), who recognised 16 *Stachybotrys* and three *Memnoniella* species in their monographic study. Jong & Davis (1976) also considered *Memnoniella* and *Stachybotrys* as distinct genera and included two *Memnoniella* and 11 *Stachybotrys* species in their culture-based study of these fungi. Although Haugland et al. (2001) suggested that *Memnoniella* should be synonymised under *Stachybotrys* based on their ITS phylogenetic study of nine *Stachybotrys* and three *Memnoniella* species, Pinruan et al. (2004) recognised 55 *Stachybotrys* and four *Memnoniella* species in their key to both genera. Wang et al. (2015) formally demoted *Memnoniella* to synonymy under *Stachybotrys*, recognising 74 *Stachybotrys* species and suggested that more species and allied genera need to be studied phylogenetically to determine the relationship between these fungi.

*Stachybotrys* has been linked to the sexual genera *Melanopsamma* (Castlebury et al. 2004, Tang et al. 2007, Wang et al. 2015) and *Ornatisspora* (Hyde et al. 1999, Whitton et al. 2012, Wang et al. 2015). *Melanopsamma pomiformis* (Saccardo 1878), the type species of the genus, is linked to the asexual morph *St. albipes*, under which it was synonymised by Wang et al. (2015). Whitton et al. (2012) linked *Ornatisspora novae-zelandiae* to *St. freycinetiae* and showed that *O. nepalensis* and *O. taiwanensis* have *Stachybotrys* asexual morphs based on occurrence of both morphs on the same materials studied. The asexual morph of *Ornatisspora palmicola*, the type of the genus, is also likely a member of *Stachybotrys* based on the occurrence of sterile conidiophore-like structures on the ascomata illustrated by Hyde et al. (1999). However, another species, *O. gamsii*, has been linked with another asexual morph *Di. aurantiospora* (Hyde et al. 1999). Despite the obvious heterogeneity in the asexual morphs linked to *Ornatisspora*, Wang et al.



(2015) synonymised *Ornatisspora* under *Stachybotrys* based on priority.

Several studies in the past have focused on the phylogenetic diversity of *St. chartarum* (Haugland & Heckman 1998, Haugland et al. 2001, Cruse et al. 2002, Andersen et al. 2003, Koster et al. 2003, 2009, Jie et al. 2013). Haugland & Heckman (1998) were the first to develop species-specific primers of nuclear rDNA for the detection and identification of toxigenic *St. chartarum* strains. Using only ITS sequence data, Haugland et al. (2001) investigated the sequence variability within and between *Memnoniella* species and its phylogenetic relationship with *Stachybotrys*. Cruse et al. (2002) investigated the cryptic nature of *St. chartarum* using sequences of multiple nuclear protein coding regions and identified two phylogenetic lineages within this species. These two phylogenetic lineages were also recognised by Andersen et al. (2003) and Koster et al. (2003) using multi-gene sequence data, resulting in the introduction of *St. chlorohalonata* for one of these lineages by Andersen et al. (2003), while retaining the other lineage as *St. chartarum*. A detailed summary of the history of phylogenetic studies of *Stachybotrys* and allied genera is provided by Wang et al. (2015).

The importance and impact of *Stachybotrys*, and in particular *St. chartarum*, on human and animal health have been well documented in the past. Known as ‘toxic black mould’ to the public and in the media, these fungi are associated with long-term water damage to buildings better known as ‘Sick Building Syndrome’ (Redlick et al. 1997, Crook & Burton 2010) that has been linked to respiratory diseases in humans (Cooley et al. 1998, Mahmoudi & Gershwin 2000, Straus et al. 2003, Brasel et al. 2005, Shoemaker & House 2005, Frazer et al. 2012). These human respiratory diseases include acute infant pulmonary haemorrhage (Etzel et al. 1998, Dearborn et al. 1999, Flappan et al. 1999, Vesper et al. 2000, Thrasher et al. 2014), asthma (Mahmoudi & Gershwin 2000, Viana et al. 2002, Kirjavainen et al. 2015) and nasal and tracheal bleeding (Dearborn et al. 1999, Flappan et al. 1999, Vesper & Vesper 2002). Stachybotryotoxicosis (Drobotko 1945) of animal livestock associated with lip edema, stomatitis, oral necrosis, rhinitis and conjunctivitis (Ozegovic et al. 1971, Schneider et al. 1979, Harrach et al. 1983) have been reported globally (Wang et al. 2015).

Wang et al. (2015) highlighted the need for a more comprehensive phylogenetic study of *Stachybotrys* and its allied genera. In the present study, the phylogenetic relationships within and between genera in the *Stachybotriaceae* are evaluated. The goal is to provide a phylogenetic backbone for the family *Stachybotriaceae* and to resolve the taxonomic irregularities noted in past literature as mentioned above.

## MATERIALS AND METHODS

### Isolates

Fungal strains were obtained from the culture collections of the CBS-KNAW Fungal Biodiversity Centre (CBS), Utrecht, The Netherlands; the Canadian Collection of Fungal Cultures (DAOMC), Agriculture and Agri-Food Canada, Ottawa, Ontario, Canada; Mycothèque de l’Université Catholique de Louvain (BCCM/MUCL), Belgium, and the working collection of Pedro W. Crous (CPC) housed at the CBS (Table 1).

### DNA isolation, amplification and analyses

Total genomic DNA was extracted from 7–14-d-old axenic cultures grown on potato dextrose agar (2 % w/w; PDA) using the Wizard® Genomic DNA purification Kit (Promega Corporation, Madison, USA) following the protocol provided by the manufacturer. Partial gene sequences were determined for

LSU, using the primers LR0R (Rehner & Samuels 1995) and LR5 (Vilgalys & Hester 1990); ITS, using primers ITS5 and ITS4 (White et al. 1990); RNA polymerase II second largest subunit (*rpb2*), using primers RPB2-5F2 and RPB2-7cR (O’Donnell et al. 2007);  $\beta$ -tubulin (*tub2*), using primers Bt2a and Bt2b (Glass & Donaldson 1995); calmodulin (*cmdA*), using primers CAL-228F (Carbone & Kohn 1999) and CAL2Rd (Groenewald et al. 2013); and translation elongation factor 1- $\alpha$  (*tef1*) using primers EF1-728F (Carbone & Kohn 1999) and EF2 (O’Donnell et al. 1998). Amplicons for each locus were generated following the protocols listed in Lombard et al. (2015a).

Integrity of the sequences was ensured by sequencing the amplicons in both directions using the same primer pairs used for amplification. A consensus sequence for each locus was assembled in MEGA v. 6 (Tamura et al. 2013) and additional sequences were obtained from GenBank (Table 1). Subsequent alignments for each locus were generated in MAFFT v. 7 (Katoh & Standley 2013) and manually corrected where necessary. Congruency of the loci were tested using the 70 % reciprocal bootstrap criterion (Mason-Gamer & Kellogg 1996) following the protocols of Lombard et al. (2015b). All novel sequences generated in this study were deposited in GenBank (Table 1) and alignments and trees in TreeBASE.

Phylogenetic analyses were based on Bayesian inference (BI), Maximum Likelihood (ML) and Maximum parsimony (MP). For both the BI and ML analyses, the evolutionary model for each partition was determined using MrModeltest (Nylander 2004) and incorporated into the analyses. For BI analyses, MrBayes v. 3.2.1 (Ronquist & Huelsenbeck 2003) was used to generate phylogenetic trees under optimal criteria for each locus. A Markov Chain Monte Carlo (MCMC) algorithm of four chains was initiated in parallel from a random tree topology with a heating parameter set at 0.3. The MCMC analyses lasted until the average standard deviation of split frequencies were below 0.01 with trees saved every 1 000 generations. The first 25 % of saved trees were discarded as the ‘burn-in’ phase and posterior probabilities (PP) were determined from the remaining trees.

The ML analyses were performed using RAxML v. 8.0.9 (Stamatakis 2014) through the CIPRES website (<http://www.phylo.org>). The robustness of the analyses was evaluated by bootstrap support (ML-BS) with the number of bootstrap replicates automatically determined by the software.

The MP analyses were done using PAUP (Phylogenetic Analysis Using Parsimony, v. 4.0b10; Swofford 2003) with phylogenetic relationships estimated by heuristic searches with 1 000 random addition sequences. Tree-bisection-reconnection was used, with branch swapping options set on ‘best trees’ only. All characters were weighted equally and alignment gaps were treated as fifth state. Measures calculated for parsimony included tree length (TL), consistency index (CI), retention index (RI) and rescaled consistency index (RC). Bootstrap analyses (MP-BS; Hillis & Bull 1993) were based on 1 000 replicates.

### Taxonomy

Axenic cultures were sub-cultured onto cornmeal agar (CMA), oatmeal agar (OA), PDA (recipes in Crous et al. 2009) and synthetic low-nutrient agar (SNA; Nirenberg 1981) without any additional materials and incubated for 7–14 d at room temperature (22–25 °C) under ambient light conditions. Gross morphological characters were examined by mounting fungal structures in clear lactic acid and measurements were made at  $\times 1\,000$  magnification using a Zeiss Axioscope 2 microscope with differential interference contrast (DIC) illumination. The 95 % confidence levels were determined for the conidial measurements with extremes given in parentheses while only

**Table 1** Details of strains included in phylogenetic analyses. GenBank accession numbers in italics were newly generated in this study.

Species	Isolate nr. <sup>1</sup>	Substrate	Collector/ Depositor	Locality	cmdA	ITS	LSU	rpb2	tef1	tub2
<i>Achroestachys betulicola</i>	CBS 142.97 = INIFAT C96/121	<i>Bambusa vulgaris</i>	R. F. Castañeda	Spain	KU845770	KU845793	KU845810	KU845830	KU845846	KU845751
	CBS 399.65 = ATCC 22173	<i>Zea mays</i>	I. Focke	Germany	KU845771	KU845794	KU845811	DQ676584	KU845847	KU845752
	<b>CBS 136397</b> = MUCL 4167 = DAOMIC 87338	<i>Betula lutea</i>	E.A. Peterson	Canada	KU845772	KU845796	KU845812	KU845831	KU845848	KU845753
<i>Ac. aurantisporea</i>	CBS 136398 = MUCL 4318	<i>Triticum aestivum</i>	J. Jooste	USA	KU845773	KU845793	KU845813	–	KU845849	KU845754
	CBS 136401 = MUCL 4308	<i>Triticum aestivum</i>	J. Jooste	USA	KU845774	KU845794	KU845814	KU845832	KU845850	KU845755
	CBS 136548 = MUCL 4319	<i>Triticum aestivum</i>	J. Jooste	USA	KU845775	KU845795	KU845815	KU845833	KU845851	KU845756
<i>Ac. humicola</i>	DAOMIC 222969	Soil	J.A. Traquir	Canada	KU845776	KU845796	KU845816	KU845834	–	KU845757
	CBS 187.73	Straw	G. White	Italy	KU845783	KU845803	KU845823	KU845839	KU845858	KU845764
	<b>DAOMIC 225565</b>	Soil	G. Tichelaar	The Netherlands	KU845778	KU845804	KU845824	KU845840	KU845859	–
<i>Ac. levigata</i>	CBS 317.72	Soil	G.C. Bhatt	Canada	KU845777	KU845797	KU845817	KU845835	KU845852	KU845758
	CBS 598.69	Soil	M. Karman	Turkey	KU845779	KU845799	KU845819	KU845837	KU845854	KU845760
	<b>CBS 868.73</b>	Soil	G.C. Bhatt	Canada	KU845780	KU845800	KU845820	–	KU845855	KU845761
<i>Ac. phylophila</i>	CBS 136394 = MUCL 15104	Soil	G.C. Bhatt	Canada	KU845781	KU845801	KU845821	–	KU845856	KU845762
	CBS 136404 = MUCL 15471	Soil	G.C. Bhatt	Canada	KU845782	KU845802	KU845822	KU845838	KU845857	KU845763
	DAOMIC 226830	Soil	D. Overy	Canada	KU845785	KU845805	KU845825	KU845841	KU845860	KU845765
<i>Ac. saccharicola</i>	<b>CBS 185.79</b> = ATCC 22172	Soil	B.P.R. Vittal	Sudan	KU845785	KU845805	KU845825	KU845841	KU845860	KU845765
	CBS 363.58	Soil	H.J. Swart	Mozambique	KU845786	KU845806	KU845826	KU845842	KU845861	KU845766
	<b>CBS 136181</b> = MUCL 53217 = FMR 11019	Plant debris	M. Hernández & K. Rodriguez	Spain	KU845787	KU845807	KU845827	KU845843	KU845862	KU845767
<i>Albosynnema elegans</i>	<b>CBS 268.76</b>	<i>Saccharum officinarum</i>	T. Watanabe	Taiwan	KU845788	KU845808	KU845828	KU845844	KU845863	KU845768
	CBS 136393 = MUCL 39119	Dead twig	C. Decock	Nepal	KU845789	KU845809	KU845829	KU845845	KU845864	KU845769
	<b>GB 3101</b>	–	–	–	–	–	AF193226	–	–	–
<i>Al. terrestris</i>	<b>CBS 117712</b>	Dead hardwood	D. T. Wicklow	USA	KU845865	KU845881	KU845900	KU845919	KU845938	KU845957
	CBS 109378 = NRRL 31066	Soil	M. Christensen	USA	KU845866	KU845882	KU845901	KU845920	KU845939	KU845958
	<b>CBS 126186</b>	Soil	M. Christensen	Namibia	KU845867	KU845883	KU845902	KU845921	KU845940	KU845959
<i>Al. verrucaria</i>	CBS 127838	Soil	M. Christensen	Namibia	KU845868	KU845884	KU845903	KU845922	KU845941	KU845960
	CPC 30056	Soil	E.V. Abbott	USA	KU845869	KU845885	KU845904	KU845923	KU845942	KU845961
	CBS 176.27	Soil	N.C. Preston	England	KU845870	KU845886	KU845905	KU845924	KU845943	KU845962
<i>Al. viridis</i>	CBS 187.46 = IMI 140056	Old canvas shoe	N.C. Preston	England	–	KU845887	KU845906	KU845925	KU845944	KU845963
	CBS 188.46 = IMI 140057	Citrus fruit	N.C. Preston	Zimbabwe	KU845871	KU845888	KU845907	KU845926	KU845945	KU845964
	CBS 189.46 = IMI 140060	<i>Solanum tuberosum</i>	N.C. Preston	Cyprus	KU845872	KU845889	KU845908	KU845927	KU845946	KU845965
<i>Alf. caricicola</i>	CBS 207.30 = IMI 140055	Soil	B.B. Kanouse	USA	KU845873	KU845890	KU845909	KU845928	KU845947	KU845966
	CBS 208.72	Soil	J.H. van Emden	Java	–	KU845891	KU845910	KU845929	KU845948	KU845967
	CBS 231.56 = IMI 140059	Baled cotton	Koolman	The Netherlands	KU845874	KU845892	KU845911	KU845930	KU845949	KU845968
<i>Alf. cyperi-esculentis</i>	<b>CBS 328.52</b> = CBS 253.47 = IMI 045541 = MUCL 19018 = NRRL 2003 = ATCC 9095 = QM 460	Soil	G.A. Greathouse	USA	KU845875	KU845893	KU845912	KU845931	KU845950	KU845969
	CBS 390.39	Soil	K. Saito	Japan	KU845876	KU845894	KU845913	KU845932	KU845951	KU845970
	CBS 962.95	Basidioma	A. Aptroot	Papua New Guinea	KU845877	KU845895	KU845914	KU845933	KU845952	KU845971
<i>Alf. ossiformis</i>	CBS 121142 = NRRL 45892	Air	D.T. Wicklow	Hawaii	KU845878	KU845896	KU845915	KU845934	KU845953	KU845972
	CBS 244.78	Soil	I.S. Damirdagh	Iraq	–	KU845897	KU845916	KU845935	KU845954	KU845973
	<b>CBS 449.71</b> = BCC 37540	Soil	M.N. Kamat	India	KU845879	KU845898	KU845917	KU845936	KU845955	KU845974
<i>Alf. putrefolia</i>	CBS 127346	Litter of <i>Carex</i> sp.	M. Christensen	USA	KU845880	KU845899	KU845918	KU845937	KU845956	KU845975
	<b>CBS 113567</b>	Soil	W. Gams & R. Zare	Iran	KU845880	KU845899	KU845918	KU845937	KU845956	KU845975
	<b>CPC 23153</b>	Soil	A.M. Pérez Sierra	Spain	KU845876	KU845893	KU845912	KU846001	KU846008	KU846014
<i>Alf. putrefolia</i>	<b>CBS 324.54</b> = IMI 055309 = MUCL 11831 = QM 7979 = BCC 38221	Soil	P.A. Orput	USA	–	KJ869143	KJ869200	–	–	–
	<b>CBS 112037</b>	Rotten leaf	A. Stichigel & J. Guarro	Brazil	–	KU845984	KU845993	KU846002	KU846009	KU846015
	–	–	–	–	–	KU845985	KU845994	KU846003	–	KU846016



Table 1 (cont.)

Species	Isolate nr. <sup>1</sup>	Substrate	Collector/ Depositor	Locality	GenBank Accession No. <sup>2</sup>					
					cmdA	ITS	LSU	rpb2	tef1	tub2
<i>Alf. putrefolia</i> (cont.)	CBS 112038	Rotten leaf	A. Stichigel & J. Guarro	Brazil	–	KU845986	KU845995	KU846004	–	KU846017
<i>Alf. terrestris</i>	CBS 168.97	Leaf litter	R.F. Castañeda	Spain	KU845978	KU845987	KU845996	KU846005	–	KU846010
	<b>CBS 477.91</b>	Soil	G. Turhan	Turkey	KU845979	KU845988	KU845997	KU846006	–	KU846011
	CBS 127305 = RMF 8009	Soil	M. Christensen	USA	KU845980	KU845989	KU845998	–	–	KU846012
<i>Alf. thymi</i>	<b>CBS 447.83</b>	<i>Thymus serpyllum</i>		The Netherlands	KU845981	KU845990	KU845999	–	–	KU846021
<i>Alfaria</i> sp.	CPC 22153	<i>Carex</i> sp.	A. Anon	France	KU845982	KU845991	KU846000	KU846007	–	KU846022
<i>Brevistachys globosa</i>	CBS 397.73	<i>Musa</i> sp.	W. Gams	Sri Lanka	KU846023	KU846037	KU846056	KU846073	–	KU846100
	<b>CBS 141056</b> = CPC 16059	<i>Musa</i> sp.	M. de Jesus Yarez-Morales	Mexico	KU846024	KU846038	KU846057	–	–	KU846101
	CPC 15951	<i>Euphorbia</i> sp.	M. de Jesus Yarez-Morales	Mexico	–	KU846039	KU846058	–	–	KU846102
	CPC 15952	<i>Euphorbia</i> sp.	M. de Jesus Yarez-Morales	Mexico	KU846025	KU846040	KU846059	–	–	KU846103
	CPC 15953	<i>Euphorbia</i> sp.	M. de Jesus Yarez-Morales	Mexico	KU846026	KU846041	KU846060	–	–	KU846104
	CPC 16060	<i>Musa</i> sp.	M. de Jesus Yarez-Morales	Mexico	–	KU846042	KU846061	–	–	KU846105
<i>Br. lateralis</i>	<b>CBS 141058</b> = CPC 17350	<i>Musa</i> sp.	P.W. Crous	Australia	KU846027	KU846043	KU846062	KU846074	–	KU846106
<i>Br. ossiformis</i>	<b>CBS 696.73</b> = ATCC 32334	<i>Zingiber</i> sp.	W. Gams	Sri Lanka	–	KU846044	KU846063	–	–	KU846107
	CBS 112792 = FMR 7685	<i>Musa paradisiaca</i>	A. Stichigel & J. Guarro	Brazil	KU846028	KU846045	KU846064	KU846075	–	KU846108
	CPC 16031	<i>Musa</i> sp.	M. de Jesus Yarez-Morales	Mexico	KU846029	KU846046	KU846065	–	–	KU846109
<i>Br. subsimplex</i>	<b>ATCC 32888</b>	<i>Eichhornia crassipes</i>		USA	–	AF205439	–	–	–	–
<i>Br. variabilis</i>	CBS 141057 = CPC 17349	<i>Musa</i> sp.	P.W. Crous	Australia	KU846030	KU846047	KU846066	KU846076	–	KU846110
<i>Calonectria lilicola</i>	<b>CBS 190.50</b>	<i>Solanum tuberosum</i>	K.B. Boedjin & J. Reitsma	Java	–	GQ280727	KM232307	–	–	–
<i>Capitofimbria compacta</i>	<b>CBS 111739</b>	Decaying leaf	A. Stichigel & J. Guarro	Brazil	KU846261	KU846287	KU846317	KU846349	–	KU846404
	MUCL 502368	Bark	C. Decock	Zimbabwe	–	KU878556	KU878557	KU878558	–	KU878559
<i>Cymostachys coffeicola</i>	<b>CBS 252.78</b>	<i>Coffea arabica</i>	W. Gams	Cuba	KU846035	KU846052	KU846071	–	–	KU846113
	CPC 25009	<i>Poinsettia</i> sp.	P.W. Crous	Thailand	–	KU846053	–	–	–	–
<i>Cy. fabispora</i>	<b>CBS 136180</b> = MUCL 39004 = INIFAT C93/322	Decaying leaf	R.F. Castañeda	Cuba	KU846036	KU846054	KU846072	KU846082	–	KU846098
	CPC 24352	<i>Aloe ferox</i>	M.J. Wingfield	Tanzania	–	KU846055	–	KU846083	–	–
<i>Didymostilbe aurantispora</i>	<b>CBS 616.85</b>	<i>Arenga tremula</i> var. <i>engleri</i>	K. Tubaki	Japan	–	KU846344	–	–	–	–
<i>Di. matsushimae</i>	CBS 549.84	<i>Arenga engleri</i>	R.J. Bandoni	Japan	–	KU846345	–	–	–	–
	CCFC 54984	Soil	M. Christensen	USA	KU846284	KU846314	KU846346	KU846375	–	KU846401
<i>Dimorphiseta terrestris</i>	<b>CBS 127345</b> = RMF 8243	<i>Solanum tuberosum</i>	H.I. Nirenberg	UK	–	KM231682	–	KM232381	–	–
<i>Fusarium sambucinum</i>	CBS 146.95	<i>Sansevieria ehrenbergii</i>	M.J. Wingfield	Tanzania	–	KR476717	KR476752	–	–	KR476794
<i>Globobotrys sanseviericola</i>	<b>CBS 138872</b> = CPC 24316	Decaying wood	C. Decock	Nepal	–	KU846135	KU846161	KU846188	–	KU846241
<i>Grandibotrys pseudotheobromae</i>	<b>CBS 136170</b> = MUCL 39293	Decaying wood	C. Decock	Nepal	–	KU846136	KU846162	KU846189	–	KU846242
	CBS 136391 = MUCL 39289	Decaying wood	C. Decock	Nepal	–	KU846137	KU846163	KU846190	–	–
<i>Gra. xylophila</i>	<b>CBS 136179</b> = MUCL 39288	Decaying wood	C. Decock	Nepal	KU846115	KU846137	KU846163	KU846217	–	–
<i>Gregatothecium humicola</i>	<b>CBS 205.96</b>	Soil	A. Aptroot	Papua New Guinea	KU846285	KU846315	KU846347	KU846376	–	KU846432
<i>Inaequalispora prestonii</i>	<b>CBS 175.73</b> = IMI 160372 = ATCC 24427	Soil	W.H. Tong	Malaysia	KU846286	KU846316	KU846348	KU846377	–	KU846403
<i>Kastanostachys aterrima</i>	<b>CBS 101310</b>	<i>Fagus sylvatica</i>	M. Réblová	Czech Republic	–	–	AF178565	KU846191	–	–
<i>Melanopsamma pomiformis</i>	CBS 325.90	<i>Fagus sylvatica</i>	D. Sisto	Italy	KU846031	KU846048	KU846067	KU846077	–	KU846111
	<b>CBS 101322</b>	<i>Fagus sylvatica</i>	K. Prásl	Czech Republic	KU846032	KU846049	KU846068	KU846078	–	–
	CBS 114119 = UPSC 2528	<i>Tilia cordata</i>	K. Holm & L. Holm	Sweden	KU846033	KU846050	KU846069	KU846079	–	KU846112
<i>Mel. xylophila</i>	<b>CBS 100343</b>	Decaying wood	W. Gams	Japan	KU846034	KU846051	KU846070	KU846080	–	KU846096
<i>Memnoniella brunneoonidiophora</i>	CBS 109477	Decayed leaf	R.F. Castañeda-Ruiz	Venezuela	–	KU846138	KU846165	KU846192	–	KU846243
<i>Mem. dichroa</i>	<b>ATCC 18913</b> = IMI 61337	Decayed leaf	R.F. Castañeda-Ruiz	Venezuela	KU846116	KU846139	KU846166	KU846193	–	KU846244
	CBS 526.50 = ATCC 18917 = IMI 017506 = MUCL 9482	<i>Senecio jacobaea</i>	A.H.S. Brown	England	–	AF081472	–	–	–	–
	CBS 123800	Herbaceous stem	M.B. Ellis	England	KU846117	KU846140	KU846167	KU846194	–	KU846220
		<i>Ilex aquifolium</i>	W. Gams	The Netherlands	KU846118	KU846141	KU846168	KU846195	–	KU846221



Table 1 (cont.)

Species	Isolate nr. <sup>1</sup>	Substrate	Collector/ Depositor	Locality	cmdA	ITS	LSU	rpb2	tef1	tub2
<i>Pa. parvum</i> (cont.)	<b>CBS 257.35</b> = IMI 140049	<i>Viola</i> sp.	N.C. Preston	UK	–	KU846298	KU846328	KU846359	KU846388	KU846415
<i>Pa. roridum</i>	CBS 212.95	Water	E.S. van Reenen-Hoekstra	The Netherlands	KU846269	KU846299	KU846329	KU846360	KU846389	KU846416
	<b>CBS 357.89</b>	<i>Gardenia</i> sp.	G. Giunchi	Italy	KU846270	KU846300	KU846330	KU846361	KU846390	KU846417
	CBS 372.50 = IMI 140050	<i>Coffea</i> sp.	O. Urhan	Colombia	KU846271	KU846301	KU846331	KU846362	KU846391	KU846418
<i>Pa. tellicola</i>	<b>CBS 478.91</b>	Soil	G. Turhan	Turkey	KU846272	KU846302	KU846332	KU846363	–	KU846419
<i>Pa. terrestris</i>	<b>CBS 564.86</b>	Soil	G. Turhan	Turkey	KU846273	KU846303	KU846333	KU846364	–	KU846420
	CBS 565.86	Soil	G. Turhan	Turkey	KU846274	KU846304	KU846334	KU846365	–	KU846421
	CBS 566.86	Soil	G. Turhan	Turkey	KU846275	KU846305	KU846335	KU846366	–	KU846422
	CBS 872.85	Soil	G. Turhan	Turkey	KU846276	KU846306	KU846336	KU846367	–	KU846423
<i>Pa. viridisporum</i>	<b>CBS 563.86</b>	Soil	G. Turhan	Turkey	KU846277	KU846307	KU846337	KU846368	–	KU846424
	<b>CBS 873.85</b>	Soil	G. Turhan	Turkey	KU846278	KU846308	KU846338	KU846369	–	KU846425
	CBS 125821	Soil	M. Christensen	USA	KU846279	KU846309	KU846339	KU846370	–	KU846426
	CBS 125835	Soil	M. Christensen	USA	KU846280	KU846310	KU846340	KU846371	–	KU846427
	CBS 126942	Soil	J.S. States	USA	KU846281	KU846311	KU846341	KU846372	–	KU846428
	CBS 127785	Soil	M. Christensen	USA	KU846282	KU846312	KU846342	KU846373	–	KU846429
	CBS 127843	Soil	M. Christensen	USA	KU846283	KU846313	KU846343	KU846374	–	KU846430
<i>Parasarcopodium ceratocaryi</i>	<b>CBS 110664</b>	<i>Ceratocaryi decipiens</i>	S. Lee	South Africa	–	AY425026	–	–	–	–
<i>Parvothecium terrestre</i>	<b>CBS 198.89</b>	Soil	L. Pfenning	Brazil	KU846449	KU846468	KU846489	KU846506	KU846528	KU846548
	CBS 534.88 = INIFAT C87/234	Leaf litter	R.F. Castañeda	Cuba	KU846450	KU846469	KU846490	KU846507	KU846529	KU846549
<i>Peethambara sundara</i>	CBS 521.96 = MUCL 39093	Dead twig	C. Decock	Nepal	–	KU846470	KU846491	KU846508	KU846530	KU846550
	<b>CBS 646.77</b>	Dead twig	C.V. Subramanian	India	–	KU846471	AF193245	KU846509	KU846531	KU846551
<i>Septomyrothecium maraitense</i>	<b>MUCL 47202</b>	Decaying leaf	C. Decock	French Guyana	–	–	KU846493	KU846510	–	–
<i>Sept. uniseptatum</i>	CBS 100966 = INIFAT C98/23-1	Leaf litter	R.F. Castañeda	Venezuela	–	–	KU846494	KU846511	–	KU846552
	MUCL 52944	–	–	–	–	–	KU846495	KU846512	–	–
<i>Sirastachys castanedaee</i>	CBS 164.97	Decaying leaf	R.F. Castañeda-Ruiz	Spain	KU846553	KU846658	KU846771	KU846885	KU846990	KU847094
	CBS 531.69 = IMI 144477	Soil	G.C. Bhatt	Canada	KU846554	KU846659	KU846772	KU846886	KU846991	KU847095
	<b>CBS 136403</b> = MUCL 39994	Decaying leaf	R.F. Castañeda-Ruiz	Spain	KU846555	KU846660	KU846773	KU846887	KU846992	KU847096
	CPC 20373	<i>Morus</i> sp.	M. Arzanlou	Iran	KU846556	KU846661	KU846774	KU846888	KU846993	KU847097
<i>Si. cylindrospora</i>	<b>CBS 136166</b> = MUCL 41106 = INIFAT C98/42	Decaying leaf	R.F. Castañeda-Ruiz	Brazil	KU846557	KU846662	KU846775	KU846889	–	KU847098
	CBS 13654 = MUCL 41088 = INIFAT C98/30	Decaying leaf	R.F. Castañeda-Ruiz	Brazil	KU846558	KU846663	KU846776	KU846890	KU846994	KU847099
<i>Si. longispora</i>	<b>ATCC 32451</b>	<i>Ilex latifolia</i>	T. Matsushima	Japan	–	AF081482	–	–	–	–
<i>Si. pandanicola</i>	<b>CBS 136545</b> = MUCL 49906	<i>Pandanus</i> sp.	O. Laurence	Singapore	–	KU846664	KU846777	–	–	KU847100
<i>Si. phaeospora</i>	CBS 253.75	Soil	J.A. Stalpers	The Netherlands	KU846559	KU846665	KU846778	–	–	KU847101
	<b>CBS 100155</b>	Decaying leaf	J. Guarro	Cuba	KU846560	KU846666	KU846779	KU846891	KU846995	KU847102
	CBS 136167 = MUCL 41195	Decaying leaf	R.F. Castañeda-Ruiz	Brazil	KU846561	KU846667	KU846780	KU846892	KU846996	KU847103
	CBS 136185 = MUCL 41191	Decaying leaf	R.F. Castañeda-Ruiz	Brazil	KU846562	KU846668	KU846781	KU846893	KU846997	KU847104
	CPC 16092	<i>Cycas</i> sp.	P.W. Crous	South Africa	KU846563	KU846669	KU846782	KU846894	–	KU847105
	CPC 16093	<i>Cycas</i> sp.	P.W. Crous	South Africa	KU846564	KU846670	KU846783	KU846895	–	KU847106
<i>Si. phyllophila</i>	CBS 173.97	Decaying leaf	R.F. Castañeda	Spain	KU846565	KU846671	KU846784	KU846896	KU846998	KU847107
	<b>CBS 136169</b> = MUCL 39919	Decaying leaf	R.F. Castañeda	Spain	KU846566	KU846672	KU846785	KU846897	KU846999	KU847108
<i>Si. pseudolongispora</i>	CBS 417.93 = INIFAT C93/213-3	Leaf litter	R.F. Castañeda	Cuba	KU846567	KU846673	KU846786	KU846898	KU847000	KU847109
	<b>CBS 100154</b>	Decaying leaf	J. Guarro	Cuba	KU846568	KU846674	KU846787	KU846899	–	KU847110
<i>Sirastachys</i> sp.	CBS 308.56 = ATCC 18877 = IMI 062338 = MUCL 9485	Soil	J.A. Meyer	Zaire	KU846569	KU846675	KU846788	KU846900	KU847001	KU847111
<i>Smaragdinisetia bisetosa</i>	<b>CBS 459.82</b>	Rotten bark	V. Rao & A.C. Rao	India	KU847206	KU847229	KU847255	KU847281	KU847303	KU847319
" <i>Stachybotrys albipes</i> "	ATCC 18873 = IMI 056393	<i>Ulmus</i> sp.	C. Booth	England	–	AF081478	–	–	–	–
<i>St. aloeficola</i>	<b>CBS 137940</b> = CPC 19705	<i>Aloe</i> sp.	P.W. Crous	South Africa	KU846570	KJ817888	KJ817890	KU846901	–	KJ817886
	CBS 137941 = CPC 19706	<i>Aloe</i> sp.	P.W. Crous	South Africa	KU846571	KJ817889	KJ817891	KU846902	–	KJ817887





Table 1 (cont.)

Species	Isolate nr. <sup>1</sup>	Substrate	Collector/ Depositor	Locality	GenBank Accession No. <sup>2</sup>					
					cmdA	ITS	LSU	rpb2	tef1	tub2
<i>St. chlorohalonata</i> (cont.)	CBS 251.89	Wood, paper and tile	R. S. Khan	Canada	KU846618	KU846724	KU846837	KU846949	KU847048	KU847159
	CBS 328.37 = ATCC 18844	Paper	O. Verona	Italy	KU846619	KU846725	KU846838	KU846950	KU847049	KU847160
	CBS 330.37	Paper	O. Verona	Italy	KU846620	KU846726	KU846839	KU846951	KU847050	KU847161
	CBS 341.35 = ATCC 18847 = MUCL 9477		N.F. Conant	USA	KU846638	KU846745	KU846858	KU846968	KU847068	KU847179
	CBS 608.94	Paper	A. Gargouri	Tunisia	KU846621	KU846727	KU846840	KU846952	KU847051	KU847162
	CBS 109281	Contaminant	B. Andersen	Denmark	KU846639	KU846746	KU846859	–	KU847069	KU847180
	CBS 109283	Building material	K.F. Nielsen	Denmark	KU846622	KU846728	KU846841	KU846953	KU847052	KU847163
	<b>CBS 109285</b>	Cardboard	K.F. Nielsen	Denmark	KU846623	KU846729	KU846842	KU846954	KU847053	KU847164
	CBS 122763	Plant debris	J. Capilla, R.F. Castañeda-Ruiz & C. Silvera	Portugal	KU846624	KU846730	KU846843	KU846955	KU847054	KU847165
<i>St. dolichophialis</i> "St. elegans"	CBS 125896	Soil	M. Christensen	USA	KU846640	KU846747	KU846860	–	KU847070	KU847181
	CBS 129226	Soil	M. Christensen	USA	KU846625	KU846731	KU846844	–	KU847055	KU847166
	CBS 136158 = MUCL 49910	Decayed wood	C. Decock	Singapore	KU846626	KU846732	KU846845	KU846956	KU847056	KU847167
	CBS 136160 = MUCL 258	Soil	J. van Holder	Belgium	KU846641	KU846748	KU846861	KU846969	KU847071	KU847182
	CBS 136192 = MUCL 3139	Grain	G.L. Hennebert		KU846642	KU846749	KU846862	KU846970	KU847072	KU847183
	CBS 136194 = MUCL 4311	<i>Triticum aestivum</i>	J.W. Jooste	USA	KU846627	KU846733	KU846846	KU846957	KU847057	KU847168
	CBS 136196 = MUCL 18020	Soil	G.L. Hennebert	France	KU846643	KU846750	KU846863	KU846971	KU847073	KU847184
	DAOMC 235557		J.D. Miller	Canada	KU846644	KU846751	KU846864	KU846972	KU847074	KU847185
	DAOMC 227011	Soil	K.A. Seifert	South Africa	KU846628	KU846734	KU846847	KU846958	–	KU847169
	HGUP 0208	Soil	Y. Wang	China	–	JX978445	–	–	–	–
HGUP 0310	Soil	Y. Wang	China	–	KC305357	–	–	–	–	
<i>St. limonisporea</i>	<b>CBS 128809</b>	Soil	M. Christensen	USA	KU846629	KU846735	KU846848	KU846959	KU847058	KU847170
	CBS 136165 = MUCL 18730	Soil	G.L. Hennebert	India	KU846630	KU846736	KU846849	KU846960	KU847059	KU847171
<i>St. mangiferae</i>	HGUP 0158	Soil	J.J. Xu	China	–	KC305253	–	–	–	–
	<b>ATCC 18852</b> = IMI 124902		D. McDonald	Nigeria	–	AF081475	–	–	–	–
<i>St. microspora</i>	CBS 186.79	Soil	B.P.R. Vittal	Sudan	KU846631	KU846737	KU846850	DQ676580	KU847060	KU847172
	<b>HGUP 0146</b>	Soil	Y.L. Jiang	China	–	KC305345	KC305345	–	–	–
<i>St. pallescens</i>	NRRL 54531	Decaying wood	D.T. Wicklow	Hawaii	–	JN093263	–	–	–	–
	<b>KAS 525</b>	Seed	G.P. White	China	KU846632	KU846738	KU846851	KU846962	KU847061	KU847173
<i>St. phaenophialis</i>	<b>ATCC 18839</b>			Japan	–	AF081476	–	–	–	–
	CBS 976.95	Soil	A. Aptroot	Papua New Guinea	KU846633	KU846739	KU846852	KU846963	KU847062	KU847174
<i>St. sansevieriae</i> "	CBS 136198 = MUCL 39087	Dead twig	C. Decock	Nepal	–	KU846740	KU846853	–	KU847063	–
	HGUP 0103	Soil	J.H. Kong	China	–	JX998165	–	–	–	–
<i>St. subcylindrospora</i>	HGUP 0180	Soil	J.J. Xu	China	–	KC305267	–	–	–	–
	<b>HGUP 0201</b>	Soil	Y.L. Zhang	China	–	KC305354	–	–	–	–
<i>St. subreniformis</i>	<b>HGUP 1051</b>	Soil	Q.R. Li	China	–	KC305344	–	–	–	–
	ATCC 18838				–	AF205441	–	–	–	–
<i>St. subsimplex</i> "	ATCC 22700	Soil	T. Matsushima	Papua New Guinea	–	AF205440	–	–	–	–
	ATCC 32334	<i>Zingiber</i> sp.	W. Gams	Sri Lanka	–	AF205442	–	–	–	–
<i>St. subsylvatica</i>	<b>CBS 126205</b>	Soil	M. Christensen	Namibia	KU846634	KU846741	KU846854	KU846964	KU847064	KU847175
	HGUP 0488				–	KC305289	–	–	–	–
<i>St. terrestris</i>	ATCC 18905 = IMI 105321	<i>Theobroma cacao</i>	T.H. Williams	Malaysia	–	AF081479	–	–	–	–
	HGUP 0142	Soil	Y.L. Jiang	China	–	KC305246	–	–	–	–
<i>St. theobromae</i> "	HGUP 0144	Soil	Y.L. Jiang	China	–	KC305247	–	–	–	–
	HGUP 0745	Soil	Y.L. Jiang	China	–	KC305322	–	–	–	–
<i>St. yunnanensis</i> "	HGUP 0143	Soil	Y.L. Jiang	China	–	KC305308	–	–	–	–
	CBS 525.50 = IMI 032542 = MUCL 9475	Soil	J.H. Warcup	England	KU846645	KU846752	KU846865	–	KU847075	KU847186

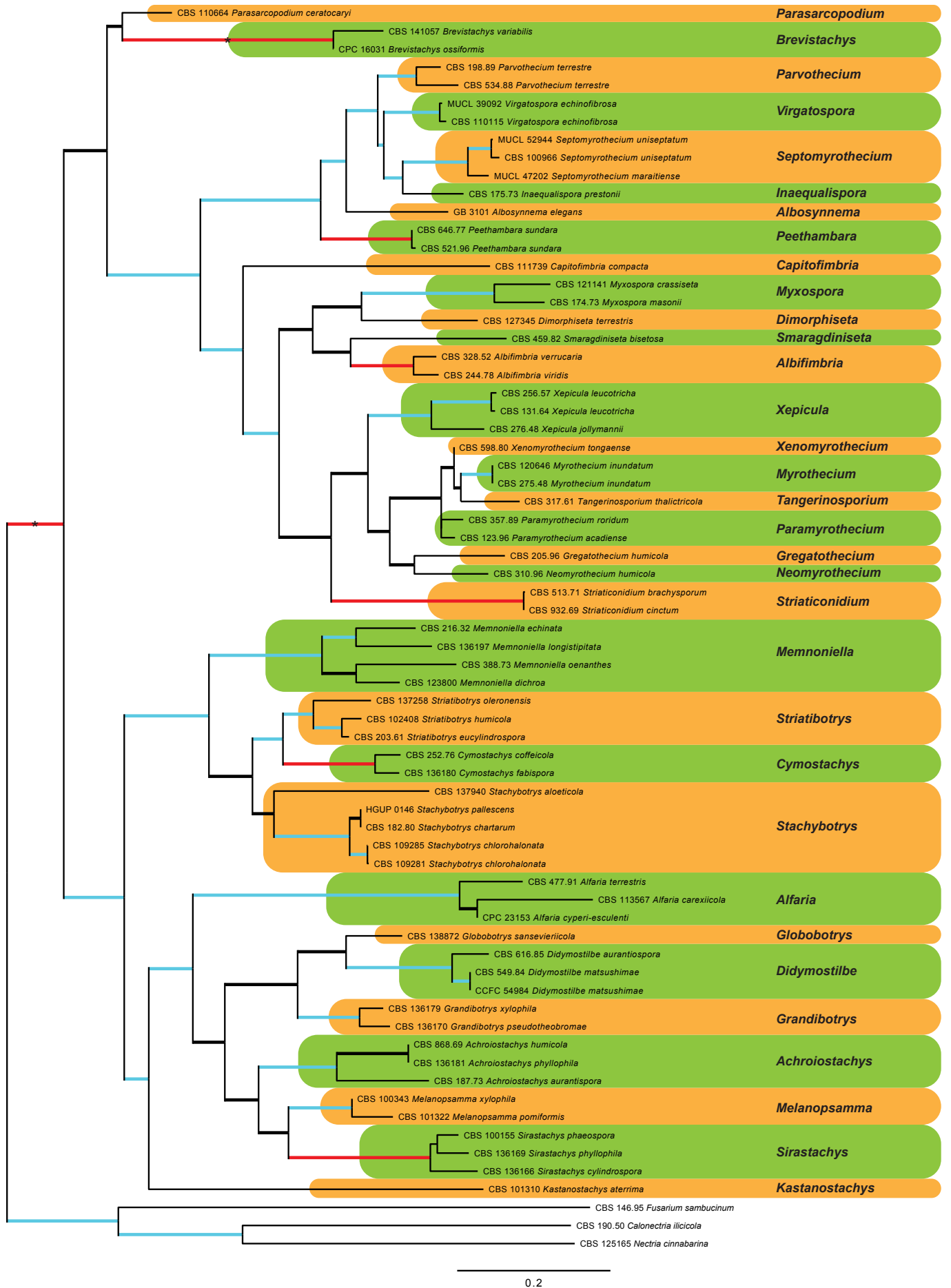
<i>Striatobotrys atypica</i>	CBS 141059 = CPC 18423 CPC 18422	<i>Iris</i> sp. <i>Iris</i> sp.	France France	KU846646 KU846647 KU846648	KU846753 KU846754 KU846755	KU846866 KU846867 KU846868	KU846973 KU846974 KU846975	KU847076 KU847077 KU847078	KU847187 KU847188 KU847189
<i>Stri. eucylindrospora</i>	CBS 203.61 = ATCC 18851 = IMI 085334 = MUCL 9483 CBS 949.72	Soil	Canada						
<i>Stri. humicola</i>	CBS 136399 = MUCL 4251	Plant debris	Turkey						
<i>Stri. oleromensis</i>	CBS 136547 = MUCL 15039	Soil	USA						
<i>Stri. rhadospora</i>	CBS 102408 CBS 137258 CBS 528.80	Soil <i>Iris pseudacorus</i> Soil	Canada France Germany						
	CBS 878.68 = ATCC 16276	Soil	Germany						
	CBS 119043	Soil	Germany						
	CBS 121801	Plant debris	Switzerland						
	CBS 136168 = MUCL 6030	Soil	Spain						
	CBS 136203 = MUCL 17023	Soil	Germany						
	CBS 136395 = MUCL 22116	Asbestos cement tile	Belgium						
	CBS 136396 = MUCL 2012	<i>Caltha palustris</i>	USA						
	DAOMC 70309	Soil	Canada						
	DAOMC 189389	Wall board	Canada						
<i>Stri. yuccae</i>	CBS 390.68	<i>Yucca flaccida</i>	Canada						
<i>Striaticonidium brachysporium</i>	CBS 131.71 = IMI 158441 = ATCC 22270	Soil	The Netherlands Ukraine						
	CBS 177.65	<i>Acacia karroo</i>	South Africa						
	CBS 513.71 = IMI 115293	Dune sand	Iran						
	CBS 126552	Soil	USA						
	CBS 127287	Soil	USA						
	CBS 128163	Soil	USA						
<i>Str. cinctum</i>	CBS 277.48 = IMI 001526 CBS 373.50 = IMI 140052 CBS 528.69 = IMI 140637 = ATCC 18947	Soil Soil Soil	New Zealand Belgium Canada						
<i>Stri. humicola</i>	CBS 932.69 = IMI 145760 CBS 258.76	Soil Soil	The Netherlands Spain						
<i>Stri. synnematum</i>	CBS 388.97	Soil	Papua New Guinea						
<i>Tangerinosporium thaltricola</i>	CBS 479.85	Palm leaf	Japan						
<i>Virgatospora echinofibrosa</i>	CBS 317.61 = IMI 034815 CBS 110115	<i>Thalicttrum flavum</i> <i>Theobroma cacao</i>	UK						
<i>Xenomyrothecium tongaense</i>	MUCL 39092 = ATCC 200437 CBS 598.80	<i>Trewia nudiflora</i> <i>Hallimeda</i> sp.	Ecuador						
<i>Xepicula crassisetata</i>	CBS 392.71	Soil	Nepal						
<i>X. jollymannii</i>	CBS 276.48 = MUCL 11830 CBS 511.76	<i>Nicotiana tabacum</i> <i>Clerodendron inermis</i>	Tonga Spain						
<i>X. leucoctricha</i>	CBS 126168 CBS 131.64 = IMI 103664 = ATCC 16686	Soil Soil	Malawi India						
	CBS 256.57 = MUCL 9860 CBS 278.78	Soil	Namibia						
	CBS 483.78	Soil	India						

<sup>1</sup> Ex-type and ex-epitype cultures indicated in **bold**.

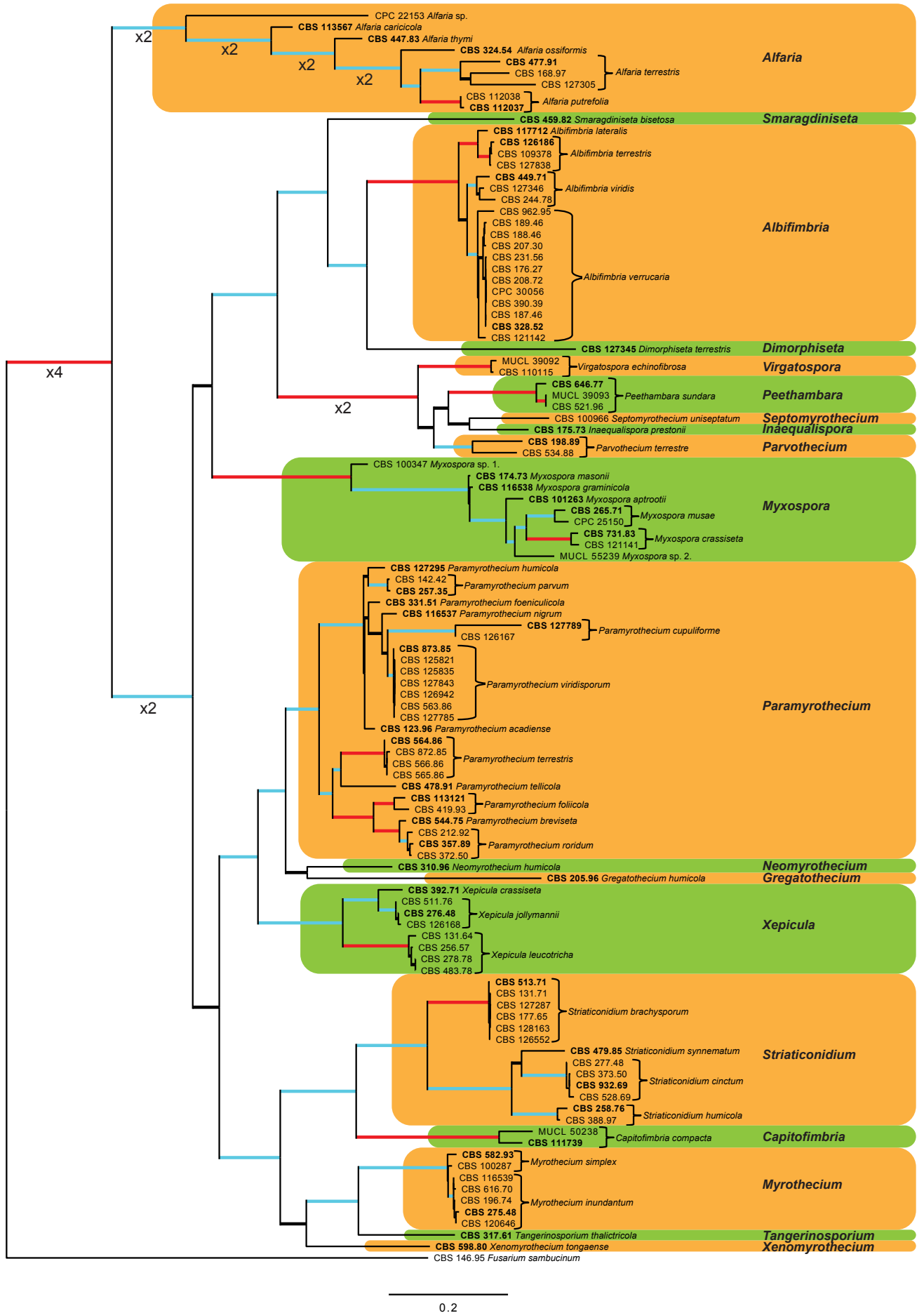
AR: Collection of A. Y. Rossman; ATCC: American Type Culture Collection, USA; BCC: BIOTEC Culture Collection, National Center for Genetic Engineering and Biotechnology (BIOTEC), Bangkok, Thailand; CBS: CBS-KNAW Fungal Diversity Centre, Utrecht, The Netherlands; CPC: Collection of P.W. Crous; DAOMC: Agriculture and Agri-Food Canada, Canadian Collection of Fungal Cultures, Canada; FMR: Facultad de Medicina, Reus, Tarragona, Spain; HGUP: Herbarium of Guizhou University, Plant Pathology, China; IMI: International Mycological Institute, CAB International, Egham, Basingstoke, UK; INIFAT: INIFAT Fungus Collection, Ministerio de Agricultura Habana, KAS: Collection of K.A. Seifert; MUCL: Mycothèque de l'Université Catholique de Louvain, Belgium; NRR: Agricultural Research Service Culture Collection, USA; QM: Quaternary Research and Development Center, US Army, Natick, MA, USA; RMF: Collection of M. Christensen.

<sup>2</sup> *cmdA*: calmodulin; ITS: internal transcribed spacer regions and intervening 5.8S ribosomal RNA; LSU: 28S ribosomal RNA large subunit; *tp2*: RNA polymerase II second largest subunit; *tef1*: translation elongation factor 1- $\alpha$ ; *tu2*: beta-tubulin.





**Fig. 1** The ML consensus tree inferred from the combined LSU and *rpb2* sequence alignments. Thickened branches indicate branches present in the ML, MP and Bayesian consensus trees. Branches with ML-BS & MP-BS = 100 % and PP = 1.0 are in red. Branches with ML-BS & MP-BS ≥ 75 % and PP ≥ 0.95 are in blue. The scale bar indicates 0.2 expected changes per site. Coloured blocks represent the accepted genera. The tree is rooted to *Calonectria ilicicola* (CBS 190.50), *Fusarium sambucinum* (CBS 146.95) and *Nectria cinnabarina* (CBS 125165).



**Fig. 2** The ML consensus tree inferred from the combined *cmdA*, ITS, *rpb2* and *tub2* sequence alignments of the *Myrothecium* s.l. dataset. Thickened branches indicate branches present in the ML, MP and Bayesian consensus trees. Branches with ML-BS & MP-BS = 100 % and PP = 1.0 are in red. Branches with ML-BS & MP-BS ≥ 75 % and PP ≥ 0.95 are in blue. The scale bar indicates 0.2 expected changes per site. The tree is rooted to *Fusarium sambucinum* (CBS 146.95). Epi- and ex-type strains are indicated in **bold**.

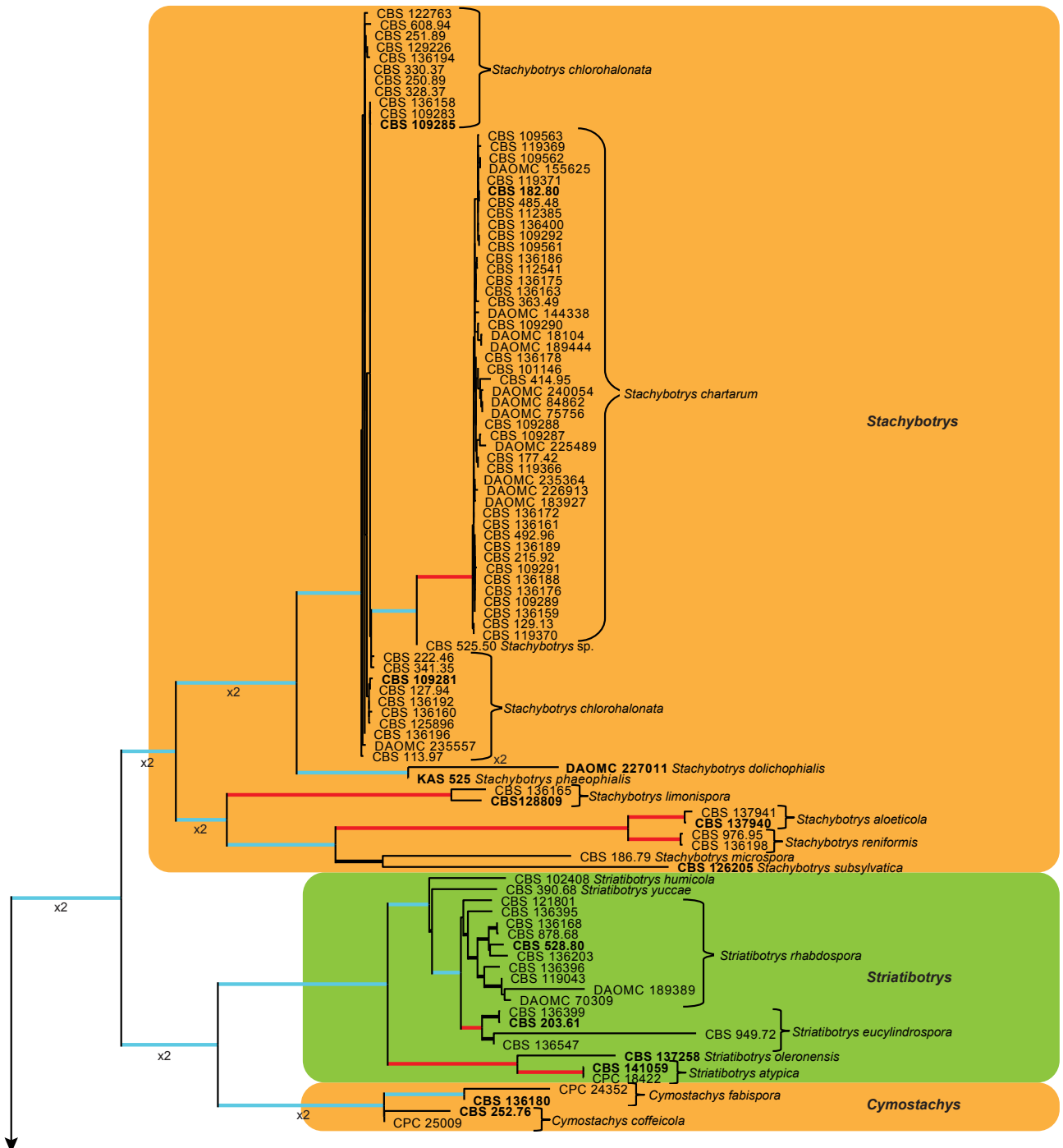
extremes are provided for other structures. At the same time, colony morphology was assessed on CMA, OA and PDA (reverse described only on PDA) using the colour charts of Rayner (1970). All descriptions, illustrations and nomenclatural data were deposited in MycoBank (Crous et al. 2004).

## RESULTS

### Phylogeny

Approximately 500–650 bases were determined for the *cmdA*, ITS, *tef1* and *tub2* gene regions and approximately 800–900 bases for the LSU and *rpb2* gene regions. The congruency analyses revealed a large number of conflicts between the *cmdA*, ITS, *tef1* and *tub2* gene regions, which could only be

resolved by separating the data into two datasets representing the *Myrothecium* s.l. dataset and *Stachybotrys* s.l. dataset, respectively. However, the *tef1* gene region of the *Myrothecium* s.l. dataset still provided a conflicting tree topology due to the large number of ambiguous regions and was therefore excluded from the analyses. The LSU and *rpb2* gene regions provided similar tree topologies, with the only variation observed in the support values of the deeper branches and were therefore combined to obtain a generic level phylogeny. For the BI and ML analyses, a GTR+I+G model was selected for all six gene regions analysed and incorporated into the analyses. The Bayesian consensus tree for the three datasets confirmed the tree topologies obtained from the ML and MP analyses, and therefore, only the ML trees are presented.



**Fig. 3** The ML consensus tree inferred from the combined *cmdA*, ITS, *rpb2*, *tef1* and *tub2* sequence alignments of the *Stachybotrys* s.l. dataset. Thickened branches indicate branches present in the ML, MP and Bayesian consensus trees. Branches with ML-BS & MP-BS = 100 % and PP = 1.0 are in red. Branches with ML-BS & MP-BS ≥ 75 % and PP ≥ 0.95 are in blue. The scale bar indicates 0.2 expected changes per site. The tree is rooted to *Peethambara sundara* (CBS 646.77). Epi- and ex-type strains are indicated in bold.

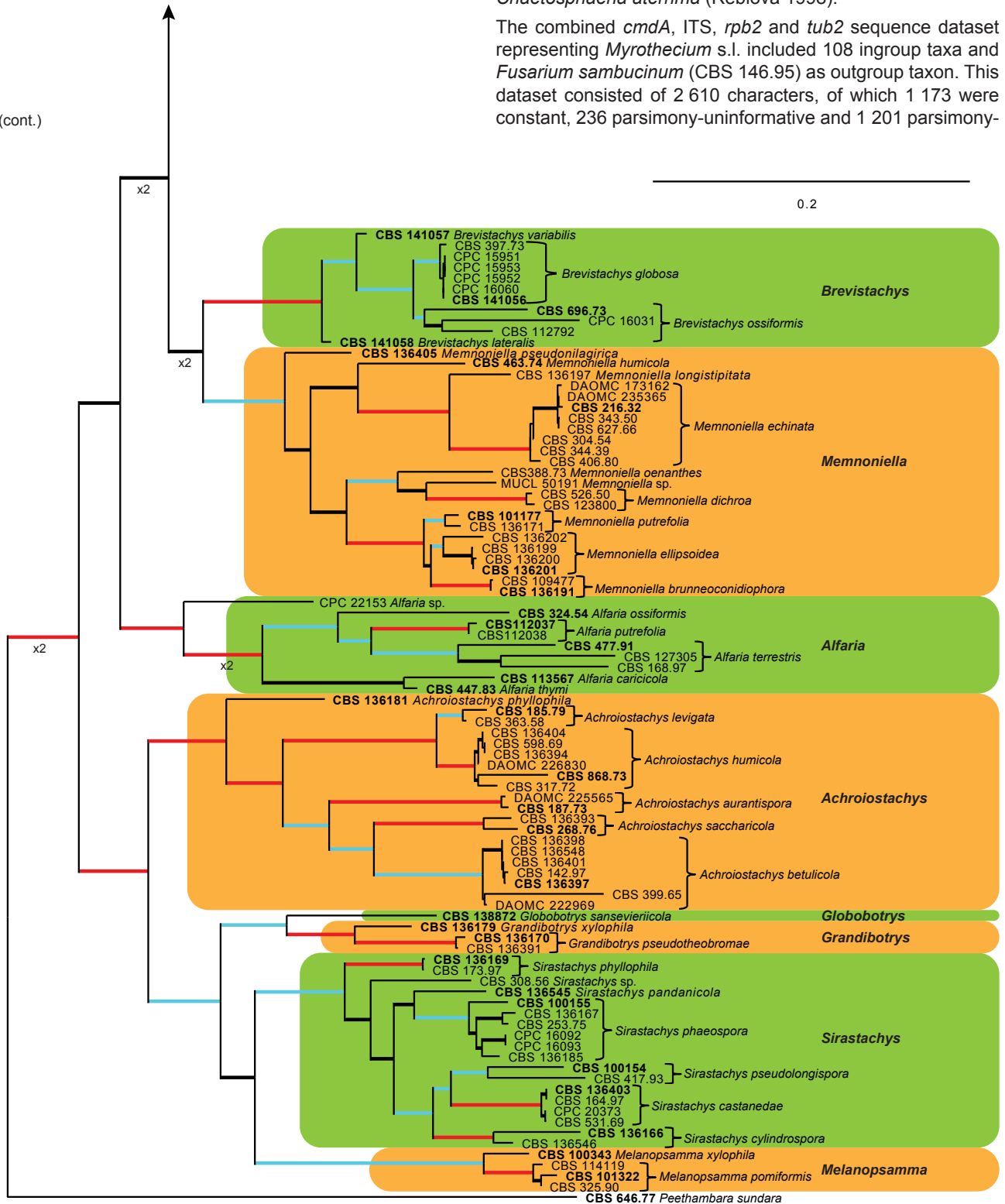


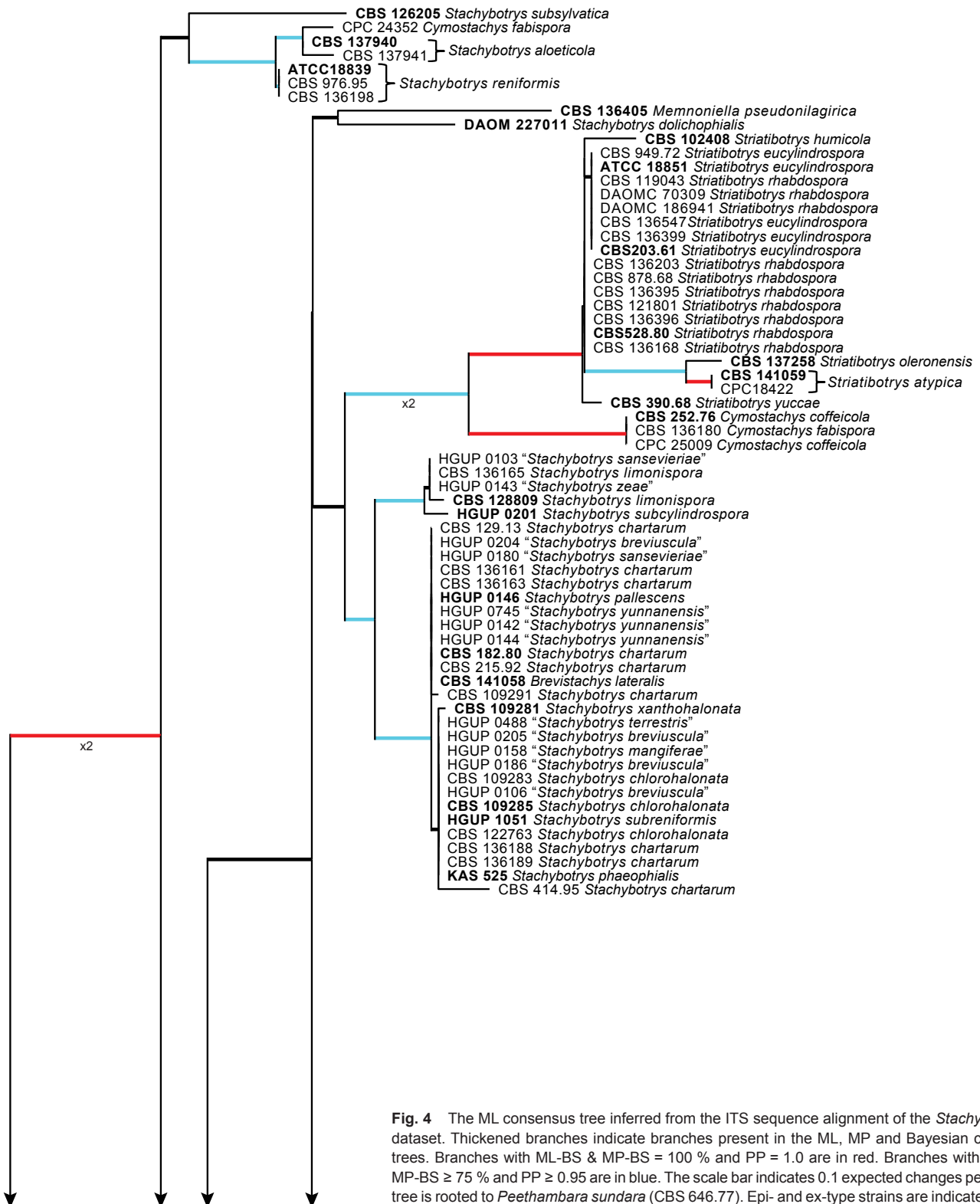
The combined LSU and *rpb2* sequence dataset presented in Fig. 1, included representatives of each clade resolved in the larger analyses of both gene regions. This dataset included 66 ingroup taxa, with *Calonectria illicicola* (CBS 190.50), *Fusarium sambucinum* (CBS 146.95) and *Nectria cinnabarina* (CBS 125165) as outgroup taxa. The sequence dataset consisted of 1 581 characters, including alignment gaps. Of these, 965 were constant, 147 parsimony-uninformative and 469 parsimony-informative. The MP analysis yielded 40 trees (TL = 3 625; CI = 0.275; RI = 0.635; RC = 0.175) and a single best ML tree with  $-\ln L = -16731.731268$  which is presented in Fig. 1. The BI lasted for 1 075 M generations, and the consensus tree, with posterior probabilities, was calculated from 1 614 trees left after 538 trees were discarded as the 'burn-in' phase.

In the phylogenetic tree (Fig. 1), the ingroup taxa resolved into a total of 21 well- to highly-supported clades and 12 single lineages. Of these, six clades and eight single lineages represented species previously considered members of the genus *Myrothecium*. Several myrothecium-like strains also clustered in a well-supported clade with *Alfaria cyperi-esculenti* (ex-type CPC 23513; Crous et al. 2014), a monophyletic sexual morph genus. Representatives of the genus *Stachybotrys* were resolved into nine well- to highly-supported clades and two single lineages. The remaining four well- to highly-supported clades represented established genera that included *Didymostilbe*, *Peethambara*, *Septomyrothecium* and *Virgatospora*. Of the remaining three single lineages, two represented the monophyletic genera *Albosynnema* and *Parasarcopodium*, with the third representing *Chaetosphaeria aterrima* (Réblová 1998).

The combined *cmdA*, ITS, *rpb2* and *tub2* sequence dataset representing *Myrothecium* s.l. included 108 ingroup taxa and *Fusarium sambucinum* (CBS 146.95) as outgroup taxon. This dataset consisted of 2 610 characters, of which 1 173 were constant, 236 parsimony-uninformative and 1 201 parsimony-

Fig. 3 (cont.)





**Fig. 4** The ML consensus tree inferred from the ITS sequence alignment of the *Stachybotrys* s.l. dataset. Thickened branches indicate branches present in the ML, MP and Bayesian consensus trees. Branches with ML-BS & MP-BS = 100 % and PP = 1.0 are in red. Branches with ML-BS & MP-BS  $\geq$  75 % and PP  $\geq$  0.95 are in blue. The scale bar indicates 0.1 expected changes per site. The tree is rooted to *Peethambara sundara* (CBS 646.77). Epi- and ex-type strains are indicated in **bold**.

informative. The MP analysis yielded 1 000 trees (TL = 8 863; CI = 0.335; RI = 0.801; RC = 0.269) and a single best ML tree with  $-\ln L = -35437.984026$  which is presented in Fig. 2. The BI lasted for 1 245 M generations, and the consensus tree, with posterior probabilities, was calculated from 1 870 trees left after 622 trees were discarded as the 'burn-in' phase.

The combined *cmdA*, ITS, *rpb2*, *tef1* and *tub2* sequence dataset representing *Stachybotrys* s.l. included 190 ingroup taxa and *Peethambara sundara* (CBS 646.77) as outgroup taxon. This dataset consisted of 3 273 characters, of which 1 184 were constant, 262 parsimony-uninformative and 1 827 parsimony-informative. The MP analysis yielded 1 000 trees (TL = 14 474; CI = 0.316; RI = 0.857; RC = 0.271) and a single best ML tree

with  $-\ln L = -54412.890264$  which is presented in Fig. 3. The BI lasted for 64.86 M generations, and the consensus tree, with posterior probabilities, was calculated from 97 292 trees left after 32 430 trees were discarded as the 'burn-in' phase.

In the phylogenetic tree (Fig. 3), the ingroup taxa also resolved into similar well-, to highly-supported clades as was observed for the combined LSU and *rpb2* phylogenetic inference. These clades also included several well- to highly-supported subclades and single lineages representing possible new phylogenetic species (see notes in Taxonomy section).

Additionally, an ITS sequence dataset of *Stachybotrys* s.l. was also analysed and presented in Fig. 4. This dataset included

Fig. 4 (cont.)



sequences obtained from GenBank for *Stachybotrys* species known in literature and also included ex- and epitype strains for which only ITS sequence data is available at present (Wang et al. 2015). This dataset included 172 ingroup taxa, with *Peethambara sundara* (CBS 646.77) as outgroup taxon. This dataset consisted of 536 characters, of which 218 were constant, 69 parsimony-uninformative and 249 parsimony-informative. The MP analysis yielded 1 000 trees (TL = 1 289; CI = 0.458; RI = 0.913; RC = 0.418) and a single best ML tree with  $-\ln L = -4850.513612$  which is presented in Fig. 4. The BI lasted for 2 055 M generations, and the consensus tree, with

posterior probabilities, was calculated from 3 084 trees left after 1 028 trees were discarded as the 'burn-in' phase.

### Taxonomy

Based on phylogenetic inference supported by morphological observations, several novel genera and species, previously treated as members of the genera *Myrothecium* and *Stachybotrys*, were identified in this study. Recognised clades representing novel genera and species are described below. Several sterile strains (CBS 308.56, CBS 525.50 and MUCL 50191 in the *Stachybotrys* s.l. dataset; CBS 100347, CPC 22153 and



MUCL 55239 in the *Myrothecium* s.l. dataset) were not treated here as these represent single lineages and more data is required to confirm their novelty. However, one species in the *Alfaria* clade is sterile and described here based on DNA sequence data following the approach of Gomes et al. (2013) and Lombard et al. (2014).

***Achroiostachys*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815916

*Etymology.* Name reflects the hyaline (Greek = áchroios) conidiophores of this genus.

*Type species.* *Achroiostachys humicola* L. Lombard & Crous.

*Sexual morph* unknown. *Conidiophores* macronematous, mononematous, erect, solitary or in groups, unbranched or rarely branched, thin-walled, hyaline, smooth, sometimes becoming slightly verrucose at the base, 1–3-septate, with an apical cluster of 2–6 conidiogenous cells. *Conidiogenous cells* phialidic, elongate ampulliform to ventricose to subcylindrical, smooth to slightly verrucose, hyaline, with a somewhat protruding apical opening. *Conidia* aseptate, hyaline, smooth, ellipsoidal to limoniform to globose to subglobose, containing 1–2 large or several small guttules, rounded at both ends or with rounded base and acute apex.

*Notes* — The asexual genus *Achroiostachys* (*Ac.*) is established here for a group of stachybotrys-like fungi that formed a highly-supported clade distantly related to the *Stachybotrys* s.str. clade. Members of this genus are distinguished by their hyaline, mostly smooth, thin-walled conidiophores and hyaline, smooth, ellipsoidal to limoniform conidia. Although morphologically reminiscent of *St. elegans* (Domsch et al. 1980), the conidiophores of *Achroiostachys* (up to 140 µm) are shorter than those reported for *St. elegans* (up to 200 µm; Domsch et al. 1980). The conidiogenous cells of *St. elegans* are subclavate

(Domsch et al. 1980), whereas those of *Achroiostachys* are ampulliform to ventricose to subcylindrical.

***Achroiostachys aurantispora*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815917; Fig. 5

*Etymology.* Name reflects the pale orange colour of the conidial mass formed by this fungus.

*Conidiophores* macronematous, mononematous, single or in groups, unbranched, erect, straight, 1–2-septate, slightly thick-walled towards the base, smooth, hyaline and glassy, mostly 70–100 × 2.5–3.5 µm, bearing a whorl of 5–9 conidiogenous cells. *Conidiogenous cells* terminal, elongate ampulliform to ventricose or clavate, hyaline, smooth, 10–13 × 3.5–4.5 µm, narrowing to a short neck about 1 µm wide. Conidial mass slimy, pale orange. *Conidia* aseptate, ellipsoidal, sometimes flattened on one side, smooth, hyaline, (7–)7.5–8.5(–10) × 4–5 µm (av. 8 × 4 µm), containing 1–2 large guttules, with an inconspicuous basal hilum and a rounded apex.

*Culture characteristics* — Colonies on PDA, OA and CMA with immersed mycelium, buff to honey, reverse on PDA buff to honey.

*Materials examined.* ITALY, Mortara, substrate unknown, Jan. 1973, collector unknown, CBS 187.73. — THAILAND, precise origin uncertain, from straw in a cushion seized at the Vancouver International Airport, 13 Jan. 1998, G. White (holotype DAOM 695772, culture ex-type, DAOMC 225565 = M97-670).

*Notes* — The conidiophores of *Achroiostachys aurantispora* (up to 100 µm) are longer than those of *Ac. betulicola* (up to 85 µm), *Ac. humicola* (up to 65 µm), *Ac. levigata* (up to 75 µm) and *Ac. phyllophila* (up to 70 µm), but shorter than those of *Ac. saccharicola* (up to 140 µm). Phylogenetic inference in this study (Fig. 3) showed that *Ac. aurantispora* formed a highly supported clade closely related to *Ac. betulicola* and *Ac. saccharicola*.

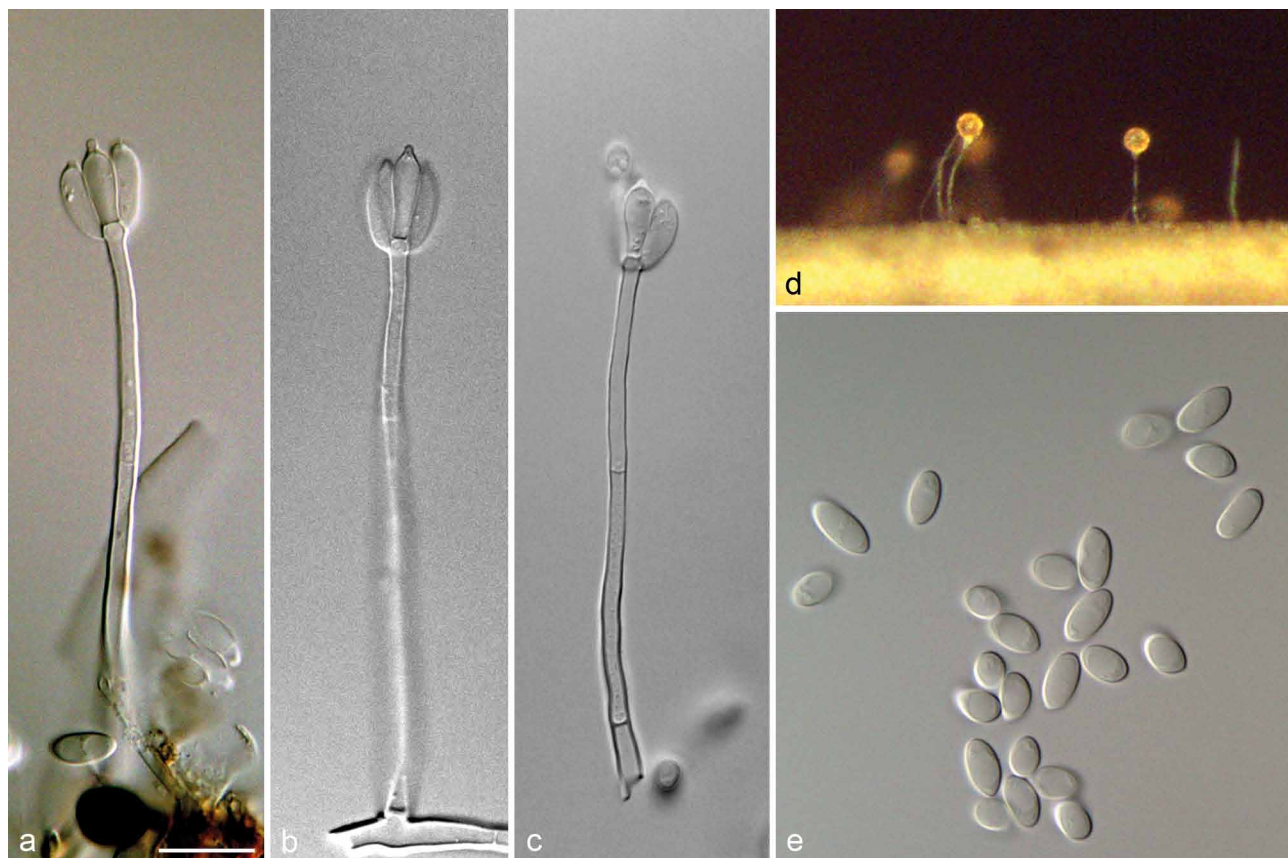


Fig. 5 *Achroiostachys aurantispora* (DAOMC 225565). a–c. Conidiophores; d. conidiophores on substrate; e. conidia. — Scale bar = 10 µm (apply to b–d).

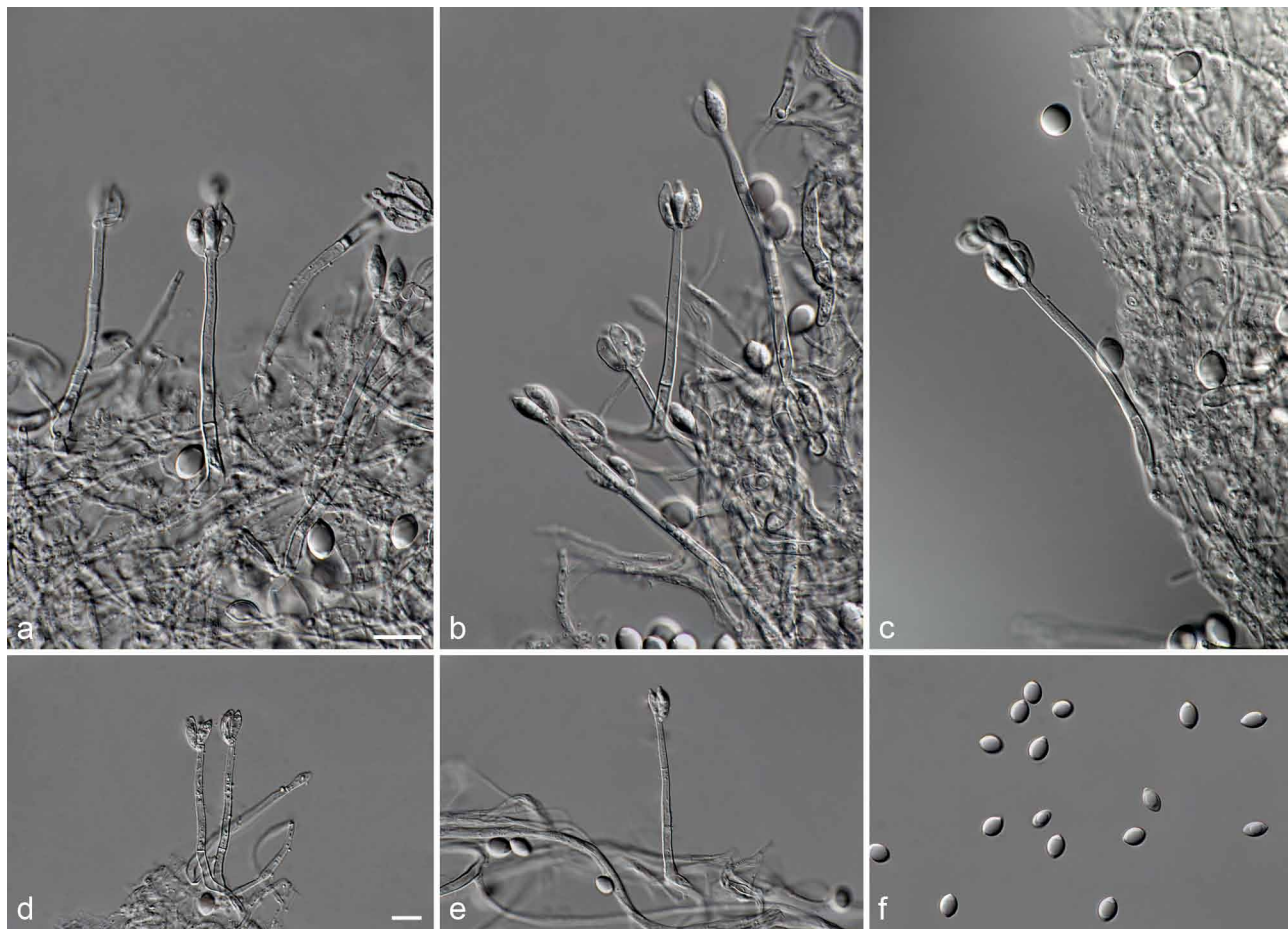


Fig. 6 *Achroiostachys betulicola* (CBS 136397). a–e. Conidiophores; f. conidia. — Scale bars = 10  $\mu$ m.

***Achroiostachys betulicola* L. Lombard & Crous, sp. nov.** — MycoBank MB815919; Fig. 6

*Etymology.* Name reflects the host genus *Betula* from which the holotype was isolated.

*Conidiophores* macronematous, mononematous, single or in groups, unbranched, erect, straight, 1–3-septate, thin-walled, smooth, hyaline, 35–85  $\times$  3–5  $\mu$ m, bearing solitary or a whorl of 2–4 conidiogenous cells. *Conidiogenous cells* terminal, elongate ampulliform to subcylindrical, hyaline, smooth, 8–11  $\times$  3–5  $\mu$ m, with a somewhat protruding apical opening. *Conidia* aseptate, globose to limoniform to ellipsoidal, smooth, hyaline, (7–)9–11(–12)  $\times$  (5–)5.5–6.5(–7)  $\mu$ m (av. 10  $\times$  6  $\mu$ m), containing 1–2 large guttules, rounded at both ends or with rounded base and acute apex.

*Culture characteristics* — Colonies on PDA, OA and CMA with mostly immersed mycelium, buff to rosy buff to salmon, with abundant conidiophores forming on the surface of the medium, bearing slimy hyaline conidial masses, reverse on PDA rosy buff to buff.

*Materials examined.* CANADA, Ontario, Dorset area, from roots of *Betula lutea*, 1961, E.A. Peterson (holotype CBS H-22419, culture ex-type CBS 136397 = MUCL 4167 = DAOMC 87338); Ontario, from soil, J.A. Traquair, DAOMC 222969. — GERMANY, Bernburg, Saale, from root of *Zea mays*, Dec. 1965, I. Focke, CBS 399.65 = ATCC 22173. — SPAIN, from leaf litter of *Bambusa vulgaris*, July 1996, CBS 142.97 = INIFAT C96/121. — USA, New York, Ithaca, campus of Cornell University, from rhizosphere of *Triticum aestivum*, May 1962, J. Jooste, CBS 136398 = MUCL 4318, CBS 136401 = MUCL 4308, CBS 136548 = MUCL 4319.

*Notes* — Phylogenetic inference in this study showed that *Ac. betulicola* formed a well-supported clade closely related to *Ac. saccharicola* and *Ac. aurantispora* (Fig. 3). The conidio-

phores of *Ac. betulicola* (up to 85  $\mu$ m) are longer than those of *Ac. humicola* (up to 65  $\mu$ m), *Ac. levigata* (up to 75  $\mu$ m) and *Ac. phyllophila* (up to 70  $\mu$ m) but shorter than those of *Ac. saccharicola* (up to 140  $\mu$ m). Additionally, the conidia of *Ac. betulicola* are slightly larger than those of the other species in the genus.

***Achroiostachys humicola* L. Lombard & Crous, sp. nov.** — MycoBank MB815920; Fig. 7

*Etymology.* Name reflects the substrate, soil, from which this fungus was isolated.

*Conidiophores* macronematous, mononematous, single or in groups, unbranched, erect, straight, 1–2-septate, thin-walled, smooth, hyaline, 30–65  $\times$  3–5  $\mu$ m, bearing a whorl of 2–6 conidiogenous cells. *Conidiogenous cells* terminal, elongate ampulliform to ventricose, hyaline, smooth, 7–12  $\times$  3–5  $\mu$ m, with a somewhat protruding apical opening. *Conidia* aseptate, globose to limoniform, smooth, hyaline, (7–)7.5–8.5(–10)  $\times$  (5–)5.5–6.5(–7)  $\mu$ m (av. 8  $\times$  6  $\mu$ m), containing 1–2 large guttules, rounded at both ends or with rounded base and acute apex.

*Culture characteristics* — Colonies on PDA, OA and CMA with abundant white to pale luteous to rosy buff aerial mycelium, with abundant conidiophores forming on the aerial mycelium and surface of the medium, bearing slimy hyaline conidial masses, reverse on PDA rosy buff to pale luteous.

*Materials examined.* CANADA, Ontario, South March, from soil under *Zea mays*, 1969, G.C. Bhatt, CBS 598.69, CBS 136404 = MUCL 15471; Waterloo, from soil in corn field, July 1967, G.C. Bhatt, CBS 136394 = MUCL 15104. — THE NETHERLANDS, Wageningen, from agricultural soil, 1969, G. Tichelaar, CBS 317.72. — TURKEY, Izmir-Bornova, substrate unknown, 1973, M. Karman (holotype CBS H-22420, culture ex-type CBS 868.73).



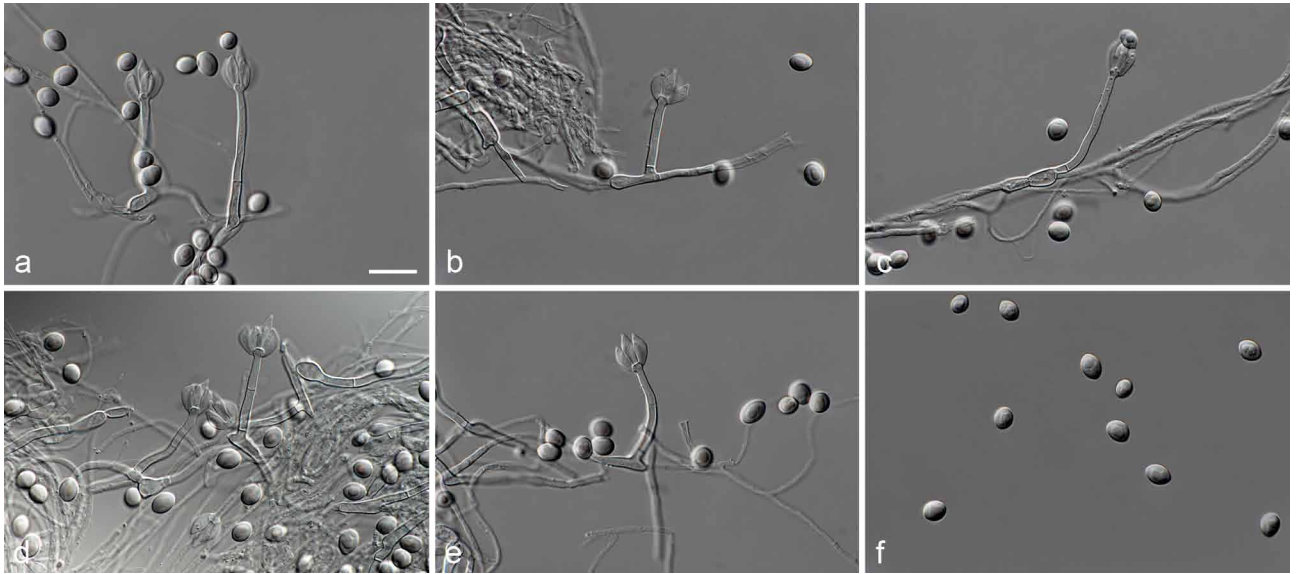


Fig. 7 *Achroistachys humicola* (CBS 868.73). a–e. Conidiophores; f. conidia. — Scale bar = 10  $\mu$ m.

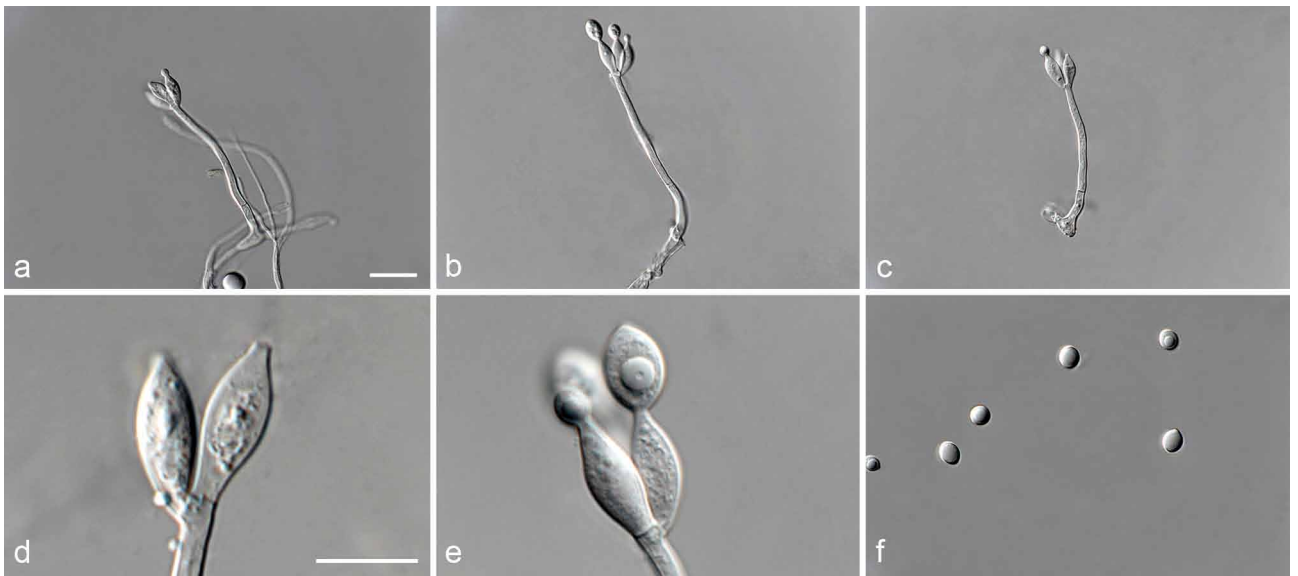


Fig. 8 *Achroistachys levigata* (CBS 185.79). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 10  $\mu$ m (apply to b–c, f); d = 10  $\mu$ m (apply to e).

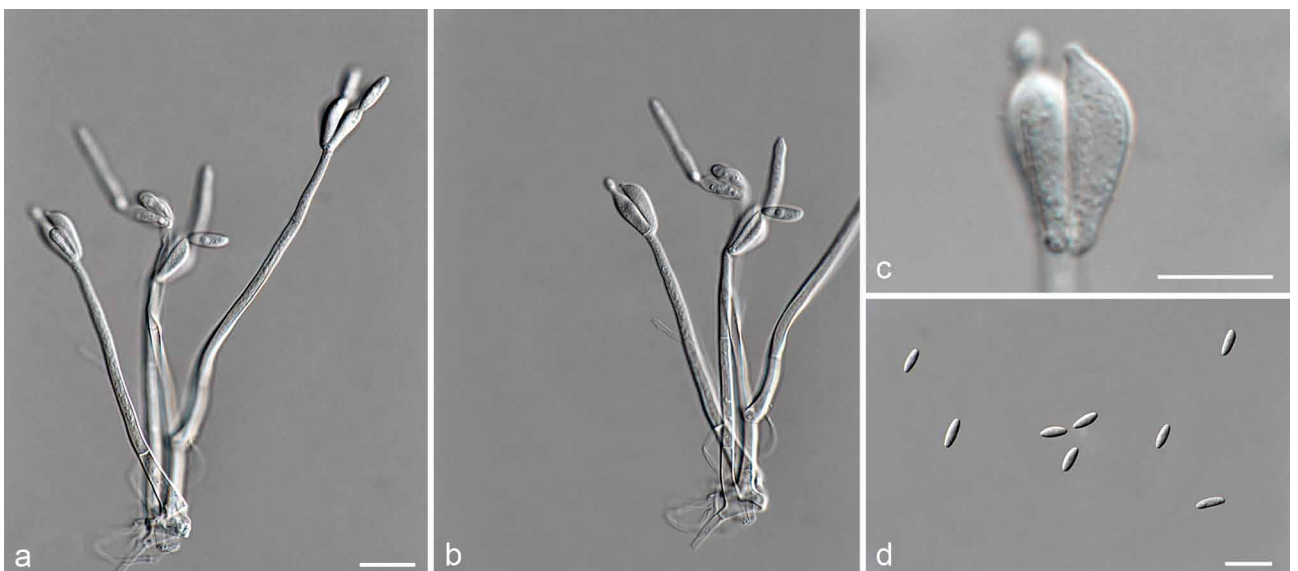


Fig. 9 *Achroistachys phyllophila* (CBS 136181). a–b. Conidiophores; c. conidiogenous cells; d. conidia. — Scale bars: a = 10  $\mu$ m (apply to b); c–d = 10  $\mu$ m.

Notes — *Achroiostachys humicola* formed a highly supported clade closely related to *Ac. levigata* (Fig. 3). This species can be distinguished from other species in the genus by their short conidiophores (up to 65  $\mu\text{m}$ ).

***Achroiostachys levigata*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815921; Fig. 8

*Etymology.* Name reflects the smooth-walled conidiophores and conidia formed by this fungus.

*Conidiophores* macronematous, mononematous, single or in groups, unbranched, erect, straight, 1–2-septate, thin-walled, smooth, hyaline, 30–75  $\times$  3–5  $\mu\text{m}$ , bearing a whorl of 2–3 conidiogenous cells. *Conidiogenous cells* terminal, elongate ampulliform to ventricose, hyaline, smooth, 9–15  $\times$  3–5  $\mu\text{m}$ , with a somewhat protruding apical opening. *Conidia* aseptate, globose to limoniform, smooth, hyaline, (7–)8.5–9.5(–10)  $\times$  (6–)6.5–7.5(–8)  $\mu\text{m}$  (av. 9  $\times$  7  $\mu\text{m}$ ), containing 1–2 large guttules, with rounded base and acutely rounded apex.

*Culture characteristics* — Colonies on PDA, OA and CMA with mostly immersed mycelium, buff to honey, with abundant conidiophores forming on the surface of the medium, bearing slimy, hyaline conidial masses, reverse on PDA buff to honey.

*Materials examined.* MOZAMBIQUE, Inhaca Island, from soil in mangrove swamp, June 1958, *H.J. Swart*, CBS 363.58. — SUDAN, Elephant White Nile Island, from soil in citrus field, Mar. 1979, *B.P.R. Vittal* (holotype CBS H-22421, culture ex-type CBS 185.79 = ATCC 22172).

Notes — Phylogenetic inference showed that *Ac. levigata* formed a well-supported clade closely related to *Ac. humicola* (Fig. 3). The conidia of *Ac. levigata* ((7–)8.5–9.5(–10)  $\times$  (6–)6.5–7.5(–8)  $\mu\text{m}$  (av. 9  $\times$  7  $\mu\text{m}$ )) are broader than those of *Ac. betulicola* ((7–)9–11(–12)  $\times$  (5–)5.5–6.5(–7)  $\mu\text{m}$  (av. 10  $\times$  6  $\mu\text{m}$ )), *Ac. humicola* ((7–)7.5–8.5(–10)  $\times$  (5–)5.5–6.5(–7)  $\mu\text{m}$  (av. 8  $\times$  6  $\mu\text{m}$ )), *Ac. phyllophila* ((8–)8.5–9.5(–10)  $\times$  3–4  $\mu\text{m}$  (av. 9  $\times$  3  $\mu\text{m}$ )) and *Ac. saccharicola* ((7–)7.5–8.5(–10)  $\times$  3–4  $\mu\text{m}$  (av. 8  $\times$  3  $\mu\text{m}$ )).

***Achroiostachys phyllophila*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815922; Fig. 9

*Etymology.* Name reflects the substrate, plant debris (Greek = phyllophilus), from which this fungus was isolated.

*Conidiophores* macronematous, mononematous, single or in groups, mostly unbranched, erect, straight, 1–3-septate, thin-walled, smooth, hyaline, 40–70  $\times$  3–5  $\mu\text{m}$ , bearing a whorl of 2–6 conidiogenous cells. *Conidiogenous cells* terminal, elongate ampulliform to ventricose, hyaline, smooth, 6–13  $\times$  3–4  $\mu\text{m}$ , with a somewhat protruding apical opening. *Conidia* aseptate, ellipsoidal to limoniform, smooth, hyaline, (8–)8.5–9.5(–10)  $\times$  3–4  $\mu\text{m}$  (av. 9  $\times$  3  $\mu\text{m}$ ), containing several small guttules, with rounded base and acutely rounded apex.

*Culture characteristics* — Colonies on PDA, OA and CMA with mostly immersed mycelium, buff to honey, with abundant conidiophores forming on the surface of the medium, bearing slimy hyaline conidial masses, reverse on PDA buff to honey.

*Material examined.* SPAIN, Valencia, Requena, Sot de Chera, from plant debris, June 2010, *M. Hernández & K. Rodríguez* (holotype CBS H-22422, culture ex-type CBS 136181 = MUCL 53217 = FMR 11019).

Notes — *Achroiostachys phyllophila* formed a single lineage basal to the other phylogenetic species in the *Achroiostachys* clade (Fig. 3). The conidiophores of *Ac. phyllophila* (up to 70  $\mu\text{m}$ ) are intermediate in length between *Ac. humicola* (up to 65  $\mu\text{m}$ ) and *Ac. levigata* (up to 75  $\mu\text{m}$ ).

***Achroiostachys saccharicola*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815923; Fig. 10

*Etymology.* Name reflects the host genus *Saccharum* from which this fungus was isolated.

*Conidiophores* macronematous, mononematous, single or in groups, unbranched, erect, straight, 1–3(–4)-septate, thin-walled, smooth, hyaline, 55–140  $\times$  3–5  $\mu\text{m}$ , bearing a whorl of 2–6 conidiogenous cells. *Conidiogenous cells* terminal, elongate ampulliform to ventricose to subcylindrical, hyaline, smooth, 9–12  $\times$  3–4  $\mu\text{m}$ , with a somewhat protruding apical opening. *Conidia* acrogenous, aseptate, ellipsoidal, smooth, hyaline, (7–)7.5–8.5(–10)  $\times$  3–4  $\mu\text{m}$  (av. 8  $\times$  3  $\mu\text{m}$ ), containing several small guttules, rounded at both ends.

*Culture characteristics* — Colonies on PDA, OA and CMA with sparse white to pale luteous aerial mycelium with mostly immersed mycelium, rosy buff, with abundant conidiophores forming on the surface of the medium, bearing slimy hyaline conidial masses, reverse on PDA rosy buff.

*Materials examined.* NEPAL, Narayani, Royal Chitwan National Park, riparian forest, from dead twig, Dec. 1994, *C. Decock*, CBS 136393 = MUCL

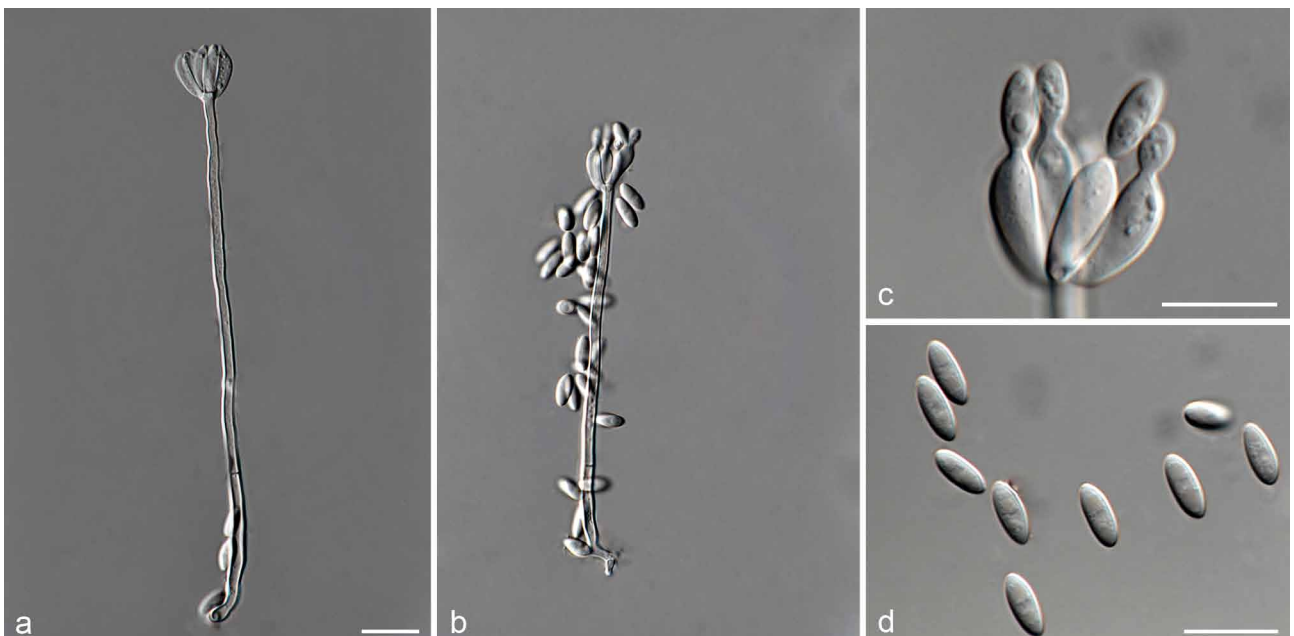
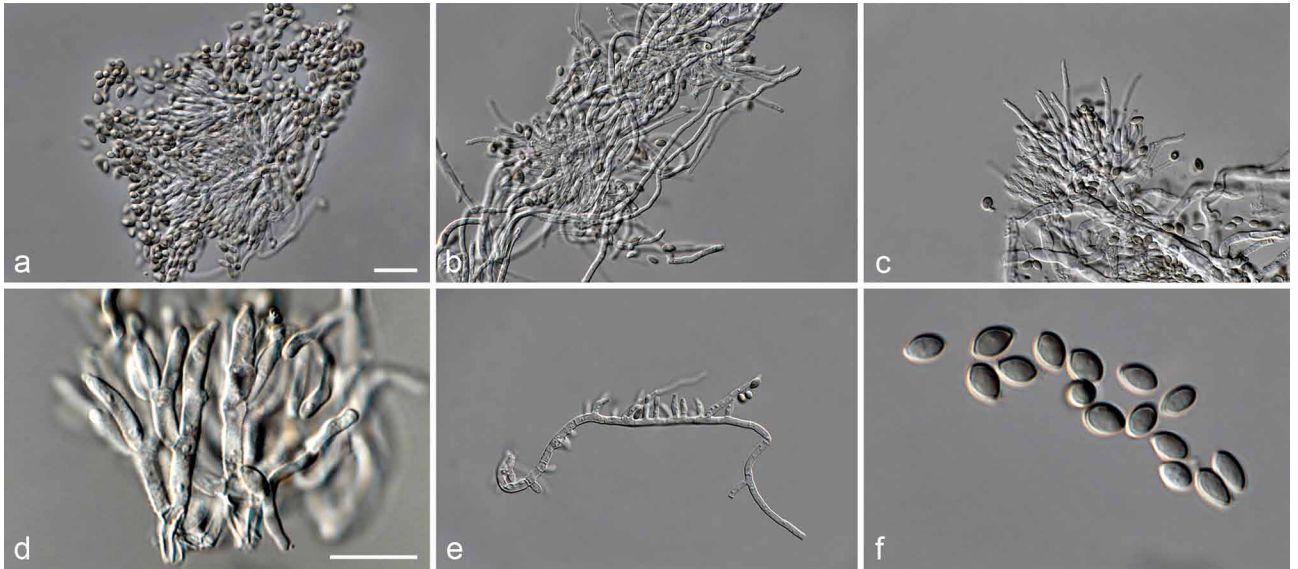
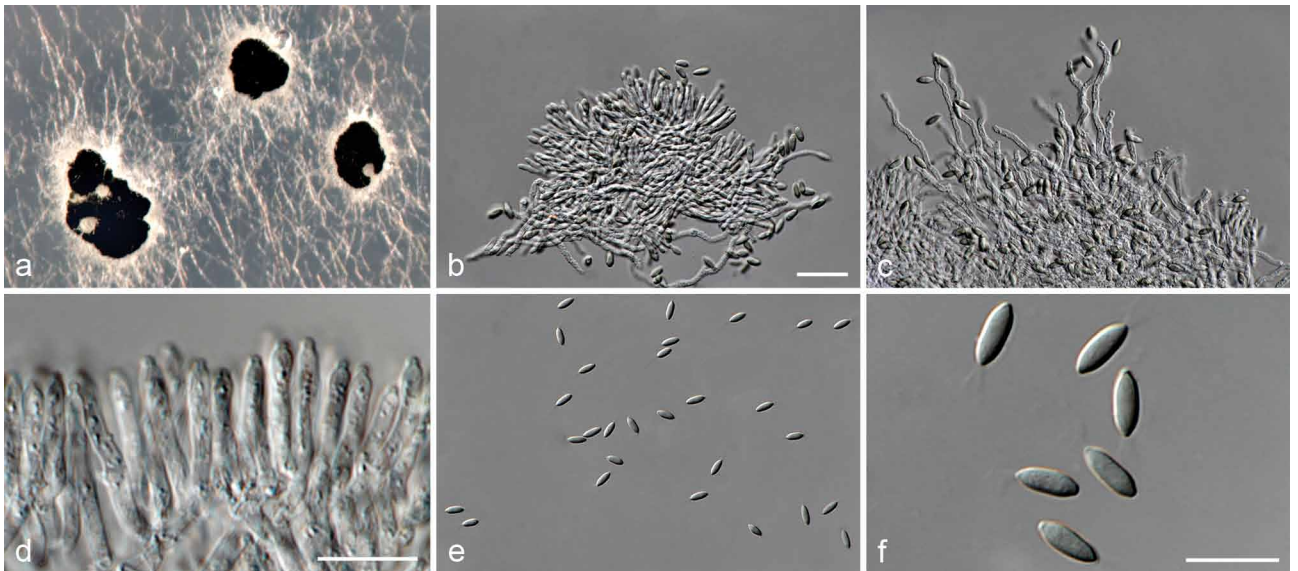


Fig. 10 *Achroiostachys saccharicola* (CBS 268.76). a–b. Conidiophores; c. conidiogenous cells; d. conidia. — Scale bars: a = 10  $\mu\text{m}$  (apply to b); c–d = 10  $\mu\text{m}$ .

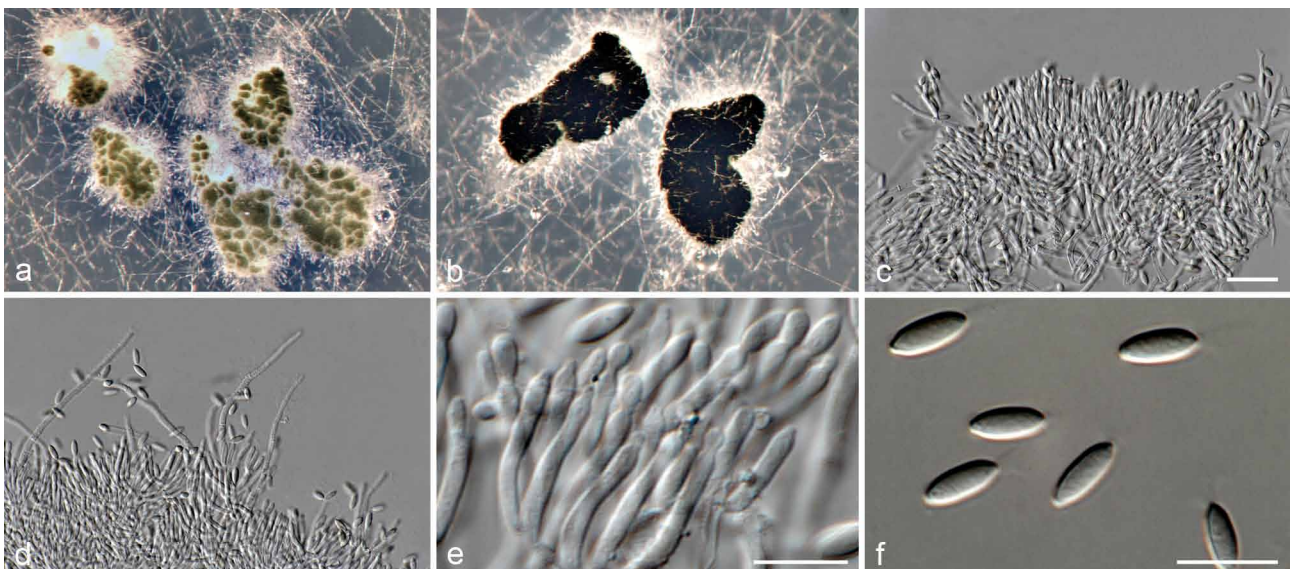




**Fig. 11** *Albifimbria lateralis* (CBS 117712). a–c. Sporodochial conidiomata; d. conidiogenous cells; e. simple conidiomata; f. conidia. — Scale bars: a = 20  $\mu$ m (apply to b–c, e–f); d = 10  $\mu$ m.



**Fig. 12** *Albifimbria terrestris* (CBS 126186). a. Sporodochial conidiomata on SNA; b. sporodochial conidiomata; c. setae; d. conidiogenous cells; e–f. conidia. — Scale bars: b = 20  $\mu$ m (apply to c, e); d, f = 10  $\mu$ m.



**Fig. 13** *Albifimbria verrucaria* (CBS 328.52). a–b. Sporodochial conidiomata on SNA; c–d. sporodochial conidiomata; e. conidiogenous cells; f. conidia. — Scale bars: c = 20  $\mu$ m (apply to d); e–f = 10  $\mu$ m.

39119. — TAIWAN, from root of *Saccharum officinarum*, 1976, T. Watanabe (holotype CBS H-18499, culture ex-type CBS 268.76).

Notes — *Achroistachys saccharicola* formed a highly supported clade (Fig. 3) and can be distinguished from other species in the genus by the formation of long conidiophores (up to 140 µm).

***Albifimbria*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815924

*Etymology.* Name reflects the characteristic white fringe surrounding the sporodochia.

*Type species.* *Albifimbria verrucaria* (Alb. & Schwein.) L. Lombard & Crous.

*Sexual morph* unknown. *Conidiomata* sporodochial or absent, reduced to simple conidiophores. *Simple conidiophores* arising directly from superficial hyphae, doliiform to reniform to allantoid, hyaline, smooth. *Sporodochia* stromatic, superficial, cupulate to discoid, scattered to gregarious, oval to elongate or irregular in outline, with a white fringe surrounding a pale olivaceous green to dark green slimy mass of conidia. *Stroma* well-developed, hyaline, of *textura globulosa* or *textura angularis*. *Setae* simple, unbranched, septate, hyaline, verrucose, thin-walled, straight to circinate, arising from the basal stroma between the conidiophores or from the white fringe. *Sporodochial conidiophores* macronematous, irregularly, verticillately or penicillately branched, hyaline, smooth. *Conidiogenous cells* phialidic, hyaline, smooth, cylindrical to allantoid, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, ellipsoidal to fusiform to limoniform to subglobose, hyaline, smooth, sometimes bearing a funnel-shaped mucoid apical appendage.

Notes — Phylogenetic inference in this study placed the ex-neotype strain (CBS 328.52 = IMI 45541; Tulloch 1972) of *Myrothecium verrucaria* (= *Peziza verrucaria*) in a highly supported clade distant to the *Myrothecium* s.str. clade (Fig. 1, 2). Therefore, the new generic name, *Albifimbria* (*Al.*), is introduced here for this clade and a new combination is provided for *M. verrucaria*. Members of *Albifimbria* are characterised by the formation of verrucose setae surrounding the sporodochia and conidia sometimes bearing a funnel-shaped mucoid appendage, not observed in *Myrothecium* s.str. (see below).

***Albifimbria lateralis*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815925; Fig. 11

*Etymology.* Name reflects the characteristic lateral phialides formed on the superficial hyphae produced by this fungus.

*Conidiomata* sporodochial or absent, reduced to simple conidiophores. *Simple conidiophores* arising from superficial hyphae, borne singly or gregarious, doliiform to cylindrical, hyaline, smooth, 5–10 × 2–3 µm, sometimes borne on a short hyaline, smooth, aseptate stipe, 3–5 × 2–3 µm. *Sporodochia* stromatic, superficial, cupulate to discoid, scattered, rarely gregarious, oval to irregular in outline, 45–100 µm diam, 20–80 µm deep, with a white setose fringe surrounding an olivaceous green agglutinated slimy mass of conidia. *Stroma* well-developed, hyaline, of *textura globulosa* or *textura angularis*. *Setae* arising from the basal stroma thin-walled, hyaline, smooth to lightly verrucose, septate, unbranched, straight to flexuous to circinate, with an obtuse apices, 30–100 µm long, 2–3 µm wide. *Sporodochial conidiophores* arising from the basal stroma, branched, hyaline, smooth, up to 95 µm long. *Conidiogenous cells* phialidic, cylindrical to elongate doliiform, hyaline, smooth, 5–18 × 2–3 µm, with conspicuous collarettes and periclinal

thickenings. *Conidia* aseptate, smooth, hyaline, fusiform to subglobose, 4–6 × 2–4 µm (av. 5 × 3 µm).

Culture characteristics — Colonies on PDA, OA and CMA with white to buff aerial mycelium with sporodochia scattered on the surface covered by slimy olivaceous green to mouse grey conidial masses, reverse on PDA honey to buff.

*Material examined.* USA, other collection details unknown (holotype CBS H-22423, culture ex-type CBS 117712).

Notes — *Albifimbria lateralis* formed a single lineage basal to the *Al. terrestris* clade (Fig. 2). This is the only species in this genus for which simple conidiophores were observed on the superficial hyphae. The conidia of *Al. lateralis* are smaller and also lack the funnel-shaped mucoid apical appendages observed for the other species in this genus.

***Albifimbria terrestris*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815926; Fig. 12

*Etymology.* Name reflects the substrate, soil, from which this fungus was isolated.

*Conidiomata* sporodochial, stromatic, superficial, cupulate to discoid, scattered or gregarious, oval to elongate or irregular in outline, 90–300 µm diam, 35–120 µm deep, with a white setose fringe surrounding a dark olivaceous green agglutinated slimy mass of conidia. *Stroma* well-developed, hyaline, of *textura globulosa* or *textura angularis*. *Setae* arising from the basal stroma thin-walled, hyaline, verrucose, septate, unbranched, flexuous to circinate, with an obtuse apices, 50–80 µm long, 2–3 µm wide. *Conidiophores* arising from the basal stroma, branched, hyaline, smooth, up to 65 µm long. *Conidiogenous cells* phialidic, cylindrical to allantoid, hyaline, smooth to lightly verrucose, 8–15 × 2–3 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, smooth, hyaline, fusiform, 6–8 × 2–3 µm (av. 7 × 3 µm), bearing a funnel-shaped mucoid apical appendage.

Culture characteristics — Colonies on PDA, OA and CMA with white aerial mycelium with sporodochia scattered on the surface covered by slimy olivaceous green conidial masses, reverse on PDA buff.

*Materials examined.* NAMIBIA, Etosha National Park, Halali Rest Camp, south of Dolomite Hill, from soil in mopane woodlands, Apr. 2001, *M. Christensen* (holotype CBS H-22424, culture ex-type CBS 126186), CBS 127838. — USA, Florida, Sabal Palm swamp, Hickory Mounds impoundment, near Ecofina river, Highway 98, from unknown dead hardwood, 20 June 2000, *D.T. Wicklow*, CBS 109378 = NRRL 31066.

Notes — *Albifimbria terrestris* formed a highly supported clade (Fig. 2) and is morphologically similar to *Al. verrucaria* (Tulloch 1972) and *Al. viridis*. The conidia of *Al. terrestris* (6–8 × 2–3 µm) are slightly smaller than those of *Al. verrucaria* (6.5–8 × 2–3.5 µm; Tulloch 1972) and *Al. viridis* (7–8 × 2–3 µm). However, phylogenetic inference is required to accurately distinguish these species.

***Albifimbria verrucaria*** (Alb. & Schwein.) L. Lombard & Crous, *comb. nov.* — MycoBank MB815927; Fig. 13

*Basionym.* *Peziza verrucaria* Alb. & Schwein., *Consp. Fungorum* Lusat.: 340. 1805.

≡ *Myrothecium verrucaria* (Alb. & Schwein.) Ditmar, *Deutschl. Fl.*, Abt. 3, Pilze *Deutschl.* 1-1: 7, t. 4. 1813.

= *Gliocladium fimbriatum* J.C. Gilman & E.V. Abbott, *Iowa State Coll. J. Sci.* 1: 304. 1927.

= *Metarhizium glutinosum* S.A. Pope, *Mycologia* 36: 343. 1944.

Description — See Tulloch (1972).

*Materials examined.* CYPRUS, from leaf of *Solanum tuberosum*, Mar. 1946, *N.C. Preston*, CBS 189.46 = IMI 140060. — ENGLAND, from old canvas shoe,



1946, *N.C. Preston*, CBS 187.46 = IMI 140056. — JAPAN, unknown substrate, Feb. 1939, *K. Saito*, CBS 390.39. — JAVA, West Java, from soil under *Camellia sinensis*, 1968, *J.H. van Emden*, CBS 208.72 — PAPUA NEW GUINEA, Madang Province, Braham, from soil in tropical forest, Nov. 1995, *A. Ap-troot*, CBS 962.95. — USA, Washington DC, from deteriorated baled cotton, 1940, *G.A. Greathouse*, CBS 328.52 = CBS 253.47 = IMI 045541 = MUCL 19018 = NRRL 2003 = ATCC 9095 = QM 460 (neotype of *Peziza verrucaria*); Louisiana, from soil, 1927, *E.V. Abbott*, CBS 176.27 = IMI 140054, NRRL 13972 = QM 7989 (ex-type of *Gliocladium fimbriatum*); locality and substrate unknown, dep. Aug. 1930, *B.B. Kanouse*, CBS 207.30 = IMI 140055; Hawaii, Onoma Bay, Alien Wet Forest, Scenic Route 19 at milepost 7, from basidioma of a resupinate polypore on a dead branch, 6 Nov. 2002, *D.T. Wicklow*, CBS 121142 = NRRL 45892. — ZIMBABWE, from Citrus fruit, 1946, *N.C. Preston*, CBS 188.46 = IMI140057.

Notes — Phylogenetic inference in this study placed the ex-neotype (CBS 328.85; Tulloch 1972) of *Al. verrucaria* in a well-supported clade, closely related but distinct to the *Al. viridis* clade (Fig. 2).

***Albifimbria viridis*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815928; Fig. 14

*Etymology.* Name reflects the green conidial masses formed on the sporodochia by this fungus.

*Conidiomata* sporodochial, stromatic, superficial, cupulate to discoid, gregarious, oval to elongate or irregular in outline, 120–650 µm diam, 55–165 µm deep, with a white setose fringe surrounding a dark olivaceous green agglutinated slimy mass of conidia. *Stroma* well developed, hyaline, of *textura globulosa* or *textura angularis*. *Setae* arising from the basal stroma thin-walled, hyaline, lightly verrucose, septate, unbranched, flexuous to circinate, with an obtuse apices, 60–90 µm long, 3–4 µm wide. *Conidiophores* arising from the basal stroma, branched, hyaline, smooth, up to 65 µm long. *Conidiogenous cells* phialidic, cylindrical, hyaline, smooth, 8–15 × 1–2 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* asep-

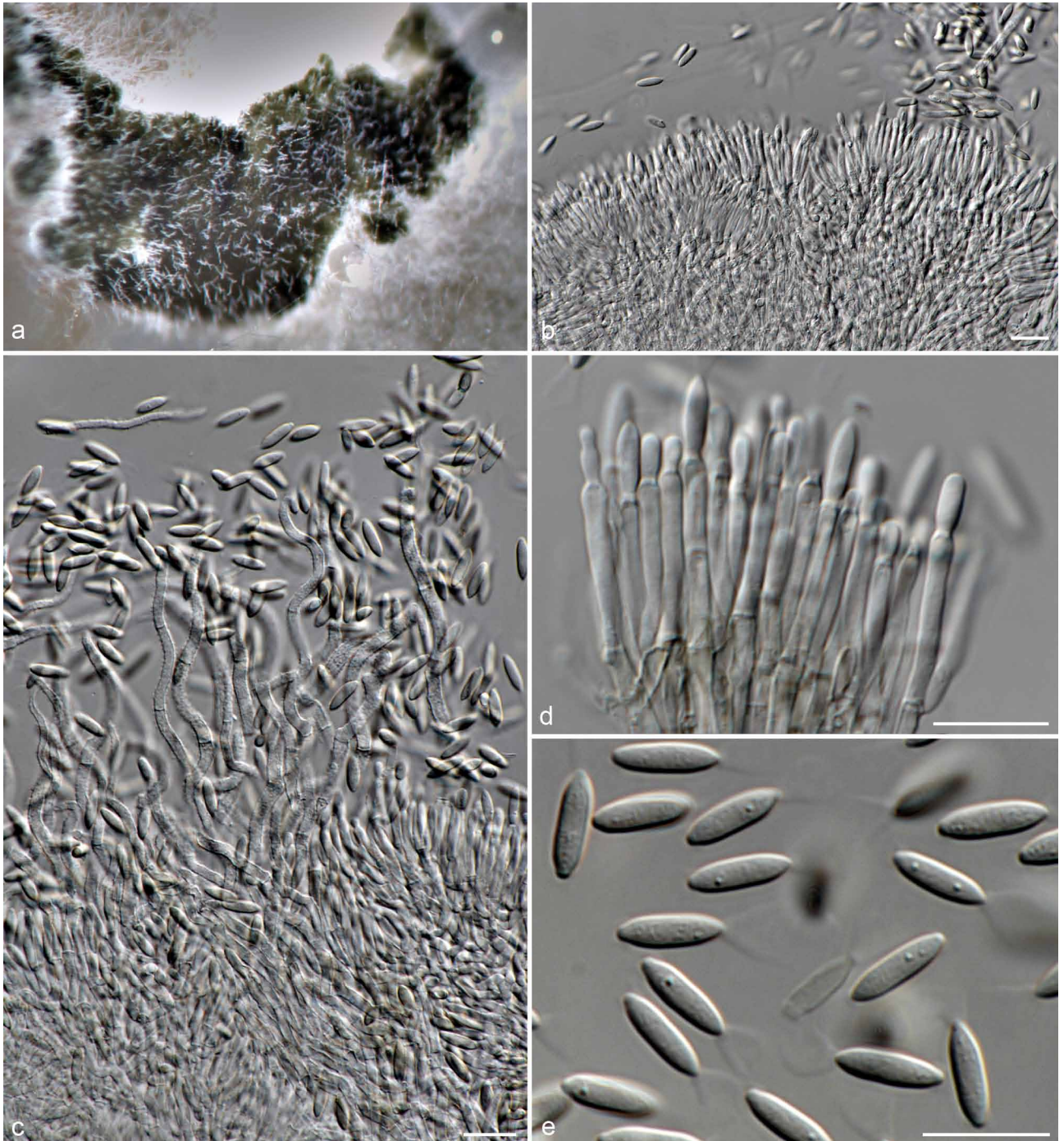


Fig. 14 *Albifimbria viridis* (CBS 449.71). a. Sporodochial conidiomata on SNA; b. sporodochial conidiomata; c. setae; d. conidiogenous cells; e. conidia. — Scale bars = 10 µm.



tate, smooth, hyaline, fusiform, 7–8 × 2–3 µm (av. 8 × 2 µm) bearing a funnel-shaped mucoid apical appendage.

Culture characteristics — Colonies on PDA, OA and CMA with white aerial mycelium becoming pale luteous towards the margins with sporodochia scattered on the surface covered by slimy olivaceous green conidial masses, and pale luteous exudate diffusing into the media, reverse on PDA pale luteous.

*Materials examined.* INDIA, Poona, from unknown substrate, June 1971, M.N. Kamat (holotype CBS H-22425, culture ex-type CBS 449.71 = BCC 37540). — IRAQ, Kurdistan, Sulaymaniyah, University of Sulaymaniyah, from air, 19 Apr. 1978, I.S. Damirdagh, CBS 244.78. — USA, Kansas, near Manhattan, Konza Prairie Research Natural Area, long term ecological research site, from soil collected in tallgrass prairie, 1986, M. Christensen, CBS 127346 = RMF 8240.

Notes — *Albifimbria viridis* formed a well-supported clade closely related to *Al. verrucaria* (Fig. 2) and is the only species that produces a pale luteous exudate that diffuses into the growth medium, which was not observed for the *Al. terrestris* and *Al. verrucaria* strains studied here. However, as mentioned, phylogenetic inference is required to accurately distinguish between these three species.

***Albosynnema*** E.F. Morris, Mycopathol. Mycol. Appl. 33, 2: 179. 1967.

*Type species.* *Albosynnema elegans* E.F. Morris, Mycopathol. Mycol. Appl. 33, 2: 179. 1967.

Description and illustration — See Morris (1967) and Bills et al. (1994).

Notes — Morris (1967) established the synnematus asexual genus *Albosynnema*, based on *A. elegans*, and considered this genus as a member of the *Stilbellaceae*. A second species, *A. filicicola* (as *A. filicola*), was later introduced by Sherwood (1974), characterised by larger (26–32 × 10–11 µm), thick-walled conidia distinguishing it from the smaller (15–22 × 5–8 µm), thin-walled conidia of *A. elegans* (Morris 1967). However, no cultures are available at this time to determine the phylogenetic position of *A. filicicola*. Bills et al. (1994), with the neotypification of *A. elegans*, and Rossman et al. (1999) considered *Albosynnema* to be closely related to several other synnematus asexual genera, such as *Didymostilbe* (= *Peet-hambara*), *Solheimia* and *Virgatospora*. Phylogenetic inference in this study supports this, with the exception of the genus *Solheimia* (Fig. 1). Bills et al. (1994) suggested that *S. costispora*, the type species of *Solheimia* (Morris 1967) could be accommodated in *Myrothecium* based on the close morphological resemblance of the conidiomata and conidia. However, preliminary analysis of the LSU gene sequence of the neotype strain (GB 3165 = CBS 102798; Bills et al. 1994) of *S. costispora* was inconclusive, placing this genus with members of the *Bionectriaceae* and *Nectriaceae*. Therefore, *S. costispora* was not included in the phylogenetic inference in this study and requires further investigation to confirm its classification.

***Alfaria*** Crous et al., Persoonia 32: 239. 2014. — MycoBank MB808923

*Type species.* *Alfaria cyperi-esculentii* Crous et al., Persoonia 32: 239. 2014.

*Ascomata* perithecial, black, hypophyllous on leaves, globose, with central ostiole; wall of 6–10 layers of thin-walled brown *textura angularis*, upper region of perithecial somewhat darker brown than base and sides; ostiolar region contain additional layers. *Paraphyses* intermingled among asci, hyaline, smooth, subcylindrical, hypha-like, with obtuse apices, septate, at times constricted at septa. *Asci* fasciculate, hyaline, short stipitate,

subcylindrical with obtuse apices, unitunicate, with apical mechanism, containing 2–8 ascospores that are bi- to tri-seriate. *Ascospores* hyaline, smooth, granular, fusoid-ellipsoid, widest in middle with obtuse ends, 0–3-septate, at times with mucoid sheath or mucoid caps. *Conidiomata* simple or myrothecium-like, sporodochial or solitary, cupulate to discoid, superficial. *Setae*, when present, septate, thick-walled or thin-walled, unbranched, smooth to lightly verrucose, straight to flexuous, becoming darkly pigmented towards the base or hyaline, tapering to a sharp or obtuse point at the apice. *Conidiophores* macronematous, verticillately or penicillately branched, hyaline, smooth to verrucose. *Conidiogenous cells* phialidic, smooth and hyaline to verrucose and pigmented, allantoid to cylindrical to elongate doliiform. *Conidia* aggregate in dry or slimy olivaceous green to mouse grey to black masses, cylindrical to ellipsoidal to ovoid, hyaline to lightly pigmented, aseptate.

Notes — The sexual genus *Alfaria* (*Alf.*), based on *A. cyperi-esculentii*, was introduced by Crous et al. (2014), associated with leaf apical necrosis of *Cyperus esculentus* (tiger nut). In their treatment of this fungus, no mention of the asexual morph was made. Based on phylogenetic inference in this study, several isolates, tentatively identified as *Myrothecium* species, clustered with the ex-type (CPC 23153) of *A. cyperi-esculentii* in a well-supported clade (Fig. 1) and are therefore newly described in this genus. Isolate CPC 22153 was sterile and, therefore, not provided with a name here. Pending on the collection of fresh isolates, it will be a new species in *Alfaria*.

***Alfaria caricicola*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815929; Fig. 15

*Etymology.* Name reflects the host genus *Carex*, from which the species was isolated.

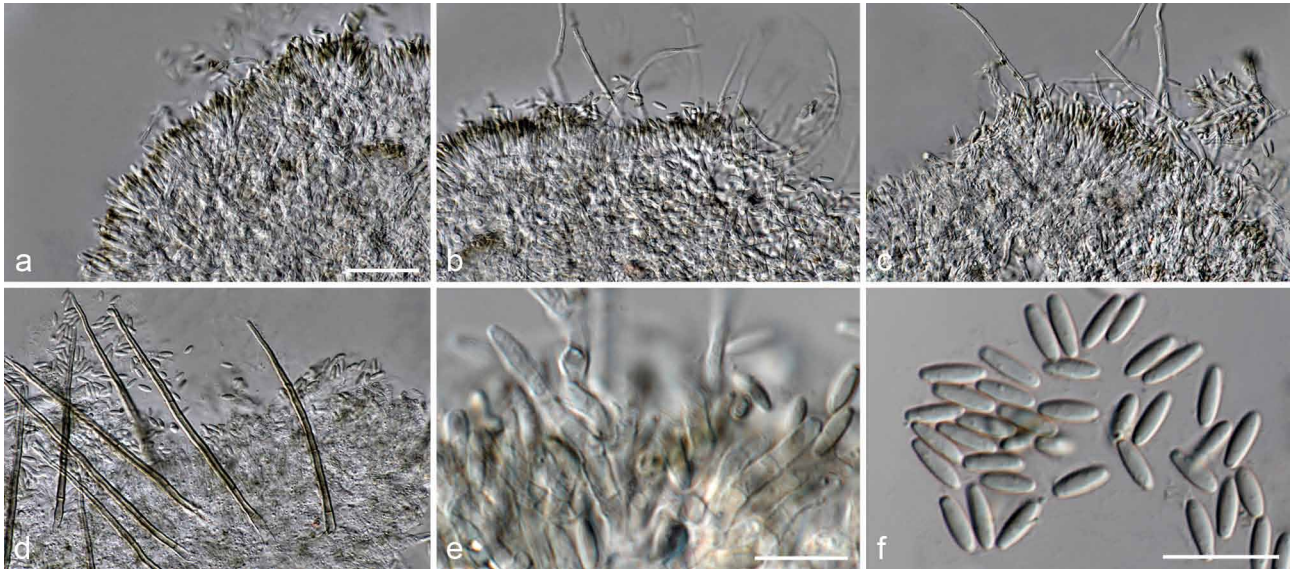
*Ascomata* not observed. *Conidiomata* sporodochial, stromatic, superficial, cupulate to discoid, scattered to gregarious, oval to elongate or irregular in outline, 180–550 µm diam, 50–100 µm deep, with a setose fringe surrounding a green agglutinated mass of conidia. *Stroma* well developed, hyaline, of *textura globulosa* or *textura angularis*. *Setae* arising from the basal stroma of two kinds: Type I scattered among the conidiogenous cells, hypha-like, thin-walled, hyaline, septate, unbranched, smooth, flexuous, with obtuse or rounded apices, 65–95 µm long, 2–5 µm wide; and Type II originating from the fringe, thick-walled, pigmented towards the bottom third, smooth, 1–3-septate, unbranched, straight, narrowing to sharp apices, 80–105 µm long, 3–5 µm wide at the broadest part. *Conidiophores* arising from the basal stroma, unbranched or branched, hyaline, smooth, up to 45 µm long. *Conidiogenous cells* phialidic, cylindrical to elongate doliiform, hyaline, smooth, 4–11 × 1–2 µm, with conspicuous collarettes and periclinal thickenings, covered by an olivaceous green mucoid layer. *Conidia* aseptate, smooth, hyaline, ellipsoidal, 4–6 × 1–2 µm (av. 5 × 2 µm).

Culture characteristics — Colonies on PDA with white aerial mycelium and luteous to pale luteous mycelium on the surface interspersed with sporodochia covered by slimy green conidial masses, reverse sienna in the centre becoming pale luteous towards the margins; on OA and CMA with white to pale luteous aerial mycelium, with pale luteous surface mycelium forming concentric rings interspersed with sporodochia covered by slimy green conidial masses.

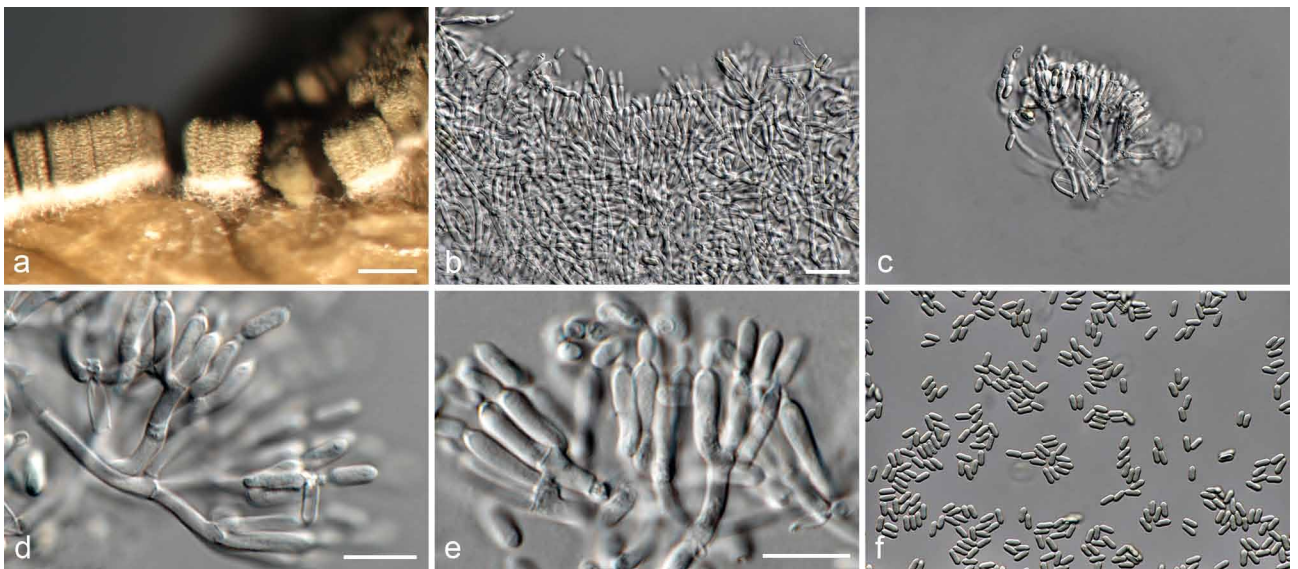
*Material examined.* IRAN, Chirabad waterfall, on litter of *Carex* sp., June 2003, W. Gams & R. Zare (holotype CBS H-22426, culture ex-type CBS 113567).

Notes — *Alfaria caricicola* formed a single lineage (Fig. 2, 3) and can be distinguished from other members of this genus by the two types of setae arising from the sporodochia.

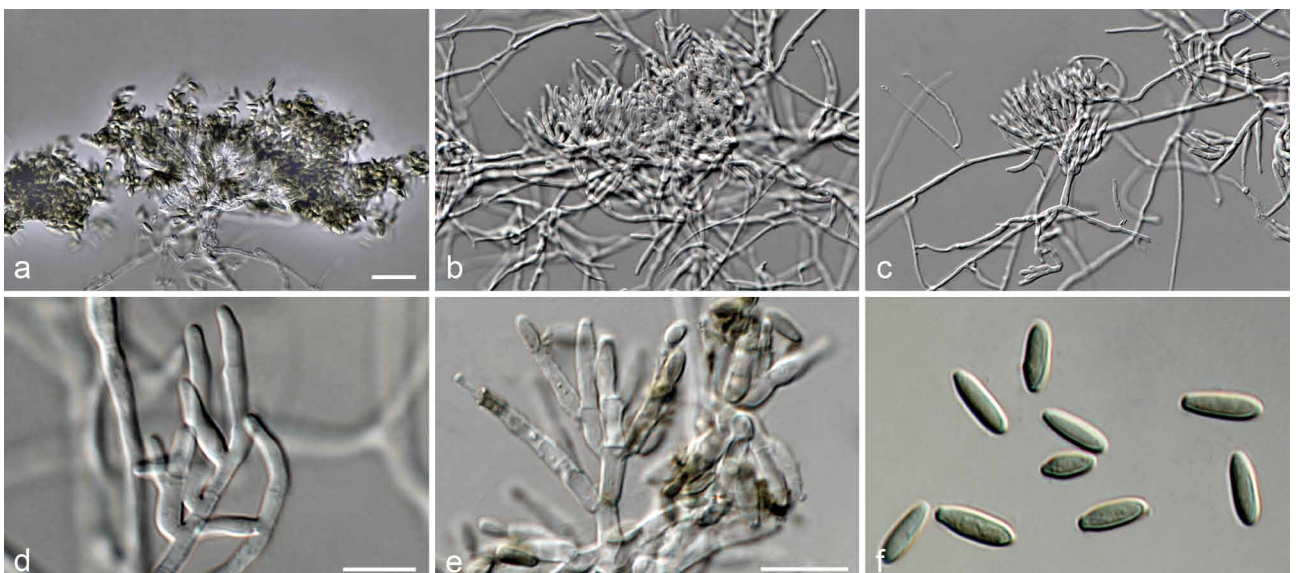




**Fig. 15** *Alfaria caricicola* (CBS 113567). a. Sporodochial conidiomata; b–c. sporodochia with Type I setae; d. Type II setae; e. conidiogenous cells; f. conidia; Scale bars: a = 20  $\mu$ m (apply to b–d); e–f = 10  $\mu$ m.



**Fig. 16** *Alfaria ossiformis* (CBS 324.54). a. Sporodochia with dry conidial pillars; b–c. sporodochial conidiomata; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 100  $\mu$ m; b = 20  $\mu$ m (apply to c, f); d–e = 10  $\mu$ m.



**Fig. 17** *Alfaria terrestris* (CBS 477.91). a–c. Sporodochial conidiomata; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 20  $\mu$ m (apply to b–c, f); d–e = 10  $\mu$ m.



***Alfaria ossiformis*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815930; Fig. 16

*Etymology.* Name reflects the characteristically bone-shaped (ossiform) conidia produced by this fungus.

*Ascomata* not observed. *Conidiomata* sporodochial, stromatic, superficial, cupulate to discoid, scattered to gregarious, oval to elongate or irregular in outline, 25–200 µm diam, 50–350 µm deep due to dry conidial pillars on top of sporodochia, without a setose fringe. *Stroma* well-developed, hyaline, of *textura globulosa* or *textura angularis*. *Conidiophores* arising from the basal stroma, unbranched or branched, hyaline, smooth, up to 65 µm long. *Conidiogenous cells* phialidic, clavate to cylindrical, hyaline, smooth, 5–10 × 2–3 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, smooth, hyaline, ossiform to ellipsoidal, straight, (5–)6–7 × 2–3 µm (av. 6 × 2 µm).

Culture characteristics — Colonies on PDA, OA and CMA with immersed mycelium giving rise to white sporodochia scattered or gregarious on the surface, covered by olivaceous green to mouse grey pillars of conidia, reverse on PDA sienna in the centre becoming pale luteous towards the margins.

*Material examined.* USA, Wisconsin, from prairie soil, Apr. 1954, P.A. Orlupt (holotype CBS H-22427, culture ex-type CBS 324.54 = IMI 055309 = MUCL 11831 = QM 7979 = BCC 38221).

Notes — *Alfaria ossiformis* represents another single lineage resolved in the *Alfaria* clade (Fig. 2, 3) and characteristically produces ossiform conidia not observed in other species of the genus. Furthermore, *Alf. ossiformis* lacks setae surrounding the sporodochia, distinguishing it from *Alf. caricicola* and *Alf. thymi*.

***Alfaria putrefolia*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815931

*Etymology.* Name reflects the substrate, rotten leaves, from which this fungus was isolated.

Cultures sterile. *Alfaria putrefolia* differs from its closest phylogenetic neighbours, *Alf. ossiformis* and *Alf. terrestris*, by unique fixed alleles in three loci based on alignments of the separate loci deposited in TreeBASE as study S18962: ITS positions: 75(indel), 78(C), 173(indel), 174(T), 266(indel), 500(T), 501(indel) and 521(indel); *rpb2* positions: 23(T), 24(T), 53(T), 128(T), 194(A), 239(C), 254(T), 260(A), 341(T), 368(T), 380(A), 383(C), 389(G), 401(T), 407(C), 444(C), 446(A), 455(A), 549(T), 558(T), 570(T), 573(C), 591(C), 609(A), 621(G), 729(C), 756(G) and 812(G); *tub2* positions: 183(A), 185(C), 188(T), 191(C), 214(T) and 335(C).

Culture characteristics — Colonies on PDA, OA and CMA with immersed mycelium, buff to honey, reverse on PDA buff to honey.

*Materials examined.* BRAZIL, Corcovado, from rotten leaf, 12 Oct. 2002, A. Stchigel & J. Guarro (holotype CBS 112037, preserved as metabolically inactive culture, culture ex-type CBS 112037), CBS 112038.

Notes — Phylogenetic inference in this study placed *Alfaria putrefolia* in a highly supported clade closely related to *Alf. ossiformis* and *Alf. terrestris* (Fig. 2, 3). All attempts to induce sporulation of both strains of *Alf. putrefolia* on the defined media failed in this study.

***Alfaria terrestris*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815932; Fig. 17

*Etymology.* Name reflects the substrate, soil, from which this fungus was isolated.

*Ascomata* not observed. *Conidiomata* sporodochial or absent, reduced to simple conidiophores. *Simple conidiophores* arising from hyphae, verticillately or penicillately branched, hyaline,

smooth, up to 20 µm long. *Sporodochia* stromatic, superficial, cupulate to discoid, scattered or gregarious, oval to elongate or irregular in outline, 125–350 µm diam, 20–100 µm deep, without a setose fringe, covered by a green to black agglutinated slimy mass of conidia. *Stroma* well developed, hyaline, of *textura globulosa* or *textura angularis*. *Sporodochial conidiophores* arising from the basal stroma, unbranched or branched, initially hyaline and smooth becoming pigmented and verrucose with age covered by an olivaceous green mucoid layer, up to 50 µm long. *Conidiogenous cells* phialidic, cylindrical to allantoid, initially hyaline and smooth becoming pigmented and verrucose with age, 5–11 × 1–3 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, smooth, hyaline, ellipsoidal to limoniform, straight, (4–)5–7 × 2–3 µm (av. 6 × 2 µm), with distinct basal hilum.

Culture characteristics — Colonies on PDA, OA and CMA with white to mouse grey aerial mycelium and sporodochia forming throughout the colony covered by slimy olivaceous green to black conidial masses, reverse on PDA olivaceous green to mouse grey.

*Materials examined.* SPAIN, from leaf litter, July 1996, R.F. Castañeda, CBS 168.97. — TURKEY, from soil, Aug. 1991, G. Turhan (holotype CBS H-22428, culture ex-type CBS 477.91). — USA, Kansas, near Manhattan, Konza Prairie Research Natural Area, long term ecological research site, from soil collected in tallgrass prairie, 1986, M. Christensen, CBS 127305 = RMF 8009.

Notes — *Alfaria terrestris* formed a well-supported subclade in the *Alfaria* clade (Fig. 2, 3). Similar to *Alf. ossiformis*, *Alf. terrestris* do not produce setae surrounding the sporodochia, distinguishing it from *Alf. caricicola* and *Alf. thymi*. *Alfaria terrestris* can be distinguished from *Alf. ossiformis* by its ellipsoidal to limoniform conidia and the formation of simple conidiophores.

***Alfaria thymi*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815933; Fig. 18

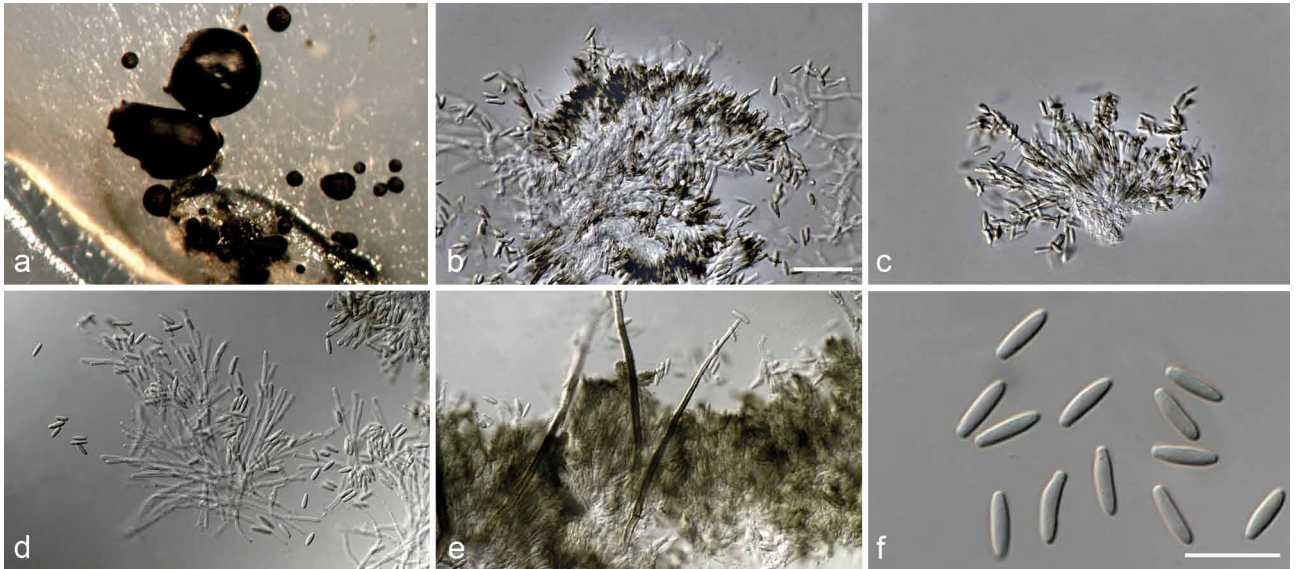
*Etymology.* Name reflects the host genus *Thymus*, from which this species was isolated.

*Ascomata* not observed. *Conidiomata* sporodochial, stromatic, superficial, cupulate to discoid, scattered, rarely gregarious, oval to elongate or irregular in outline, 20–120 µm diam, 80–250 µm deep, without a setose fringe surrounding a green to black agglutinated slimy mass of conidia. *Stroma* well-developed, hyaline, of *textura globulosa* or *textura angularis*. *Setae* arising from the basal stroma thick-walled, pigmented towards the bottom third, smooth to lightly verrucose, 1–3-septate, unbranched, straight to slightly curved, narrowing to a sharp apices, 70–100 µm long, 2–4 µm wide at the broadest part. *Conidiophores* arising from the basal stroma, unbranched or branched, initially hyaline and smooth, becoming pigmented and verrucose with age, up to 70 µm long. *Conidiogenous cells* phialidic, cylindrical to allantoid, initially hyaline and smooth becoming pigmented and verrucose with age, 7–18 × 1–2 µm, with conspicuous collarettes and periclinal thickenings, covered by an olivaceous green mucoid layer. *Conidia* aseptate, smooth, hyaline, ellipsoidal, straight to slightly curved, 5–7(–8) × 1–2 µm (av. 6 × 2 µm).

Culture characteristics — Colonies on PDA, OA and CMA with white aerial mycelium and sporodochia forming at the margins of the colony covered by slimy black conidial masses, reverse on PDA sienna to buff.

*Material examined.* THE NETHERLANDS, Limburg, Schin op Geul, on *Thymus serpyllum*, June 1983, collector unknown (holotype CBS H-22429, culture ex-type CBS 447.83).

Notes — *Alfaria thymi* also formed a single lineage in the *Alfaria* clade (Fig. 2, 3). Furthermore, it produces one type of seta surrounding the sporodochia, which distinguishes it from *Alf. caricicola*.



**Fig. 18** *Alfaria thymi* (CBS 447.83). a. Sporodochial conidiomata on SNA; b–c. sporodochia; d. conidiogenous cells; e. setae; f. conidia. — Scale bars: b = 20  $\mu\text{m}$  (apply to c–e); f = 10  $\mu\text{m}$ .

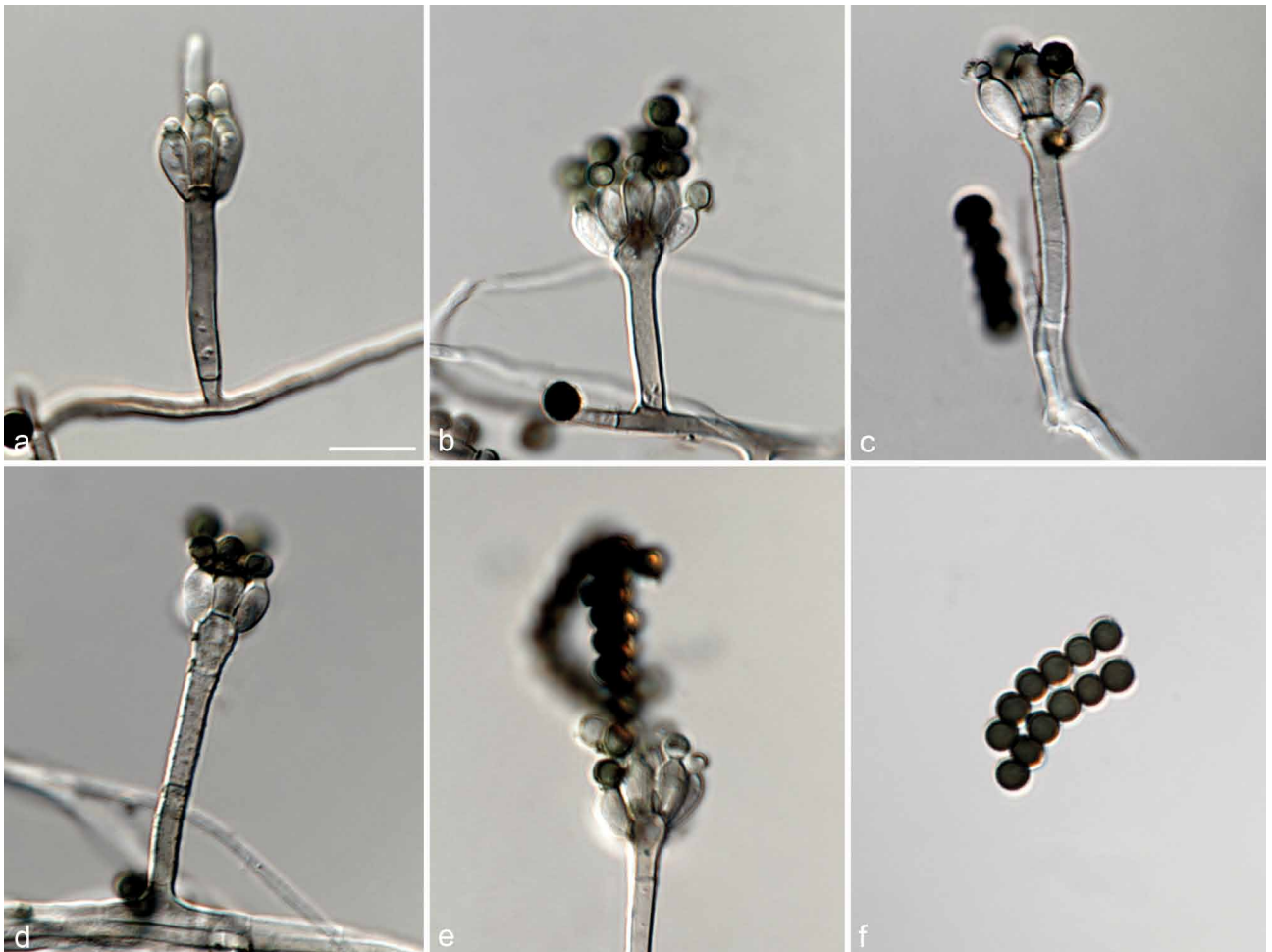
***Brevistachys*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815934

*Etymology.* Name reflects the short stachybotrys-like conidiophores characteristic of these fungi.

*Type species.* *Brevistachys variabilis* L. Lombard & Crous.

*Sexual morph* unknown. *Conidiophores* macronematous, mononematous, short, erect, solitary or in groups, unbranched or rarely branched, thin- or thick-walled, hyaline or subhyaline,

smooth or verrucose, 1-septate towards the bottom third, sometimes with bulbous apice from which a whorl of 3–8 conidiogenous cells radiate. *Conidiogenous cells* born on the apice or stipe of the conidiophores or directly on vegetative hyphae, phialidic, ellipsoidal to subcylindrical to elongate doliiform, smooth to verrucose, hyaline to subhyaline, with conspicuous collarettes. *Conidia* aseptate, hyaline to dark brown, smooth to verrucose, obovoid to globose to ossiform to ellipsoidal, aggregating in slimy masses.



**Fig. 19** *Brevistachys globosa* (CBS 141056). a–e. Conidiophores; f. conidia in chains. — Scale bar = 10  $\mu\text{m}$  (apply to all).



Notes — The genus *Brevistachys* (*Br.*) is established here to accommodate stachybotrys-like species having distinctly short conidiophores and conidiogenous cells born on conidiophores or directly from vegetative hyphae, not known for *Stachybotrys* s.str. (Hughes 1958, McKenzie 1991, Wang et al. 2015). Phylogenetic inference in this study showed that representatives of this group of fungi formed a distinct highly supported clade distant to the *Stachybotrys* s.str. Clade (Fig. 1, 3). ITS sequence data placed the ex-epitype strain (ATCC 32888; Haugland et al. 2001) of *St. subsimplex* (= *Memnoniella subsimplex*; Deighton 1960) within the *Brevistachys* clade (Fig. 4), and therefore a new combination is provided for this species in the genus *Brevistachys*. Based on the description provided by Rao (1962) for *Memnoniella zingiberis* (now *St. zingiberis*; Wang et al. 2015) this species might also belong to this genus. However, due to a lack of DNA sequence data for *St. zingiberis* to confirm this, we refrain from providing a new combination at this time.

***Brevistachys globosa*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815935; Fig. 19

*Etymology.* Name reflects the globose conidia produced by this fungus.

*Conidiophores* simple, macronematous, mononematous, single or in groups, mostly unbranched, erect, straight to slightly flexuous, 1-septate, thin-walled, initially smooth and hyaline becoming subhyaline and lightly verrucose, 20–40 × 2–4 µm, sometimes with a slightly bulbous apice, 4–5 µm diam, bearing a whorl of 3–8 conidiogenous cells. *Conidiogenous cells* terminal, elongate doliiform to subcylindrical, hyaline, smooth, 5–8

× 2–3 µm, with conspicuous collarettes. *Conidia* acrogenous, aggregating in slimy masses, aseptate, globose, initially smooth and hyaline becoming darkly pigmented and verrucose, 3–5 × 3–5 µm (av. 4 × 3 µm), borne in chains.

*Culture characteristics* — Colonies on PDA, OA and CMA with mostly immersed mycelium and conidiophores forming on the surface of the medium, with slimy black conidial masses, reverse on PDA mouse grey.

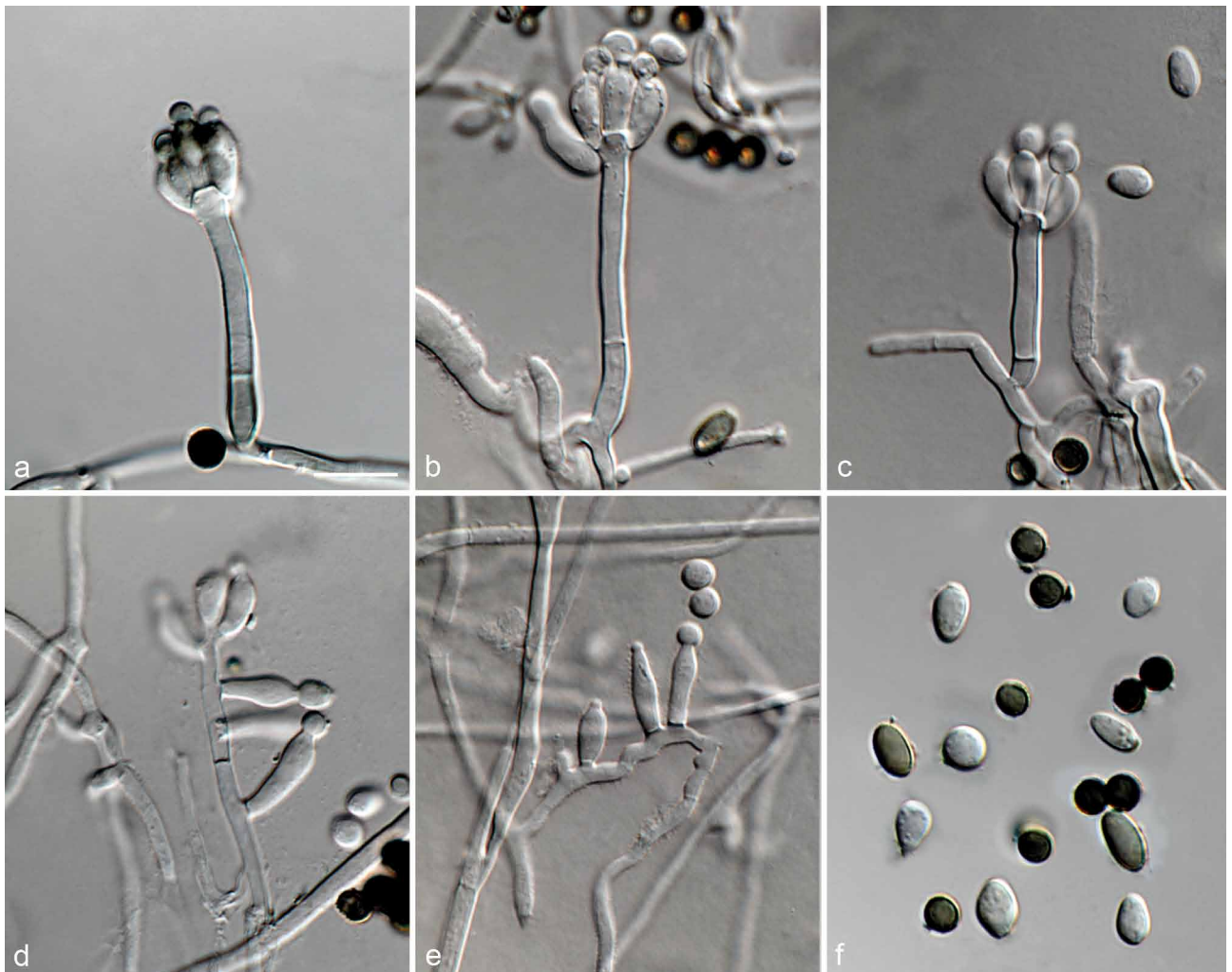
*Materials examined.* MEXICO, from *Musa* sp., 30 Oct. 2008, *M. de Jesus Yarez-Morales* (holotype CBS H-22473, culture ex-type CBS 141056 = CPC 16059), CPC 16060; Tamaulipas, from *Euphorbia* sp., 31 Oct. 2008, *M. de Jesus Yarez-Morales*, CPC 15951–3. — SRI LANKA, Anuradhapura, from dead leave of *Musa* sp., Mar. 1973, *W. Gams*, CBS 397.73.

Notes — *Brevistachys globosa* formed a well-supported clade (Fig. 3) and only produces globose conidia distinguishing it from other species in this genus.

***Brevistachys lateralis*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815936; Fig. 20

*Etymology.* Name reflects the characteristic lateral phialides formed on the superficial hyphae produced by this fungus.

*Conidiophores* simple, macronematous, mononematous, single or in groups, mostly unbranched, erect, straight to slightly flexuous, thin-walled, hyaline, 1-septate, smooth, 20–40 × 2–5 µm, sometimes with a slightly bulbous apice, 4–5 µm diam, bearing a whorl of 3–6 conidiogenous cells. *Conidiogenous cells* terminal or born laterally on vegetative hyphae and stipe of the conidiophores, elongate doliiform to subcylindrical, hya-



**Fig. 20** *Brevistachys lateralis* (CBS 141058). a–c. Conidiophores; d. conidiogenous cells carried laterally on the stipe of a conidiophore; e. conidiogenous cells carried laterally on a hyphae; f. conidia. — Scale bar = 10 µm (apply to all).



line, smooth,  $5\text{--}9 \times 3\text{--}5 \mu\text{m}$ , with conspicuous collarettes. *Conidia* acrogenous, aggregating in slimy masses, aseptate, globose to ellipsoidal, initially smooth and hyaline becoming darkly pigmented and verrucose,  $3\text{--}7(\text{--}8) \times 3\text{--}4 \mu\text{m}$  (av.  $5 \times 4 \mu\text{m}$ ), borne in chains.

Culture characteristics — Colonies on PDA, OA and CMA with mostly immersed mycelium and conidiophores forming on the surface of the medium, with slimy black conidial masses, reverse on PDA mouse grey.

*Material examined.* AUSTRALIA, Queensland, Cape Tribulation, from *Musa* sp., 9 Aug. 2009, P.W. Crous (holotype CBS H-22430, culture ex-type CBS 141058 = CPC 17350).

Notes — *Brevistachys lateralis* formed a basal single lineage in the *Brevistachys* clade (Fig. 3) and is morphologically similar to *Br. variabilis*, but can be distinguished by producing globose to ellipsoidal conidia and having lateral phialides forming on the stipes of the conidiophores.

***Brevistachys ossiformis*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815937; Fig. 21

*Etymology.* Name reflects the characteristically bone-shaped (ossiform) conidia produced by this fungus.

*Conidiophores* simple, macronematous, mononematous, single or in groups, unbranched, erect, straight to slightly flexuous,

1-septate, thick-walled, smooth, subhyaline becoming darker towards the apice,  $15\text{--}45 \times 2\text{--}5 \mu\text{m}$ , sometimes with a slightly bulbous apice,  $4\text{--}5 \mu\text{m}$  diam, bearing a whorl of 3–8 conidiogenous cells. *Conidiogenous cells* terminal, elongate doliform to subcylindrical, subhyaline, smooth,  $4\text{--}6 \times 2\text{--}3 \mu\text{m}$ , with conspicuous collarettes. *Conidia* acrogenous, aggregating in slimy masses, aseptate, ossiform to ellipsoidal, initially smooth and hyaline becoming darkly pigmented and verrucose,  $3.5\text{--}5.5 \times 2\text{--}3 \mu\text{m}$  (av.  $4.5 \times 3 \mu\text{m}$ ), borne in chains.

Culture characteristics — Colonies on PDA with mostly immersed aerial mycelium and conidiophores forming on the surface of the medium, rosy vinaceous to salmon with mouse grey to iron-grey spots of sporulation on the surface, reverse on PDA pale luteous to pale salmon; on OA with mostly immersed white aerial mycelium with mouse grey to iron grey spots of sporulation on the surface; on CMA with mostly immersed aerial mycelium, white to pale luteous, with olivaceous green spots of sporulation on the surface.

*Materials examined.* BRAZIL, Ceará State, Baturité Mountains, Guaramiranga, from dying leaves and branches of *Musa paradisiaca*, 3 July 2001, A.M. Stchigel & J. Guarro, CBS 112792 = FMR 7685. — MEXICO, Colima, from *Musa* sp., 17 Nov. 2008, M. de Jesus Yarez-Morales, CPC 16031. — SRI LANKA, Hakgala Gardens, from dead leaf of *Zingiber* sp., Aug. 1973, W. Gams (holotype CBS H-14401, culture ex-type CBS 696.73 = ATCC 32334).

Notes — *Brevistachys ossiformis* is characterised by having the longest conidiophores (up to  $45 \mu\text{m}$ ) and producing ossi-

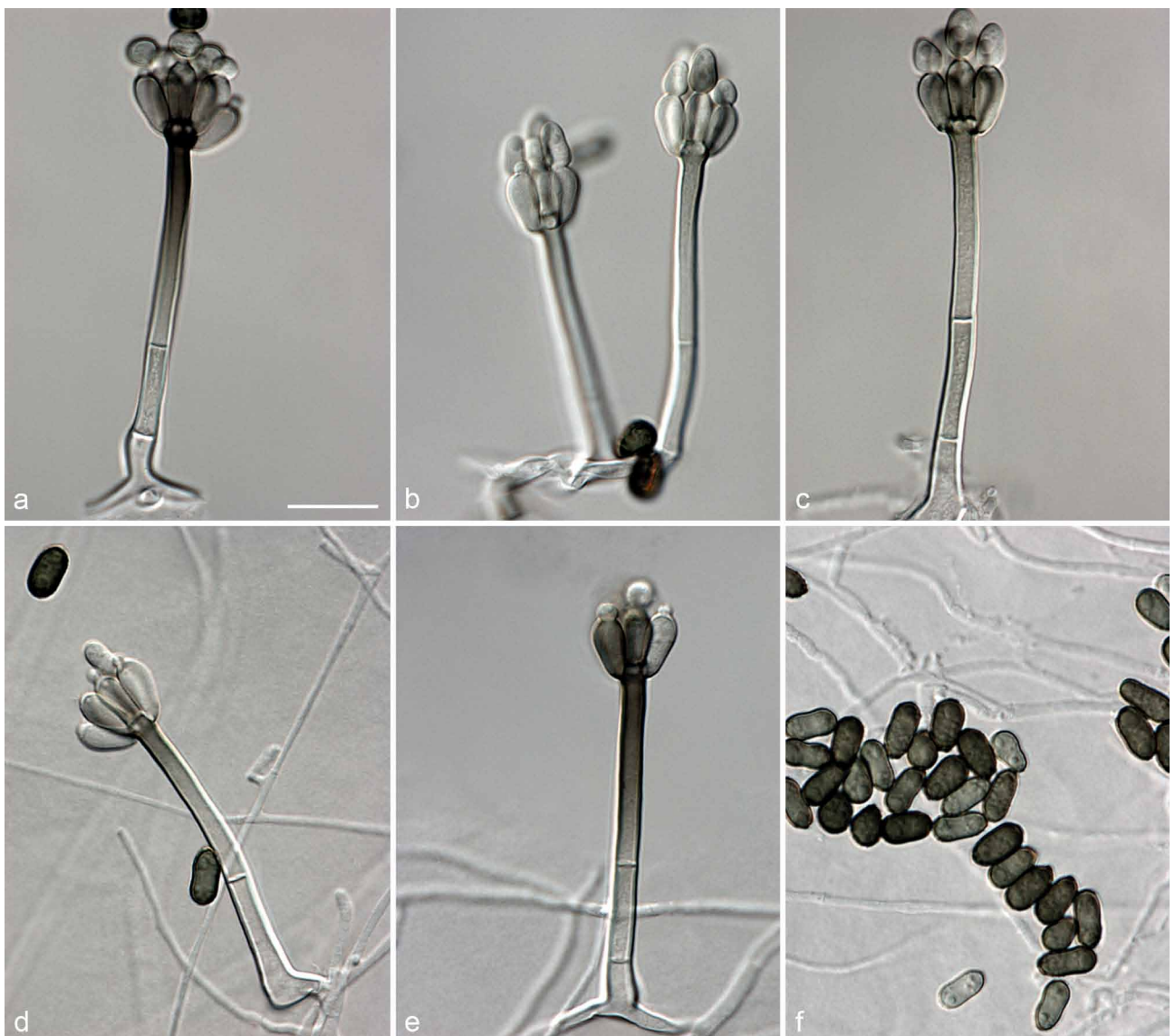


Fig. 21 *Brevistachys ossiformis* (CBS 696.73). a–e. Conidiophores; f. conidia in chains. — Scale bar =  $10 \mu\text{m}$ .

form conidia, not observed for the other species in this genus. Phylogenetic inference showed that *Br. ossiformis* formed a well-supported clade closely related to *Br. globosa* (Fig. 3).

***Brevistachys subsimplex*** (Cooke) L. Lombard & Crous, *comb. nov.* — MycoBank MB815938

*Basionym.* *Stachybotrys subsimplex* Cooke, Grevillea 12: 33. 1883.  
 = *Memnoniella subsimplex* (Cooke) Deighton, Mycol. Pap. 78: 5. 1960.  
 = *Haplographium musae* Sawada, Natn. Taiwan Univ., Coll. Agric., Spec. Publ. 8: 193. 1959.

Description and illustration — See Deighton (1960) and Wang et al. (2015).

***Brevistachys variabilis*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815939; Fig. 22

*Etymology.* Name reflects the various conidial shapes produced by this fungus.

*Conidiophores* simple, macronematous, mononematous, single or in groups, mostly unbranched, erect, straight to slightly flexuous, hyaline, 1-septate, smooth, 20–40 × 2–4 µm, sometimes with a slightly bulbous apice, 4–6 µm diam, bearing a whorl of 3–8 conidiogenous cells. *Conidiogenous cells* terminal or born laterally on vegetative hyphae, elongate doliiform to sub-cylindrical, hyaline, smooth, 5–10 × 3–4 µm, with conspicuous collarettes. *Conidia* acrogenous, aggregating in slimy masses, aseptate, globose to obovoid to ellipsoidal, initially smooth and hyaline becoming darkly pigmented and verrucose, (3–)4–8 × 3–4 µm (av. 6 × 3 µm), borne in chains.

Culture characteristics — Colonies on PDA, OA and CMA with mostly immersed mycelium and conidiophores forming on the surface of the medium, carrying slimy black conidial masses, reverse on PDA mouse grey.

*Material examined.* AUSTRALIA, Queensland, Cape Tribulation, from *Musa* sp., 9 Aug. 2009, P.W. Crous (holotype CBS H-22431, culture ex-type CBS 1411057 = CPC 17349).

Notes — *Brevistachys variabilis* formed a single lineage, basal to the *Br. globosa* and *Br. ossiformis* clades (Fig. 3). The various conidial shapes produced by *Br. variabilis* distinguishes this species from other members of this genus.

***Capitofimbria*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815940

*Etymology.* Name reflects the capitate apex of the marginal hyphae surrounding the sporodochia of this fungus.

*Type species.* *Capitofimbria compacta* (R.F. Castañeda et al.) L. Lombard & Crous.

*Sexual morph* unknown. *Conidiomata* sporodochial, stromatic, superficial, scattered or rarely gregarious, oval to irregular in outline, amphigenous, pulvinate, with olivaceous green to dark green slimy mass of conidia, lacking a white setose fringe surrounding an olivaceous green to dark green slimy mass of conidia. *Stroma* well developed, hyaline to subhyaline, of *textura globulosa* and *textura angularis*. *Marginal hyphae* branched or unbranched, septate, terminating in a capitate to clavate, thick-walled cell, coarsely rugose or tuberculate, compactly grouped, pale brown-green becoming dark brown-green at the apex, encircling the sporodochia. *Conidiophores* macronematous, septate, tightly aggregated, subhyaline to pale olivaceous brown at the apex, smooth. *Conidiogenous cells* phialidic, aseptate, smooth, cylindrical to slightly subulate, with a conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, cylindrical, olivaceous brown, smooth, rounded at both ends (adapted from Castañeda-Ruiz et al. 2008).



Fig. 22 *Brevistachys variabilis* (CBS 1411057). a–d. Conidiophores; e. conidiogenous cells carried laterally on a hyphae; f. conidia. — Scale bar = 10 µm.



Notes — Phylogenetic inference in this study placed the ex-type strain (CBS 111739) of *Myrothecium compactum* (Castañeda-Ruiz et al. 2008) in a highly supported clade distant to the *Myrothecium* s.str. clade (Fig. 2). Therefore, the new generic name, *Capitofimbria*, is introduced here for this clade and a new combination is provided for *Myr. compactum*. *Capitofimbria* is characterised by the marginal hyphae terminating in a capitulate to clavate thick-walled cell surrounding the sporodochia.

***Capitofimbria compacta*** (R.F. Castañeda et al.) L. Lombard & Crous, *comb. nov.* — MycoBank MB815941; Fig. 23

*Basionym.* *Myrothecium compactum* R.F. Castañeda et al., *Mycotaxon* 103: 5. 2008.

Description — See Castañeda-Ruiz et al. (2008).

*Materials examined.* BRAZIL, Rio de Janeiro, Rio de Janeiro, "Pista Cláudio Coutinho, near Pão de Açúcar, on decaying leaves of unknown plant, 12 Oct. 2002, A.M. Stchigel & J. Guarro (holotype CBS-H6584a, culture ex-type CBS 111739 = IMI 390539 = INIFAT C02/95). — ZIMBABWE, Manicaland, Chipinge Forest Botanical Reserve, mountainous rainforest, on bark of dead branch, 22 Jan. 1996, C. Decock, ZW-96-346 = MUCL 50238 (as *Myrothecium flavovirens*).

***Cymostachys*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815942

*Etymology.* Name reflects the characteristic cymosely branched conidiophores of this genus.

*Type species.* *Cymostachys fabispora* L. Lombard & Crous.

*Sexual morph* unknown. *Conidiophores* macronematous, mononematous, erect, mostly in groups, irregularly cymosely branched, thin-walled, hyaline to subhyaline, smooth to slightly verrucose, septate, with 3–6 conidiogenous cells radiating from the apex. *Conidiogenous cells* phialidic, clavate, smooth to slightly verrucose, olivaceous brown to dark brown at the apex becoming hyaline to subhyaline towards the base, with conspicuous collarettes. *Conidia* aseptate, olivaceous brown to dark brown, smooth to verrucose, fabiform to globose, rounded at both ends, aggregating in dark slimy masses.

Notes — The asexual genus *Cymostachys* (*Cy.*) is established here for stachybotrys-like fungi characterised by their irregularly cymosely branched conidiophores and olivaceous brown to dark brown, fabiform conidia. Phylogenetic inference in

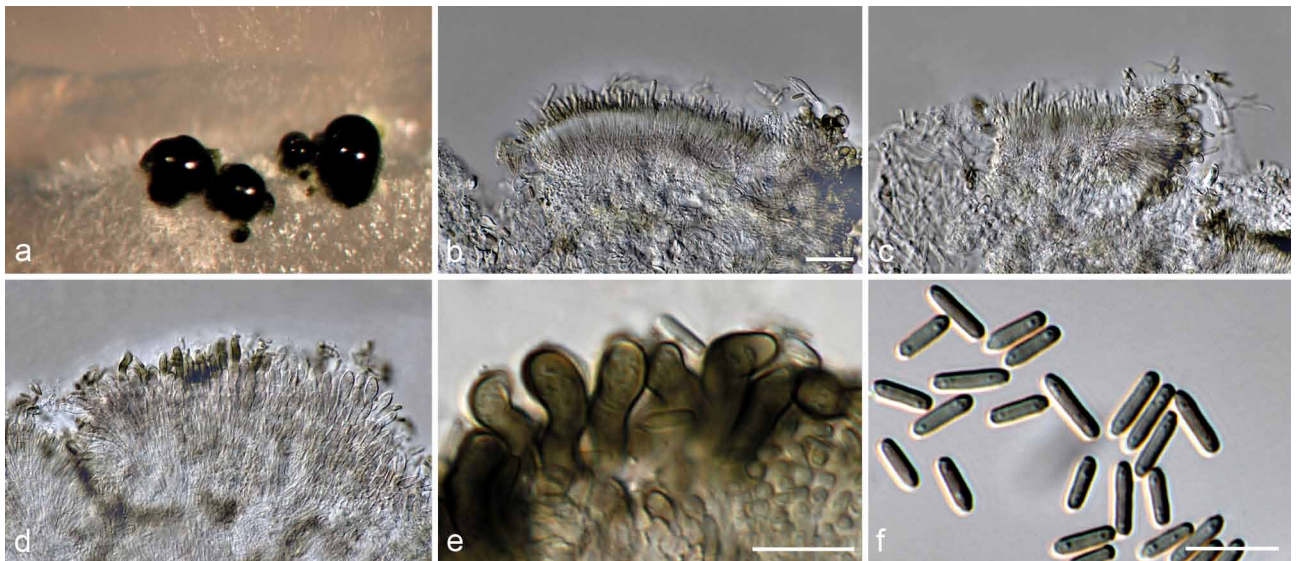


Fig. 23 *Capitofimbria compacta* (CBS 111739). a. Sporodochial conidiomata on SNA; b–c. sporodochia; d–e. marginal hyphae of the sporodochia; f. conidia. — Scale bars: b = 20  $\mu$ m (apply to c–d); e–f = 10  $\mu$ m.

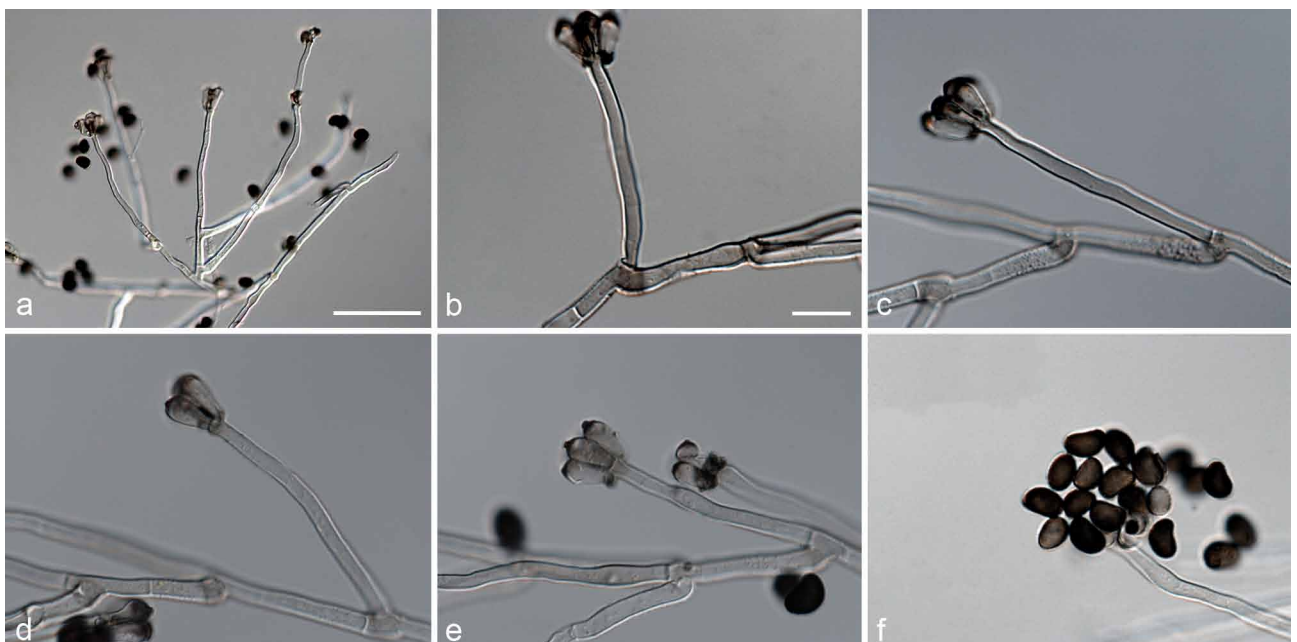


Fig. 24 *Cymostachys coffeicola* (CBS 252.76). a–e. Conidiophores; f. conidia. — Scale bars: a = 50  $\mu$ m; b = 10  $\mu$ m (apply to c–f).

this study placed these fungi in a well-supported clade distantly related to the *Stachybotrys* s.str. clade (Fig. 3).

***Cymostachys coffeicola*** L. Lombard & Crous, sp. nov. — MycoBank MB815943; Fig. 24

*Etymology.* Name reflects the host genus *Coffea*, from which this fungus was isolated.

*Conidiophores* macronematous, mononematous, mostly in groups, thin-walled, cymosely branched, erect, straight to slightly flexuous, hyaline to subhyaline, 1–2-septate, smooth to slightly verrucose, 50–135 × 4–6 µm, bearing a whorl of 3–6 conidiogenous cells. *Conidiogenous cells* phialidic, clavate, olivaceous brown to dark brown at the apex becoming hyaline to subhyaline towards the base, smooth to slightly verrucose, 8–12 × 4–6 µm, with conspicuous collarettes. *Conidia* arogenous, aseptate, fabiform, olivaceous brown to dark brown, smooth to verrucose, (7–)7.5–8.5(–10) × (5–)5.5–6.5(–7) µm (av. 8 × 5 µm), rounded at both ends, aggregating in dark slimy masses.

*Culture characteristics* — Colonies on PDA, OA and CMA with sparse white aerial mycelium, consisting of mostly immersed mycelium, mouse grey becoming dark mouse grey towards the margins; conidiophores forming on the surface of the medium, with slimy black conidial masses, reverse on PDA pale purplish grey to dark mouse grey.

*Materials examined.* CUBA, La Habana, Cacabual, from *Coffea arabica*, Apr. 1976, W. Gams (holotype CBS-H18497, culture ex-type CBS 252.76). — THAILAND, Bangkok, Chatuchak district, Queen Sirikit Park, from *Poinsettia* sp., Aug. 2014, P.W. Crous, CPC 25009.

*Notes* — *Cymostachys coffeicola* can be distinguished by their longer conidiophores (up to 135 µm) compared to those of *Cy. fabispora* (up to 100 µm). The conidia of *Cy. coffeicola* ((7–)7.5–8.5(–10) × (5–)5.5–6.5(–7) µm (av. 8 × 5 µm)) are also slightly larger than those of *Cy. fabispora* ((6–)6.5–7.5(–8) × 4–5 µm (av. 7 × 4 µm)). Phylogenetic inference in this study distinguished these two species, placing *Cy. fabispora* in a well-supported clade, distinct from *Cy. coffeicola* (Fig. 3).

***Cymostachys fabispora*** L. Lombard & Crous, sp. nov. — MycoBank MB815944; Fig. 25

*Etymology.* Name reflects the fabiform conidia produced by this fungus.

*Conidiophores* macronematous, mononematous, mostly in groups, thin-walled, cymosely branched, erect, straight to slightly flexuous, hyaline to subhyaline, 1–2-septate, smooth to slightly verrucose, 40–100 × 3–8 µm, bearing a whorl of 3–6 conidiogenous cells. *Conidiogenous cells* phialidic, clavate, olivaceous brown to dark brown at the apex becoming hyaline to subhyaline towards the base, smooth to slightly verrucose, 6–19 × 3–5 µm, with conspicuous collarettes. *Conidia* arogenous, aseptate, fabiform, olivaceous brown to dark brown, smooth to verrucose, (6–)6.5–7.5(–8) × 4–5 µm (av. 7 × 4 µm), rounded at both ends, aggregating in dark slimy masses.

*Culture characteristics* — Colonies on PDA, OA and CMA with mostly immersed mycelium, honey to amber, and conidiophores forming on the surface of the medium, carrying slimy black conidial masses, reverse on PDA sienna to honey.

*Materials examined.* CUBA, Valencia, Requena, Sot de Chera, from decaying leaf, Oct. 1993, R.F. Castañeda (holotype CBS H-22433, culture ex-type CBS 136180 = MUCL 39004 = INIFAT C93/322). — TANZANIA, Serengeti, from *Aloe ferox*, Feb. 2014, M.J. Wingfield, CPC 24352.

*Notes* — See notes under *Cym. coffeicola*.

***Didymostilbe*** Henn., Hedwigia 41: 148. 1902 (non *Didymostilbe* Bres. & Sacc. 1902)

*Type species.* *Didymostilbe coffeae* Henn., Hedwigia 41: 148. 1902.

*Description and illustration* — See Seifert (1985).

*Notes* — Species of *Didymostilbe* are characterised by large, thick-walled conidia, having prominent apical and/or basal mammiform protuberances (Seifert 1985). This genus is presently classified as a member of the *Bionectriaceae* (*Hypocreales*, *Hypocreomycetidae*) according to MycoBank and Index Fungorum. However, phylogenetic inference in this study showed that representatives of this genus belong to the *Stachybotriaceae* (Fig. 1). No living cultures of *Di. coffeae*, the type species of this genus, is presently available for phylogenetic study. Hyde et al. (1999) linked *Ornatisspora gamsii* to the asexual morph *Di. aurantiospora* based on the close proximity of both morphs in the holotype and several other collections, while at the same time reported differently looking setae or conidiophore-like structures occurring on the ascomatal wall. However, this link still needs to be proven experimentally.

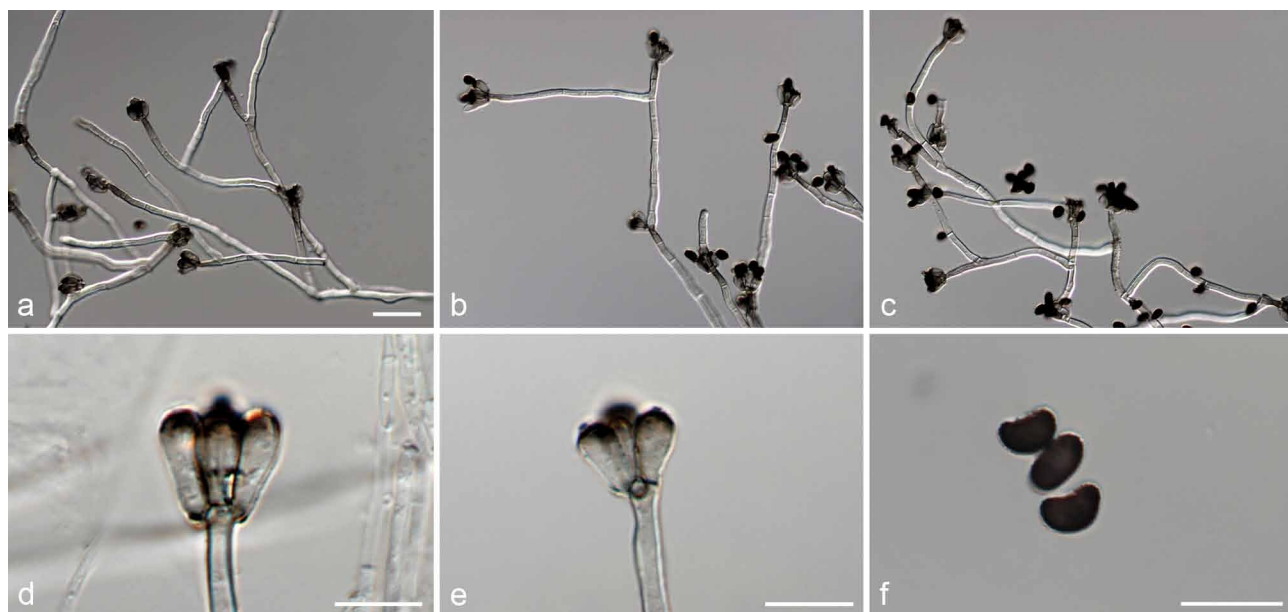


Fig. 25 *Cymostachys fabispora* (CBS 136180). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 20 µm (apply to b–c); d–f = 10 µm.



***Dimorphiseta*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815956

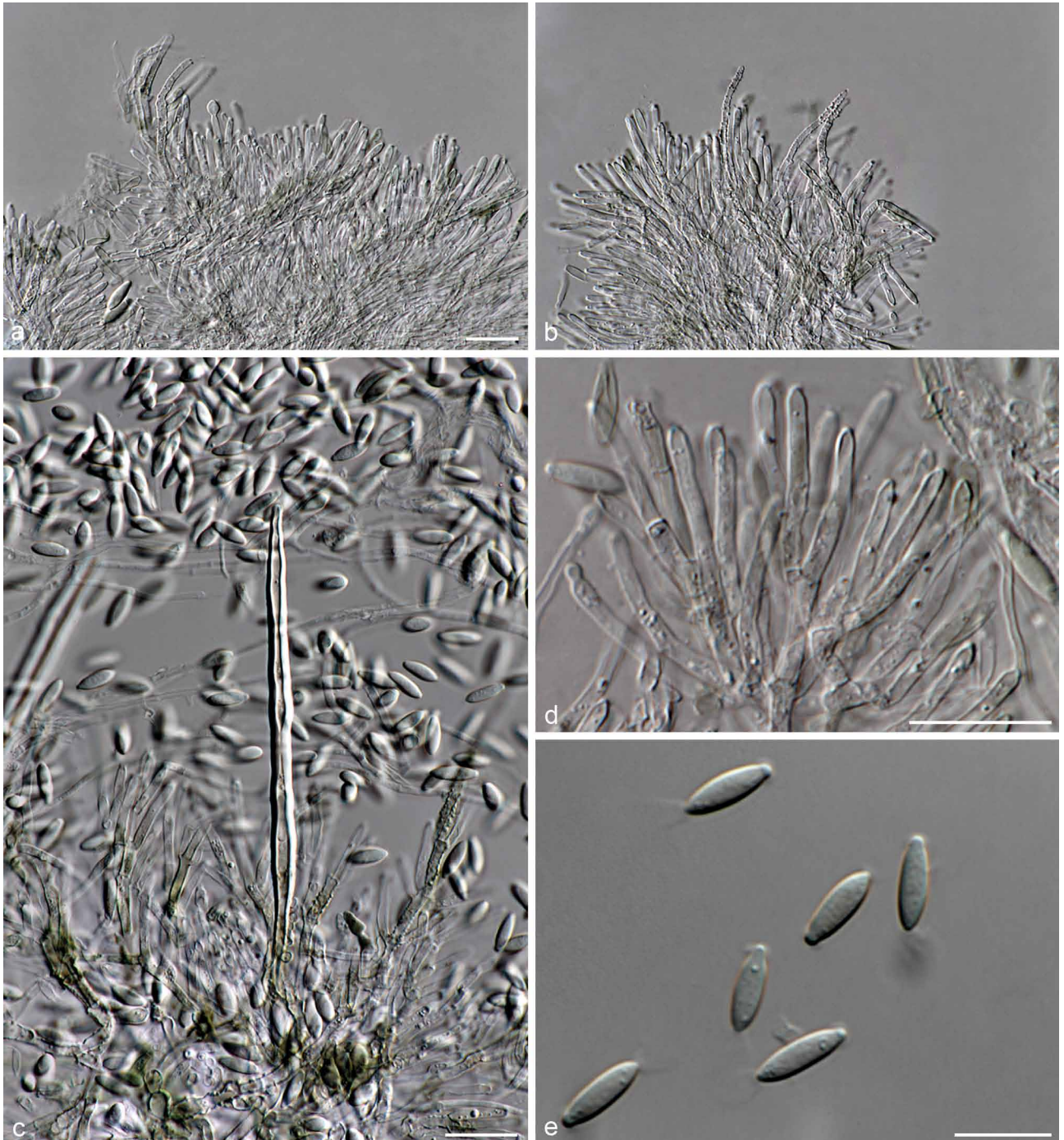
*Etymology.* Name reflects the two types of setae surrounding the sporodochia of this fungus.

*Type species.* *Dimorphiseta terrestris* L. Lombard & Crous.

*Sexual morph* unknown. *Conidiomata* sporodochial, stromatic, superficial, cupulate, scattered to gregarious, oval to elongate or irregular in outline, surrounded by two types of setae inclosing an olivaceous green to dark green slimy mass of conidia. *Stroma* well developed, hyaline, of *textura globulosa* or *textura angularis*. *Type I setae* thin-walled, flexuous to circinate, verrucose, hyaline, tapering to an obtuse apice. *Type II setae* hyaline, septate, thick-walled, smooth, tapering to a sharp apice. *Conidiphores* macronematous, irregularly, verticillately or penicillately branched, hyaline, smooth or verrucose, sometimes covered by

an olivaceous green mucoid layer. *Conidiogenous cells* phialidic, hyaline, smooth, cylindrical, becoming narrowed at the tip, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, fusiform, hyaline, smooth, with a funnel-shaped mucoid apical appendage.

*Notes* — The monotypic genus, *Dimorphiseta*, is introduced here for a strain (CBS 127345) that formed a single lineage basal to the *Albifimbria* clade and sister to *Smaragdiniseta* (Fig. 1, 2). Although morphologically similar to *Smaragdiniseta*, the Type I setae of *Dimorphiseta* are hyaline, and not emerald green as recorded for *Smaragdiniseta* (Rao & De Hoog 1983). The Type II setae of *Dimorphiseta* taper to sharp apices, whereas those of *Smaragdiniseta* narrow to an obtuse apice (Rao & De Hoog 1983). Additionally, the conidia of *Dimorphiseta* bear a funnel-shaped mucoid apical appendage, not observed for *Smaragdiniseta* (Rao & De Hoog 1983).



**Fig. 26** *Dimorphiseta terrestris* (CBS 127345). a. Sporodochial conidiomata; b. sporodochia with Type I setae; c. sporodochia with Type II setae; d. conidiogenous cells; e. conidia. — Scale bars: a = 20 µm (apply to b); c–e = 10 µm.



***Dimorphiseta terrestris*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815957; Fig. 26

*Etymology.* Name reflects the substrate, soil, from which this fungus was isolated.

*Conidiomata* sporodochial, stromatic, superficial, cupulate to discoid, scattered, rarely gregarious, oval to elongate or irregular in outline, 50–150 µm diam, 50–250 µm deep, with a setose fringe surrounding a green to black agglutinated slimy mass of conidia. *Stroma* well developed, hyaline, of a *textura globulosa* or *textura angularis*. *Setae* arising from the basal stroma, of two types: *Type I setae* thin-walled, hyaline, verrucose, flexuous to circinate, septate, 35–50 µm long, 2–4 µm wide narrowing to a sharp apices. *Type II setae* thick-walled, hyaline, smooth, septate, unbranched, straight to slightly curved, narrowing to a sharp apices, 70–95 µm long, 3–4 µm wide at the broadest part. *Conidiophores* arising from the basal stroma, branched, hyaline, smooth becoming verrucose, up to 45 µm long, sometimes covered by an olivaceous green mucoid layer. *Conidiogenous cells* phialidic, cylindrical, hyaline, smooth, 11–23 × 1–3 µm, with conspicuous collarettes and periclinal thickenings, sometimes covered by an olivaceous green mucoid layer. *Conidia* aseptate, smooth, hyaline, fusiform, straight, (7–)8–10 × 2–3 µm (av. 9 × 3 µm), bearing a funnel-shaped mucoid apical appendage.

Culture characteristics — Colonies on PDA, OA and CMA with white aerial mycelium and sporodochia forming on the surface of the medium and on the aerial mycelium covered by slimy olivaceous green to black conidial masses, producing a pale luteous exudate that diffuses into the medium, reverse on PDA pale luteous.

*Material examined.* USA, Kansas, near Manhattan, Konza Prairie Research Natural Area, long term ecological research site, from soil collected in tallgrass prairie, 1986, *M. Christensen* (holotype CBS H-22442, culture ex-type CBS 127345 = RMF 8243).

***Globobotrys*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815990

*Etymology.* Name reflects the characteristic smooth-walled globose conidia produced by this genus.

*Type species.* *Globobotrys sansevieriicola* (Crous & M.J. Wingf.) L. Lombard & Crous.

*Sexual morph* unknown. *Conidiophores* macronematous, mononematous, erect, solitary or in groups, mostly unbranched, thin-walled, hyaline, smooth, 1(–2)-septate, with a whorl of 3–8 conidiogenous cells radiating from the apex. *Conidiogenous cells* phialidic, subcylindrical to clavate to broadly reniform, smooth, thick-walled, hyaline becoming pale brown, with conspicuous collarettes. *Conidia* aseptate, hyaline to olivaceous brown, smooth, thick-walled, globose to broadly ellipsoidal, with a truncate hilum, containing one or two large guttules.

Notes — Phylogenetic inferences in this study placed the ex-type strain (CBS 138872) of *St. sansevieriicola* as a single lineage basal to the *Didymostilbe* and *Grandibotrys* clades, distinct from the *Stachybotrys* s.str. clade (Fig. 1, 3). Therefore, the asexual morph genus *Globobotrys* is established here, characterised by thick and smooth-walled conidia that distinguish it from *Stachybotrys* s.str. and other *Stachybotrys*-like genera. Hence, a new combination is provided for *St. sansevieriicola* in *Globobotrys*.

***Globobotrys sansevieriicola*** (Crous & M.J. Wingf.) L. Lombard & Crous, *comb. nov.* — MycoBank MB815991

*Basionym.* *Stachybotrys sansevieriicola* Crous & M.J. Wingf., *Persoonia* 34: 175. 2015.

Description and illustration — See Crous et al. (2015).

*Material examined.* TANZANIA, Olduvai Gorge, on leaves of *Sansevieria ehrenbergii*, Feb. 2014, *M.J. Wingfield* (holotype CBS H-22220, culture ex-type CBS 138872).

***Grandibotrys*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815992

*Etymology.* Name reflects the characteristic large conidia produced by this genus.

*Type species.* *Grandibotrys pseudotheobromae* L. Lombard & Crous.

*Sexual morph* unknown. *Conidiophores* macronematous, mononematous, erect, solitary or in groups, unbranched or branched, thin-walled, hyaline, smooth, septate, with a whorl of 2–4 conidiogenous cells radiating from the apex. *Conidiogenous cells* phialidic, subcylindrical to clavate to fusiform, smooth, hyaline, with conspicuous collarettes. *Conidia* aseptate, olivaceous green to dark brown, smooth, thick-walled, limoniform to ellipsoidal, with a mammiform apex and rounded base.

Notes — The asexual genus *Grandibotrys* (*Gra.*) is established here for a group of stachybotrys-like fungi characterised by large, olivaceous green to dark brown conidia, having a mammiform apical and/or basal protrudance. Phylogenetic inference in this study showed that these fungi formed a well-supported clade distinct from the *Stachybotrys* s.str. clade (Fig. 1, 3). Wang et al. (2015) designated the ITS sequence AF081479 (GenBank accession number of ATCC 18905) as epitype of *St. theobromae*, erroneously linking it to the strain ATCC 18877 (= *St. parvispora*). Furthermore, Wang et al. (2015) failed to indicate the holotype of *St. theobromae*, rendering the epitypification invalid (Art. 9.8; McNeill et al. 2012). Phylogenetic inference of the ITS sequence data placed ATCC 18905 within the *Grandibotrys* clade (Fig. 4), but we refrain from providing a new combination for this species pending valid epitypification.

***Grandibotrys pseudotheobromae*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815993; Fig. 27

*Etymology.* Name reflects the morphological similarity to *Stachybotrys theobromae*.

*Conidiophores* macronematous, mononematous, single, thin-walled, unbranched or branched once, erect, straight to slightly flexuous, hyaline, septate, smooth, 95–210 × 4–8 µm, bearing a whorl of 2–4 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to subcylindrical to fusiform, hyaline, smooth, 20–28 × 5–9 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, limoniform, olivaceous brown to dark brown, smooth, thick-walled, (20–)21–25(–27) × (14–)14.5–15.5(–17) µm (av. 23 × 15 µm), with a mammiform apex and rounded base.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white to pale luteous aerial mycelium with conidiophores forming on the aerial mycelium, carrying slimy olivaceous green to black conidial masses, reverse on PDA pale luteous to buff.

*Materials examined.* NEPAL, Narayani, Royal Chitwan National Park, Sauraha area, from decaying wood, Dec. 1994, *C. Decock* (holotype CBS H-22443, culture ex-type CBS 136170 = MUCL 39293), CBS 136391 = MUCL 39289.

Notes — *Grandibotrys pseudotheobromae* is morphologically reminiscent of *St. theobromae* but can be distinguished by having longer conidiophores (up to 210 µm) compared to those of *St. theobromae* (up to 200 µm; Hansford 1943). The conidia of *Gra. pseudotheobromae* ((20–)21–25(–27) × (14–)14.5–15.5(–17) µm (av. 23 × 15 µm)) are also slightly smaller than those of *St. theobromae* (20–28 × 15–18 µm; Hansford 1943).



**Fig. 27** *Grandibotrys pseudotheobromae* (CBS 136170). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 20  $\mu$ m (apply to b–c); d = 10  $\mu$ m (apply to e–f).



**Fig. 28** *Grandibotrys xylophila* (CBS 136179). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 20  $\mu$ m (apply to b–c); d = 10  $\mu$ m (apply to e–f).



***Grandibotrys xylophila*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815994; Fig. 28

*Etymology.* Name reflects the substrate, decaying wood, from which this fungus was isolated.

*Conidiophores* macronematous, mononematous, single, thin-walled, unbranched or branched once, erect, straight to slightly flexuous, hyaline, septate, smooth, 95–200 × 4–9 µm, bearing a whorl of 2–4 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to subcylindrical to fusiform, hyaline, smooth, 22–30 × 6–9 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, limoniform to ellipsoidal, olivaceous brown to dark brown, smooth, thick-walled, (23–)27–35(–39) × (9–)12–14 µm (av. 31 × 13 µm), with a mammiform apex and rounded base.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white to pale luteous aerial mycelium with conidiophores forming on the aerial mycelium, carrying slimy olivaceous green to black conidial masses and producing a pale luteous exudate that diffuse into the medium, reverse on PDA pale luteous to buff.

*Material examined.* NEPAL, Narayani, Royal Chitwan National Park, Sauraha area, from decaying wood, Dec. 1994, C. Decock (holotype CBS H-22444, culture ex-type CBS 136179 = MUCL 39288).

Notes — *Grandibotrys xylophila* formed a single lineage basal to the highly supported clade representing *Gra. pseudotheobromae* (Fig. 3). The conidia of *Gra. xylophila* ((23–)27–35(–39) × (9–)12–14 µm (av. 31 × 13 µm)) are larger than those of *Gra. pseudotheobromae* ((20–)21–25(–27) × (14–)14.5–15.5(–17) µm (av. 23 × 15 µm)) and *St. theobromae* (20–28 × 15–18 µm; Hansford 1943).

***Gregatothecium*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815995

*Etymology.* Name reflects the gregarious conidiomata produced by this fungus.

*Type species.* *Gregatothecium humicola* L. Lombard & Crous.

*Sexual morph* unknown. *Conidiomata* sporodochial, consisting of numerous aggregated penicillate conidiophores, or reduced to separate penicillate or subverticillate conidiophores. *Sporodochia* stromatic, superficial, scattered or gregarious, orbicular or irregular in outline, without a setose fringe forming an olivaceous green slimy mass of conidia from which emerge hyphal-like setae. *Stroma* poorly developed, hyaline to subhyaline, of *textura globulosa* and *textura angularis*. *Setae* arising from the basal stroma, adjacent to cells that give rise to the conidiophore stipe, unbranched, straight to flexuous, hyaline, thin-walled, septate, tapering to an acutely to subobtusely rounded apex. *Conidiophores* consist of a stipe, penicillate arrangement of fertile branches and an extension of the stipe. *Stipe* hyaline to subhyaline, septate becoming constricted at the septum, smooth. *Conidiogenous apparatus* with several series of aseptate branches (up to 6), hyaline, smooth, with terminal branches producing 3–6 conidiogenous cells. *Conidiogenous cells* phialidic, hyaline, aseptate, cylindrical to subcylindrical, straight to slightly curved, apex with minute periclinal thickening and an inconspicuous collarette. *Conidia* aseptate, cylindrical to subcylindrical, rounded at both ends, held in fascicles in olivaceous green slime.

Notes — The monophyletic asexual genus *Gregatothecium* (*Gre.*) is established here for a single phylogenetic lineage (Fig. 1, 2), morphologically reminiscent of the nectriaceae genera *Calonectria* (Lombard et al. 2010, 2015a, b), *Cylindrocladiella* (Lombard et al. 2012, 2015b) and *Dematioccladiella* (Crous et al. 2005, Lombard et al. 2015b). This genus can be distinguished

from these three nectriaceae genera by the slimy olivaceous green conidial masses produced on the conidiophores and sporodochia, and its phylogenetic placement in the *Stachybotriaceae*. This fungus is also morphologically reminiscent of *Pa. roridum*, but lacks the straight to curling, repeatedly branched marginal hyphae as recorded by Tulloch (1972).

***Gregatothecium humicola*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815996; Fig. 29

*Etymology.* Name reflects the substrate, soil, from which this fungus was isolated.

*Conidiomata* sporodochial, consisting of numerous aggregated penicillate conidiophores, or reduced to separate penicillate or subverticillate conidiophores. *Sporodochia* stromatic, superficial, scattered or gregarious, orbicular or irregular in outline, 150–600 µm diam, 65–100 µm deep, without a setose fringe, with a green to black agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline to subhyaline, smooth, of *textura globulosa* and *textura angularis*. *Setae* arising from the basal stroma, adjacent to cells that give rise to the conidiophore stipe, unbranched, straight to flexuous, hyaline, thin-walled, septate, 120–140 µm long, 2–3 µm wide tapering to an acutely to subobtusely rounded apex. *Conidiophores* consist of a stipe, penicillate arrangement of fertile branches and an extension of the stipe. *Stipes* unbranched, hyaline to subhyaline, septate becoming constricted at the septum, smooth, 10–30 × 2–4 µm; stipe extension septate, straight to flexuous, unbranched, hyaline, thin-walled, 65–100 µm long, 2–3 µm wide at the basal septum, tapering to an acutely to subobtusely rounded apex. *Conidiogenous apparatus* with several series of aseptate, hyaline branches; primary branches aseptate, unbranched, smooth, 6–10 × 2–3 µm; secondary branches aseptate, unbranched, smooth, 5–7 × 2–3 µm; tertiary branches and additional branches (–6) aseptate, unbranched, smooth, 4–6 × 1–3 µm, each terminal branch producing 3–6 conidiogenous cells. *Conidiogenous cells* phialidic, hyaline, aseptate, cylindrical to subcylindrical, straight to slightly curved, 6–12 × 1–2 µm, apex with minute periclinal thickening and inconspicuous collarette. *Conidia* aseptate, smooth, hyaline, cylindrical to subcylindrical, rounded at both ends, 5–6 × 1–2 µm (av. 5 × 1 µm), lacking funnel-shaped mucoid appendages, held in fascicles in olivaceous green slime.

Culture characteristics — Colonies on PDA, OA and CMA with sparse white aerial mycelium that becomes mostly immersed turning buff to sienna. Sporodochia forming on the surface of the medium and on the aerial mycelium covered by slimy olivaceous green to black conidial masses, producing a buff to luteous exudate that diffuses into the medium, reverse on PDA buff to sienna.

*Material examined.* PAPUA NEW GUINEA, Madang, Jais Aben, from soil along coral reef coast, Nov. 1995, A. Aptroot (holotype CBS H-22445, culture ex-type CBS 205.96).

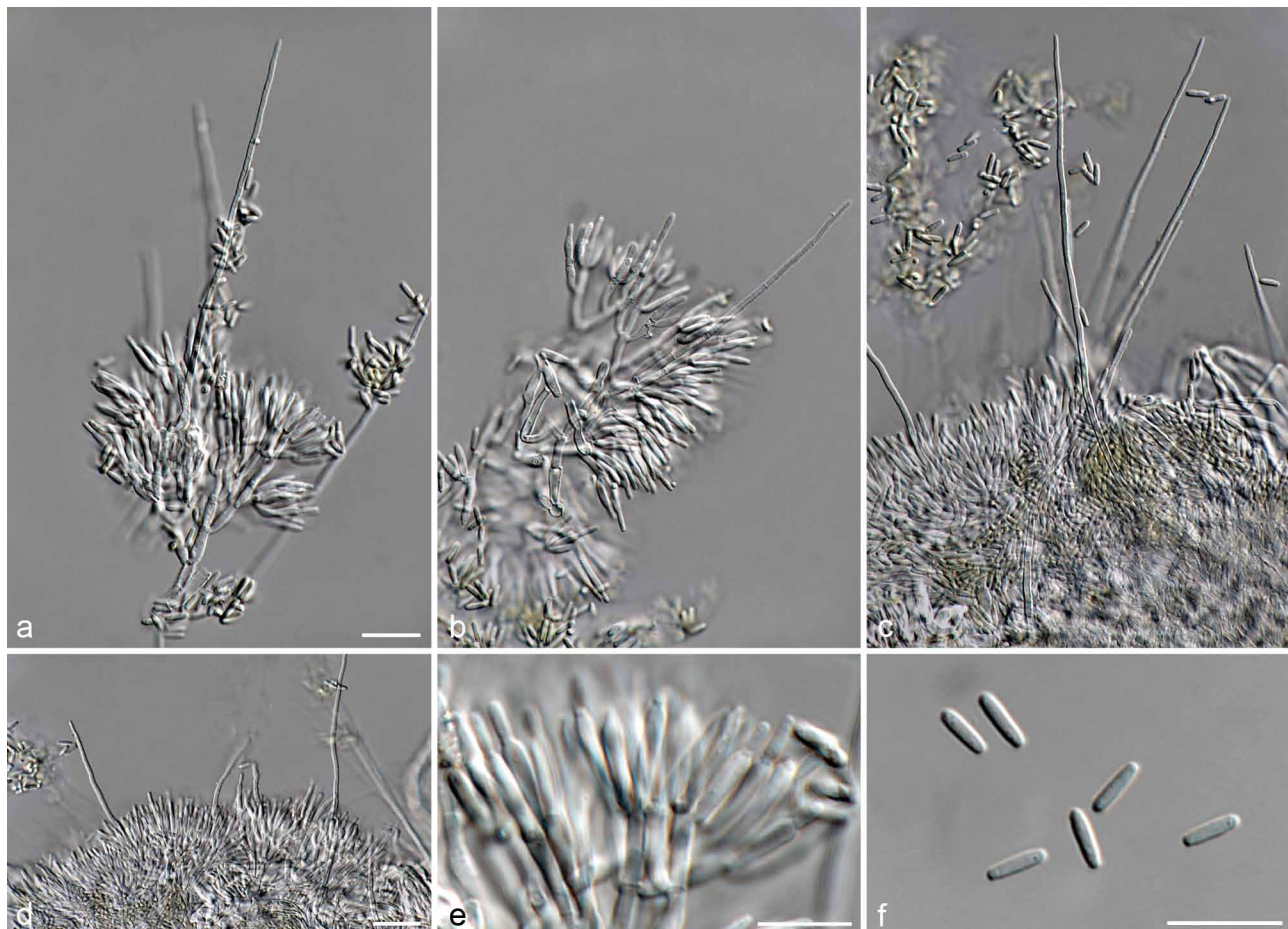
***Inaequalispora*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815997

*Etymology.* Name reflects the asymmetrically ellipsoidal conidia produced by this fungus.

*Type species.* *Inaequalispora prestonii* (M.C. Tulloch) L. Lombard & Crous.

*Sexual morph* unknown. *Conidiomata* sporodochial, stromatic, superficial, scattered or gregarious, orbicular or irregular in outline, with a white setose fringe surrounding an olivaceous green to dark green slimy mass of conidia. *Stroma* poorly developed, hyaline, composed of *textura angularis*. *Setae* thick-walled, septate, flexuous, hyaline, tapering to an obtuse apice that becomes lightly verrucose. *Conidiophores* macronematous,





**Fig. 29** *Gregatothecium humicola* (CBS 205.96). a–b. Penicillate conidiophores; c–d. sporodochial conidiophores; e. conidiogenous cells; f. conidia. — Scale bars: a = 20  $\mu$ m (apply to b–c); d = 20  $\mu$ m; e–f = 10  $\mu$ m.

penicillately branched, hyaline, smooth to lightly verrucose at the base. *Conidiogenous cells* phialidic, hyaline, smooth, subcylindrical, becoming narrowed at the tip, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, fusiform to ellipsoidal to asymmetrically ellipsoidal, hyaline, smooth, sometimes with a slightly curved acute apex and a narrow truncate base, with a funnel-shaped mucoid apical appendage (adapted from Tulloch 1972 and Nag Raj 1995).

**Notes** — Nag Raj (1995) questioned Tulloch's (1972) treatment of *Myr. prestonii* and provided a narrower concept for this species, while retaining the holotype as IMI 160372 (= isotype strain CBS 175.73). However, phylogenetic inference in this study showed that the isotype of *Myr. prestonii* formed a unique single lineage, sister to the *Septomyrothecium* s.str. clade and distant to the *Myrothecium* s.str. clade (Fig. 1). Therefore, the genus *Inaequalispora* is introduced here and a new combination is provided for *Myr. prestonii*.

***Inaequalispora prestonii*** (M.C. Tulloch) L. Lombard & Crous, *comb. nov.* — MycoBank MB815998; Fig. 30

*Basionym.* *Myrothecium prestonii* M.C. Tulloch, Mycol. Pap. 130: 12. 1972.

**Description** — See Tulloch (1972) and Nag Raj (1995).

**Material examined.** MALAYSIA, from forest soil, July–Aug. 1971, W.H. Tong (holotype CBS H-7392, culture isotype CBS 175.73 = IMI 160372 = ATCC 24427).

***Kastanostachys*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815999

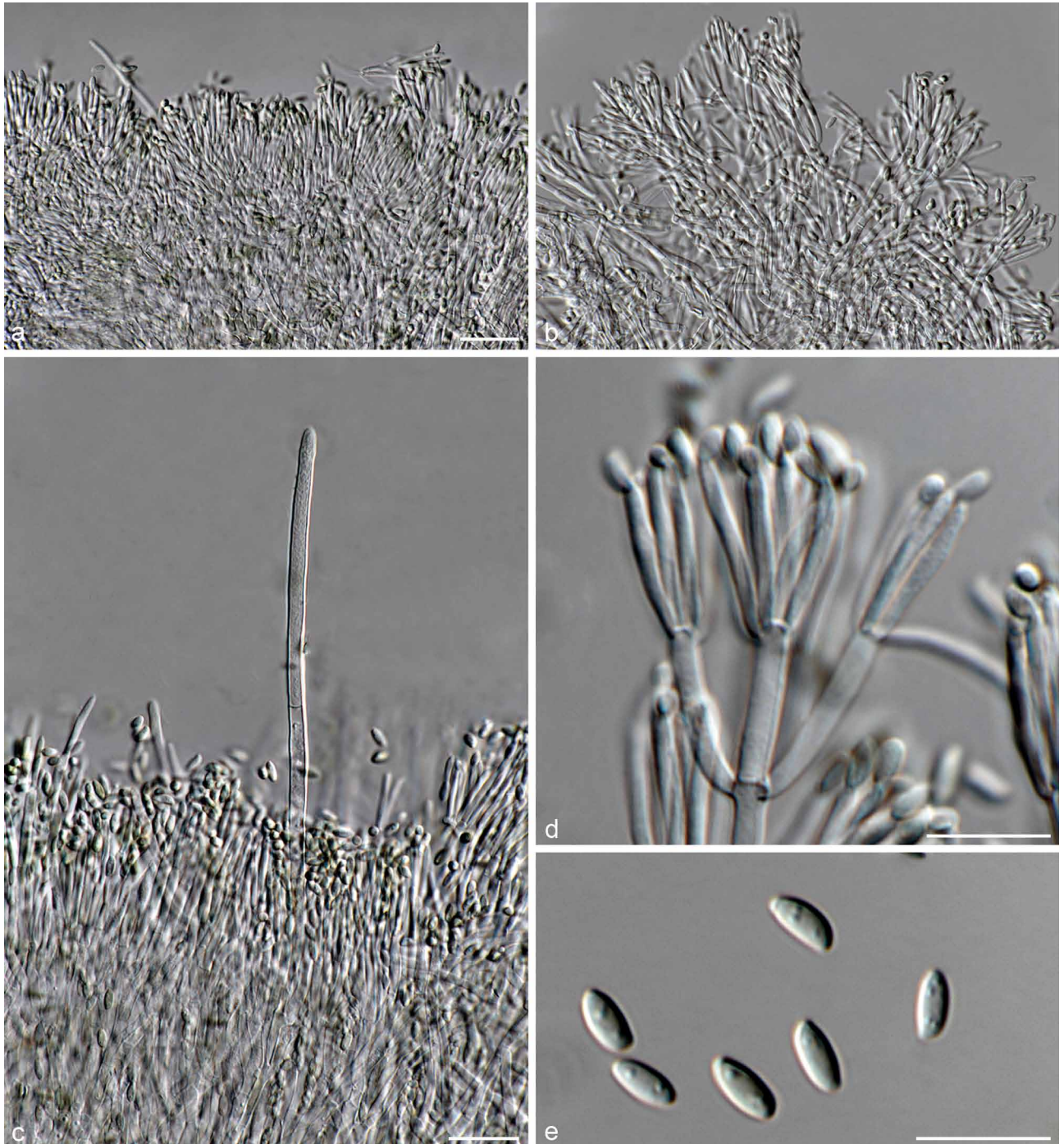
**Etymology.** Name reflects the brown (Greek = kastanós) stachybotrys-like conidiophores in this genus.

**Type species.** *Kastanostachys aterrima* (Fuckel) L. Lombard & Crous.

*Ascomata* perithecial, superficial with base slightly immersed, solitary or in groups of 2–4, globose to subglobose, ostiolate, papillate, black, glabrous, bearing conidiophores identical with those arising from the substrate. *Ascomatal wall textura prismatica*, consisting of two layers: outer layer of thick-walled, melanised cells; inner layer of hyaline, compressed, elongated cells. *Asci* unitunicate, 8-spored, cylindrical, shortly stipitate, truncate to broadly rounded at the apex, with a visible apical annulus. *Paraphyses* abundant among asci, branching, anastomosing, septate, hyaline. *Ascospores* fusiform, 1-septate, not or slightly constricted at the septum, hyaline, smooth, enclosed in a hyaline sheath that disintegrates with age, each cell containing 1–2 oil drops. *Conidiophores* macronematous, unbranched, thick-walled, septate, erect, with one to occasionally three percurrent proliferations, dark brown, paler towards the apex and enlarging to form a more or less distinct vesicle. *Vesicle* pale brown to subhyaline, clavate, smooth, bearing phialides in the upper part. *Phialides* aseptate, hyaline, cylindrical to clavate, straight or curved with indistinct collarettes. *Conidia* hyaline, smooth, ellipsoidal, slightly truncate at the base, forming a slimy head on the conidiophores (adopted from Réblová 1998).

**Notes** — Réblová (1998) compared the type material of *Melanomma aterrima* (Fuckel 1872) to a similar fungus (M.R. 871/96 = CBS 101310) isolated from a decayed stump of *Fagus sylvatica* collected in Czech Republic and concluded that both were conspecific. Based on the ascomatal morphology, Réblová (1998) then transferred this species to the sexual genus *Chaetosphaeria* (*Chaetosphaeriaceae*, *Chaetosphaeriales*; Réblová et al. 1999, Huhndorf et al. 2004) and linked it to an undescribed *Custingophora* sp. (*Gondwanamycetaceae*, *Microascales*; Réblová et al. 2011). Our phylogenetic inference in this





**Fig. 30** *Inaequalispora prestonii* (CBS 175.73). a–b. Sporodochial conidiomata; c. seta; d. conidiogenous cells; e. conidia. — Scale bars: a = 20  $\mu$ m (apply to b); c = 20  $\mu$ m; d, e = 10  $\mu$ m.

study showed that the Czech isolate (CBS 101310) belongs to the *Stachybotriaceae* (Fig. 1), and therefore, a new combination is provided for this species in the newly established genus *Kastanostachys*. As no living type material is available for *C. aterrima*, we designate CBS 101310 as epitype.

***Kastanostachys aterrima*** (Fuckel) L. Lombard & Crous, *comb. nov.* — MycoBank MB816000; Fig. 31

*Basionym.* *Melanomma aterrima* Fuckel, *Jahrb. Nassauischen Vereins Naturk.* 25–26, Nachtr. 1: 304. 1872.

≡ *Zignoella aterrima* (Fuckel) Sacc., *Michelia* 1: 346. 1878.

≡ *Chaetosphaeria aterrima* (Fuckel) Réblová, *Czech Mycol.* 50: 165. 1998.

*Typification.* CZECH REPUBLIC, Southern Bohemia, Šumava Mts, glacial cirque of the lake Černé jezero near Železná Ruda, on a decayed stump of *Fagus sylvatica*, 23 Oct. 1996, *M. Réblová* (epitype of *Kastanostachys aterrima* designated here, PRM 934970, MBT204281, culture ex-epitype CBS

101310). — GERMANY, Aepfelbach, on a branch of *Fagus sylvatica*, autumn, *leg. Fuckel* (G – holotype of *Melanomma aterrima*).

**Description and illustration** — See Réblová (1998).

*Additional material examined.* F. Petrak, *Flora Bohemiae et Moraviae exsiccata* Lfg. 1, no. 2: CZECH REPUBLIC, Moravia, Hranice na Moravě (Mährisch Weisskirchen), military school park, on decayed wood of a stump, 3 Oct. 1912, *J. Petrak* (as *Eriosphaeria vermicularioides*, PRM 777947).

***Melanopsamma*** Niessl, *Verh. Naturf. Vereins Brünn* 14: 200. 1876

*Type species.* *Melanopsamma pomiformis* (Pers.) Sacc.

*Ascomata* perithecial, superficial or borne on a poorly developed stroma, solitary or in groups, ostilate, papillate, globose below and flattened above with the upper surface tending to collapse



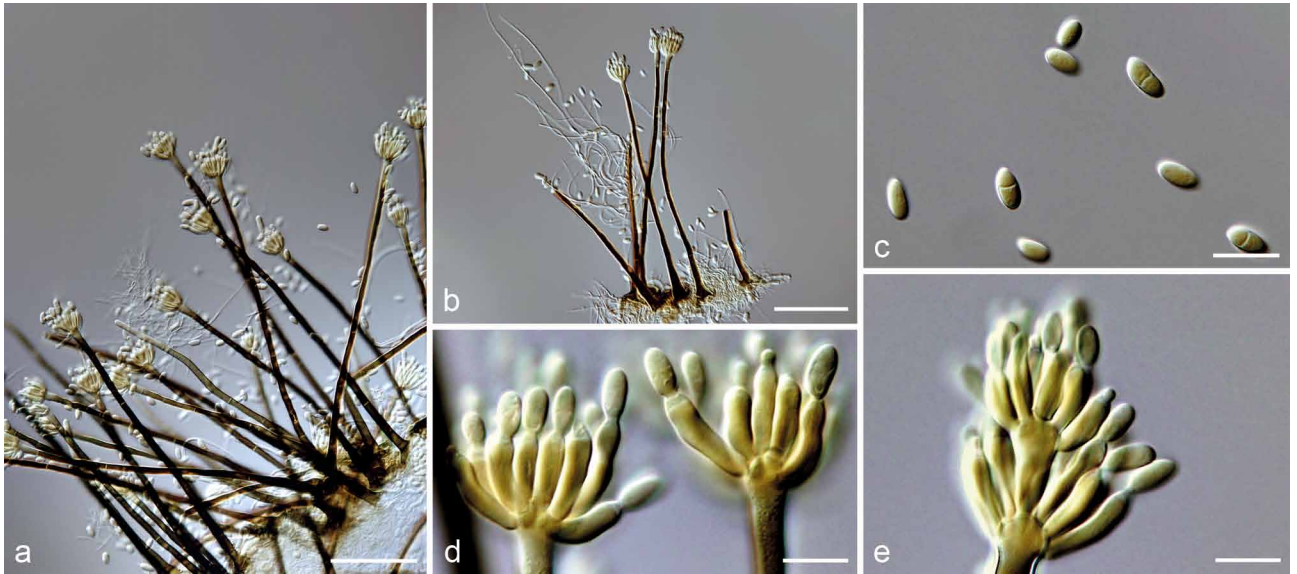


Fig. 31 *Kastanostachys aterrima* (CBS 101310). a–b. Conidiophores; c. conidia; d–e. conidiogenous cells. — Scale bars: a–b = 50  $\mu$ m; c–e = 10  $\mu$ m.

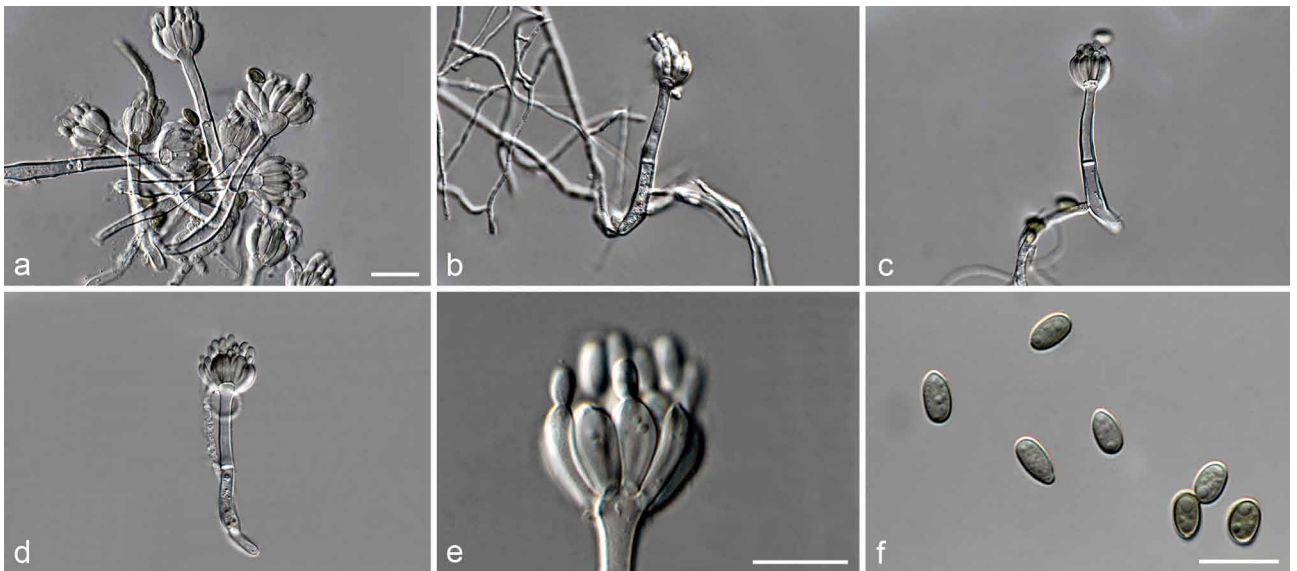


Fig. 32 *Melanopsamma pomiformis* (CBS 101322). a–d. Conidiophores; e. conidiogenous cells; f. conidia. — Scale bars: a = 10  $\mu$ m (apply to b); e–f = 10  $\mu$ m.

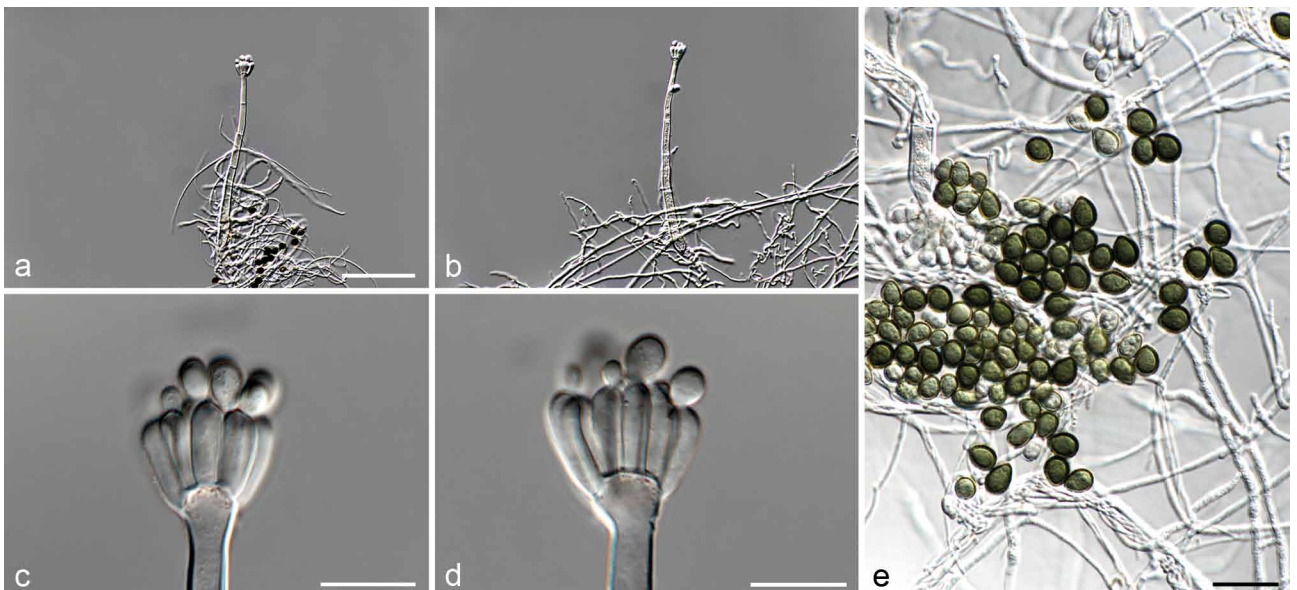


Fig. 33 *Melanopsamma xylophila* (CBS 100343). a–b. Conidiophores; c–d. conidiogenous cells; e. conidia. — Scale bars: a = 50  $\mu$ m (apply to b); c–e = 10  $\mu$ m.



inward forming a shallow cup, black, bearing conidiophores identical with those arising from the substrate. *Ascomatal wall* usually covered with a wax-like secretion, consisting of two layers: outer layer of thick-walled, melanised cells; inner layer of hyaline, thin-walled, elongated cells. *Asci* unitunicate, 8-spored, cylindrical to clavate, truncate or occasionally rounded at the thickened apex. *Paraphyses* abundant among asci, hyaline, anastomosing. *Ascospores* ellipsoidal, 1-septate, slightly constricted at the septum, hyaline, smooth (adopted from Booth 1957). *Conidiophores* macronematous, mononematous, erect, solitary or in groups, unbranched, thick-walled, hyaline, smooth or slightly verrucose, 1–5-septate, with bulbous apices from which 4–10 conidiogenous cells radiate. *Conidiogenous cells* phialidic, subcylindrical to clavate to elongate doliiform, smooth, hyaline, with conspicuous collarettes. *Conidia* aseptate, hyaline to olivaceous brown to dark brown, smooth to verrucose, limoniform to obovoid to globose to ellipsoidal, containing 1–2 small guttules, with rounded ends or with acute apex and rounded base.

Notes — The sexual genus *Melanopsamma* (*Mel.*) is re-instated here after Wang et al. (2015) synonymised this genus under *Stachybotrys* based on ITS sequence analysis and its link to *St. albipes* (Jong & Davies 1976, Castlebury et al. 2004, Wang et al. 2015). Phylogenetic inference in this study showed that these fungi formed a well-supported clade, distant to the *Stachybotrys* s.str. clade (Fig. 1, 3). Booth (1957) studied the type and other authentic material of *Mel. pomiformis*, the type species of the genus, and designated Persoon's No. 910 (in Herb. L.) as lectotype. As there is no living type material presently available for *Mel. pomiformis*, we select to designate CBS 101322 as ex-epitype for this species.

***Melanopsamma pomiformis*** (Pers.) Sacc., *Michelia* 1: 347. 1878 — Fig. 32

- ≡ *Sphaeria pomiformis* Pers., *Syn. Meth. Fung.*: 65. 1801.
- ≡ *Melanomma pomiformis* (Pers.) Nitschke ex Fuckel, *Jahrb. Nassauischen Vereins Naturk.* 23–24: 159. 1870.
- ≡ *Eriosphaeria pomiformis* (Pers.) Sacc., *Michelia* 1: 33. 1877.
- ≡ *Psilosphaeria pomiformis* (Pers.) Cooke, *Grevillea* 16: 50. 1887.
- ≡ *Nectria pomiformis* (Pers.) Höhn., *Sitzungsber. Akad. Wiss. Wien, Math.-Naturwiss. Kl. Abt. I* 128: 568. 1919.
- ≡ *Chaetosphaeria pomiformis* (Pers.) E. Müll., *Beitr. Kryptogamenfl. Schweiz* 11: 588. 1962.
- = *Sporocybe albipes* Berk. & Broome, *Ann. Mag. Nat. Hist., Ser. II*, 8: 19. 1851.
- ≡ *Fuckelina albipes* (Berk. & Broome) Höhn., *Zentralbl. Bakt. ParasitKde, Abt II* 60: 14. 1923.
- ≡ *Stachybotrys albipes* (Berk. & Broome) S.C. Jong & E.E. Davis, *Mycotaxon* 3: 425. 1976.

*Typification.* Herb. L on dry wood of unknown host, Persoon's No. 910: 264–737 (lectotype fide Booth). — CZECH REPUBLIC, Southern Bohemia, Šumava Mts, glacial cirque of the lake Černé jezero near Železná Ruda, on a decayed stump of *Fagus sylvatica*, 7 Nov. 1997, K. Prášil (epitype of *Mel. pomiformis* designated here, PRM 934971, MBT204282, culture ex-epitype CBS 101322).

*Ascomata* not examined. *Conidiophores* simple, macronematous, mononematous, single or in groups, thick-walled, unbranched, erect, straight, hyaline, 1–2-septate, smooth, 30–60 × 5–7 µm, with a bulbous apices, 10–25 µm diam, bearing a whorl of 4–10 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to elongate doliiform, hyaline, smooth, 7–11 × 2–5 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, obovoid to globose to ellipsoidal, hyaline to olivaceous brown, smooth to slightly verrucose, (5–)6.5–7.5(–9) × (3–)3.5–4.5(–5) µm (av. 7 × 4 µm), rounded at both ends or with an acute apex and rounded base.

Culture characteristics — Colonies on PDA, OA and CMA with mostly immersed mycelium with conidiophores forming

on the surface of the medium, carrying slimy olivaceous green conidial masses, reverse on PDA pale olivaceous green.

*Additional materials examined.* ITALY, Bari, on decaying bark of *Fagus sylvatica*, 1990, D. Sisto, CBS 325.90. — SWEDEN, Uppland, Dalby, Ekbacken, from *Tilia cordata*, 5 Mar. 1988, K. Holm & L. Holm, CBS 114119 = UPOSC 2528.

Notes — CBS 101322 is designated as ex-epitype of *Mel. pomiformis* here based on its close morphological resemblance (Booth 1957, Jong & Davies 1976). Phylogenetic inference of the ITS sequence data placed an authentic strain (ATCC 18873; Booth 1957, Jong & Davies 1976) in a well-supported clade with CBS 101322 (Fig 4). The multi-locus phylogenetic inference showed that *Mel. pomiformis* formed a highly supported clade (Fig. 1, 3) and can be distinguished from *Mel. xylophila* by its much shorter conidiophores (up to 60 µm vs up to 200 µm) and smaller, smooth-walled conidia.

***Melanopsamma xylophila*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816001; Fig. 33

*Etymology.* Name reflects the substrate, decaying wood, from which this fungus was isolated.

*Ascomata* not observed. *Conidiophores* simple, macronematous, mononematous, single or in groups, thick-walled, unbranched, erect, straight to slightly flexuous, hyaline, 1–5-septate, smooth, 105–200 × 8–15 µm, with a bulbous apices, 10–20 µm diam, bearing a whorl of 4–10 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to subcylindrical, hyaline, smooth, 8–13 × 3–4 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, limoniform to obovoid, olivaceous brown to dark brown, verrucose, (7–)7.5–8.5(–9) × (5–)5.5–6.5(–7) µm (av. 8 × 6 µm), with an acute apex and rounded base.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white aerial mycelium and conidiophores forming on the aerial mycelium and surface of the medium, carrying slimy black conidial masses, reverse on PDA white to rosy buff.

*Material examined.* JAPAN, Nagano Prefecture, Kakuma Valley, from decaying wood, 13 Aug. 1997, W. Gams (holotype CBS 100343, preserved as metabolically inactive culture, culture ex-type CBS 100343).

Notes — *Melanopsamma xylophila* formed a single lineage in the *Melanopsamma* clade, distinct from *Mel. pomiformis* (Fig. 3).

***Memnoniella*** Höhn., *Zentralbl. Bakt. ParasitKde, Abt. II*, 60: 16. 1923

= *Spinomyces* Saito, *J. Ferment. Technol.* 17: 2. 1939 (non *Spinomyces* Bat. & Peres).

*Type species.* *Memnoniella echinata* (Riv.) Galloway.

*Sexual morph* unknown. *Conidiophores* macronematous, mononematous, erect, solitary or in groups, unbranched, thick-walled, hyaline to pale olivaceous brown, smooth to slightly verrucose at the apex, 1–4-septate, with 3–12 conidiogenous cells radiating from the apex. *Conidiogenous cells* phialidic, subcylindrical to clavate, smooth, hyaline to pale olivaceous brown, with conspicuous collarettes. *Conidia* aseptate, initially hyaline becoming olivaceous brown to dark brown, smooth to verrucose, thick-walled, ellipsoidal to globose to reniform, rounded at both ends, sometimes carried in dry or slimy chains (adapted from Galloway 1933 and Jong & Davis 1976).

Notes — Wang et al. (2015) demoted *Memnoniella* to synonymy under *Stachybotrys* based on priority of the two names following the argument by Smith (1962) that conidial disposition in dry or slimy chains is not sufficient evidence to segregate these two genera. This was further corroborated by ITS

sequence data of a limited number of taxa that included nine species of *Stachybotrys* and three of *Memnoniella* (Haugland et al. 2001). Phylogenetic inference in this study, which included a larger sampling of taxa and more loci, clearly showed that the isolate treated by Galloway (1933) as *Mem. echinata* (CBS 216.32) grouped in a well-supported clade distinct from the *Stachybotrys* s.str. clade (Fig. 1, 3). Therefore, we select to resurrect the genus *Memnoniella* and epitypify the type species of the genus, *Mem. echinata*, using Galloway's strain (see Galloway 1933 for specimen comparisons). *Memnoniella* can be distinguished from *Stachybotrys* by the formation of mostly smooth, thick-walled and unbranched conidiophores giving rise to conidia sometimes carried in dry chains.

***Memnoniella brunneoconidiophora*** L. Lombard & Crous, sp. nov. — MycoBank MB816002; Fig. 34

*Etymology.* Name reflects the olivaceous brown conidiophores of this fungus.

*Conidiophores* simple, macronematous, mononematous, single, thick-walled, unbranched, erect, straight to slightly flexuous, hyaline at the base becoming olivaceous brown towards the apex, 1–2-septate, smooth to slightly verrucose, 30–45 × 3–5 µm, bearing 3–6 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to subcylindrical, olivaceous brown, smooth, 7–11 × 3–5 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, ellipsoidal, olivaceous brown to dark brown, verrucose, thick-walled, (6–)7.5–8.5(–9) × (3–)3.5–4.5(–5) µm (av. 8 × 4 µm), rounded at both ends or sometimes bearing an apical hilum.

*Culture characteristics* — Colonies on PDA, OA and CMA with abundant white to aerial mycelium, producing a luteous extracellular pigment that diffuse into the media, with abundant conidiophores forming on the aerial mycelium and surface of the media, carrying dry to slimy mouse grey to black conidial masses, reverse on PDA pale luteous.

*Materials examined.* VENEZUELA, Colonia Tovar, from decayed leaf, 25 Nov. 2000, R.F. Castañeda-Ruiz (holotype CBS H-22446, culture ex-type CBS 136191 = MUCL 43313), CBS 109477.

*Notes* — *Memnoniella brunneoconidiophora* formed a highly supported clade closely related to *Mem. ellipsoidea* and *Mem. putrefolia* (Fig. 3). This species can be distinguished from both latter species by its short conidiophores (up to 45 µm) compared to those of *Mem. ellipsoidea* (up to 140 µm) and those of *Mem. putrefolia* (up to 90 µm). The conidia of *Mem. brunneoconidiophora* ((6–)7.5–8.5(–9) × (3–)3.5–4.5(–5) µm (av. 8 × 4 µm)) are slightly smaller than those of *Mem. ellipsoidea* ((8–)8.5–9.5(–10) × (4–)4.5–5.5(–6) µm (av. 9 × 5 µm)) and *Mem. putrefolia* ((8–)9–11 × (4–)4.5–5.5(–6) µm (av. 10 × 5 µm)).

***Memnoniella dichroa*** (Grove) L. Lombard & Crous, comb. nov. — MycoBank MB816003; Fig. 35

*Basionym.* *Stachybotrys dichroa* Grove, J. Bot., Lond. 24: 201. 1886.

*Description and illustrations* — See Grove (1886) and Wang et al. (2015).

*Materials examined.* ENGLAND, Exeter, Devon, from herbaceous stem, 15 Sept. 1947, M.B. Ellis, CBS 526.50 = ATCC 18917 = IMI 017506 = MUCL 9482. — THE NETHERLANDS, Baarn, garden Molenweg, from leaf litter of *Ilex aquifolium*, Sept. 2008, W. Gams, CBS 123800.

*Notes* — Phylogenetic inference of the ITS sequence data showed that CBS 123800 grouped in a well-supported clade that included the ex-epitype of *St. dichroa* (Fig 4; ATCC 18913; Wang et al. 2015). Phylogenetic inference of the combined loci also placed CBS 123800 in the *Memnoniella* clade (Fig. 3), and therefore a new combination is provided here for *St. dichroa*.

***Memnoniella echinata*** (Riv.) Galloway, Trans. Brit. Mycol. Soc. 18: 165. 1933 — Fig. 36

≡ *Penicillium echinatum* Riv., Dei Parassiti Vegetali: 451. 1873.

≡ *Haplographium echinatum* (Riv.) Sacc., Syll. Fung. 4: 307. 1886.

≡ *Stachybotrys echinata* (Riv.) G. Sm., Trans. Brit. Mycol. Soc. 45: 392. 1962.

= *Periconia papyrogena* Sacc., Michelia 1: 273. 1878.

≡ *Stachybotrys papyrogena* (Sacc.) Sacc., Fungi Ital.: tab. 900. 1881.

≡ *Sterigmatobotrys papyrogena* (Sacc.) Oud., Ned. Kruidk. Arch., ser. 2, 4: 548. 1886.

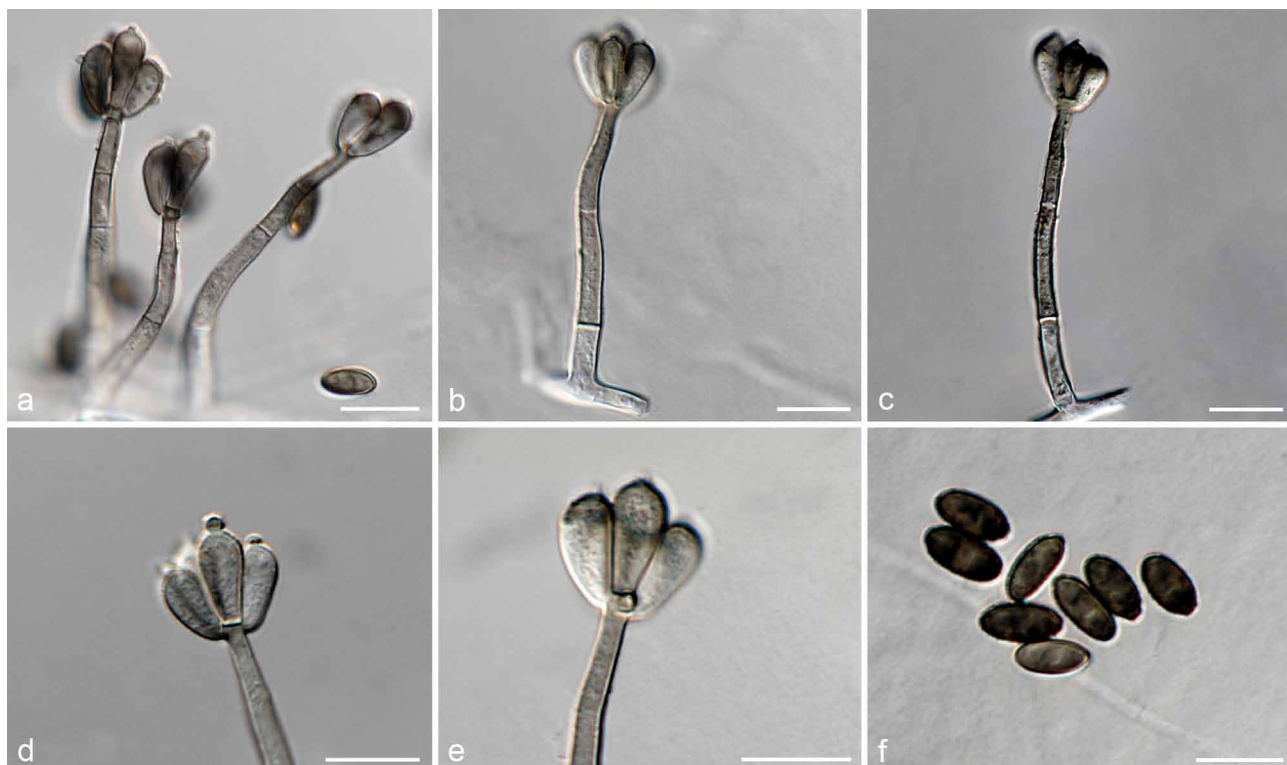


Fig. 34 *Memnoniella brunneoconidiophora* (CBS 136191). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars = 10 µm.

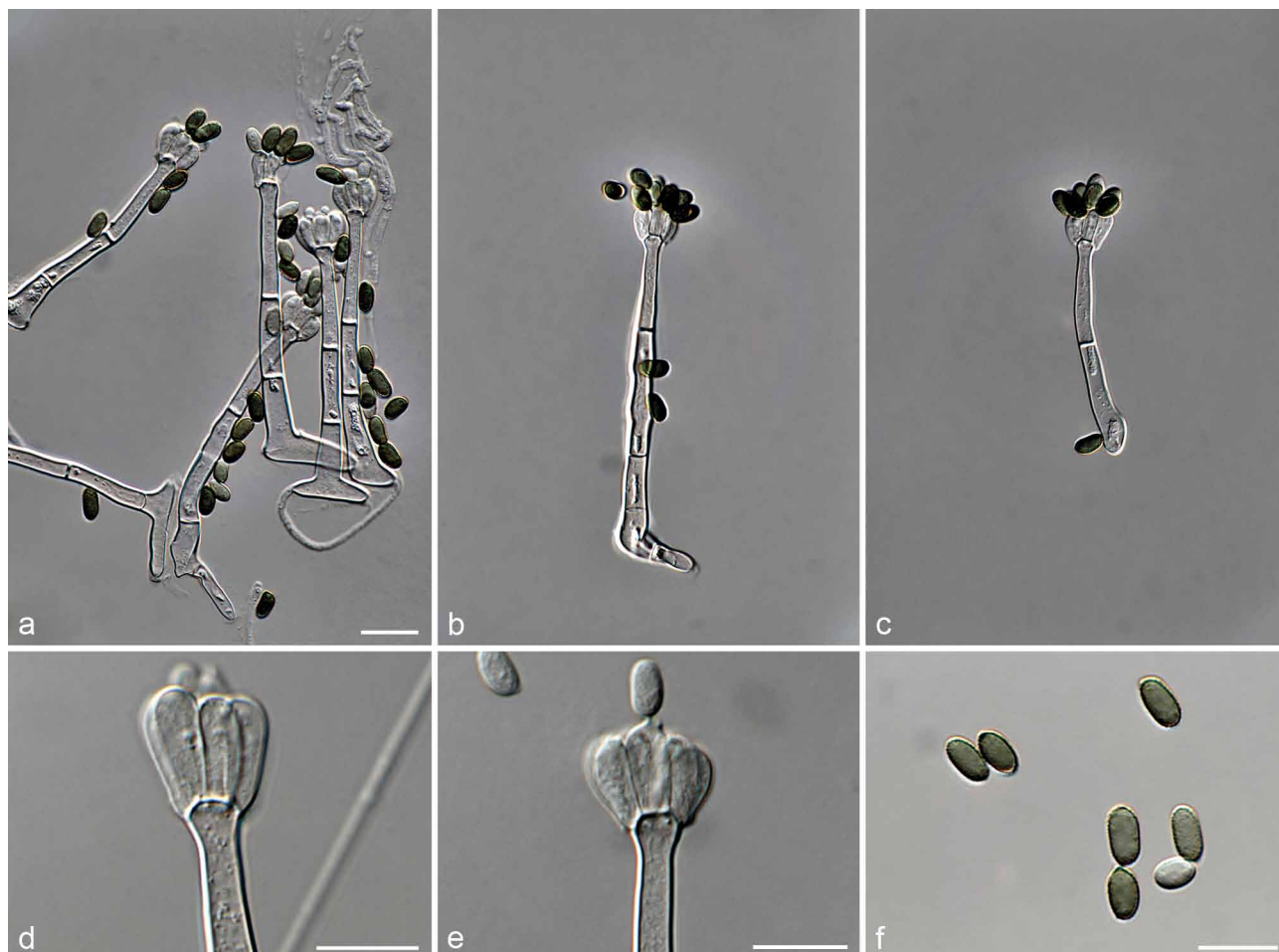


Fig. 35 *Memnoniella dichroa* (CBS 526.50). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 20  $\mu$ m (apply to b–c); d–f = 10  $\mu$ m.

= *Memnoniella aterrima* Höhn., Zentralbl. Bakt. ParasitKde, Abt. 2 60: 16. 1923.

= *Spinomyces japonica* Saito, J. Ferment. Technol. 17: 2. 1939 (nom. inval. Art. 36).

**Typification.** ITALY, from clumps of *Triticum saltivum*, 1873, S. Rivolta (Galloway 1933, f. 1, lectotype of *Penicillium echinatum* designated here (as Rivolta's Dei Parassiti Vegetali p. 451, f. 150–151)), MBT204286. — ENGLAND, Manchester, Didsbury, The Towers, Shirely Institute, British Cotton Industry Research Association, from cotton yarn, Feb. 1932, L.B. Galloway (epitype of *Penicillium echinatum* designated here, CBS H-22447, MBT204287, culture ex-epitype CBS 216.32).

**Conidiophores** simple, macronematous, mononematous, single, thick-walled, unbranched, erect, straight to slightly flexuous, hyaline becoming olivaceous brown, septate, smooth to slightly verrucose, 40–100  $\times$  4–6  $\mu$ m, bearing 6–10 conidiogenous cells. **Conidiogenous cells** phialidic, clavate to subcylindrical, olivaceous brown, smooth, 7–10  $\times$  2–5  $\mu$ m, with conspicuous collarettes. **Conidia** acrogenous, aseptate, globose, olivaceous brown to dark brown, verrucose, thick-walled, 3–6  $\times$  3–5  $\mu$ m (av. 5  $\times$  4  $\mu$ m), formed in long dry chains.

**Culture characteristics** — Colonies on PDA, OA and CMA with immersed mycelium, amber to sienna, with abundant conidiophores forming on the surface of the media, carrying slimy olivaceous brown to black conidial masses, reverse on PDA amber.

**Additional materials examined.** CANADA, Ontario, Ottawa, from air using a RCS sampler, date unknown, H. McGregor no. 229.3, DAOM 235365; ibid, from endotracheal tubes in a hospital, Oct. 1979, L. Gour no. 79M-153, DAOM 173162. — INDONESIA, from filter paper, 1 Oct. 1949, K.B. Boedjin & J. Reitsma, CBS 343.50. — JAPAN, from contaminated sake lees, Feb. 1939, K. Saito, CBS 344.39 (isotype of *Spinomyces japonica*). — SOLOMON ISLANDS, Bougainville Island, from tent canvas, 1944, W.H. Weston, CBS 627.66 = IMI 045547 = NRRL 2181. — THE NETHERLANDS, Eastern Flevoland, Houtribbos,

from *Pulvinula constellation*, 26 June 1980, H.A. van der Aa, CBS 406.80. — USA, substrate unknown, P.B. Marsh, CBS 304.54 = ATCC 9597.

**Notes** — The newly designated ex-epitype strain (CBS 216.32) of *Mem. echinata* clustered in a highly supported clade, closely related to the single lineage representing *Mem. longistipitata* (Fig. 3).

***Memnoniella ellipsoidea*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816005; Fig. 37

**Etymology.** Name reflects the ellipsoidal conidia produced by this fungus.

**Conidiophores** simple, macronematous, mononematous, single, thick-walled, unbranched, erect, straight to slightly flexuous, hyaline becoming olivaceous brown towards the apex, 1–2-septate, smooth, 55–140  $\times$  4–8  $\mu$ m, bearing 3–6 conidiogenous cells. **Conidiogenous cells** phialidic, clavate to subcylindrical, hyaline, smooth, 8–12  $\times$  4–6  $\mu$ m, with conspicuous collarettes. **Conidia** acrogenous, aseptate, ellipsoidal, olivaceous brown to dark brown, verrucose, gluttulate, thick-walled, (8–)8.5–9.5 (–10)  $\times$  (4–)4.5–5.5(–6)  $\mu$ m (av. 9  $\times$  5  $\mu$ m), rounded at both ends.

**Culture characteristics** — Colonies on PDA, OA and CMA with abundant white to pale luteous aerial mycelium, with abundant conidiophores forming on the aerial mycelium and surface of the media, carrying dry to slimy mouse grey to black conidial masses, reverse on PDA pale luteous.

**Materials examined.** BRAZIL, from *Bromelia* sp., R.F. Castañeda-Ruiz, CBS 136202 = MUCL 41876. — NEPAL, Narayani, Royal Chitwan National Park, from a dead twig, Dec. 1994, C. Decock (holotype CBS H-22448, culture ex-type CBS 136201 = MUCL 39090), CBS 136199 = MUCL 39088, CBS 136200 = MUCL 39089.



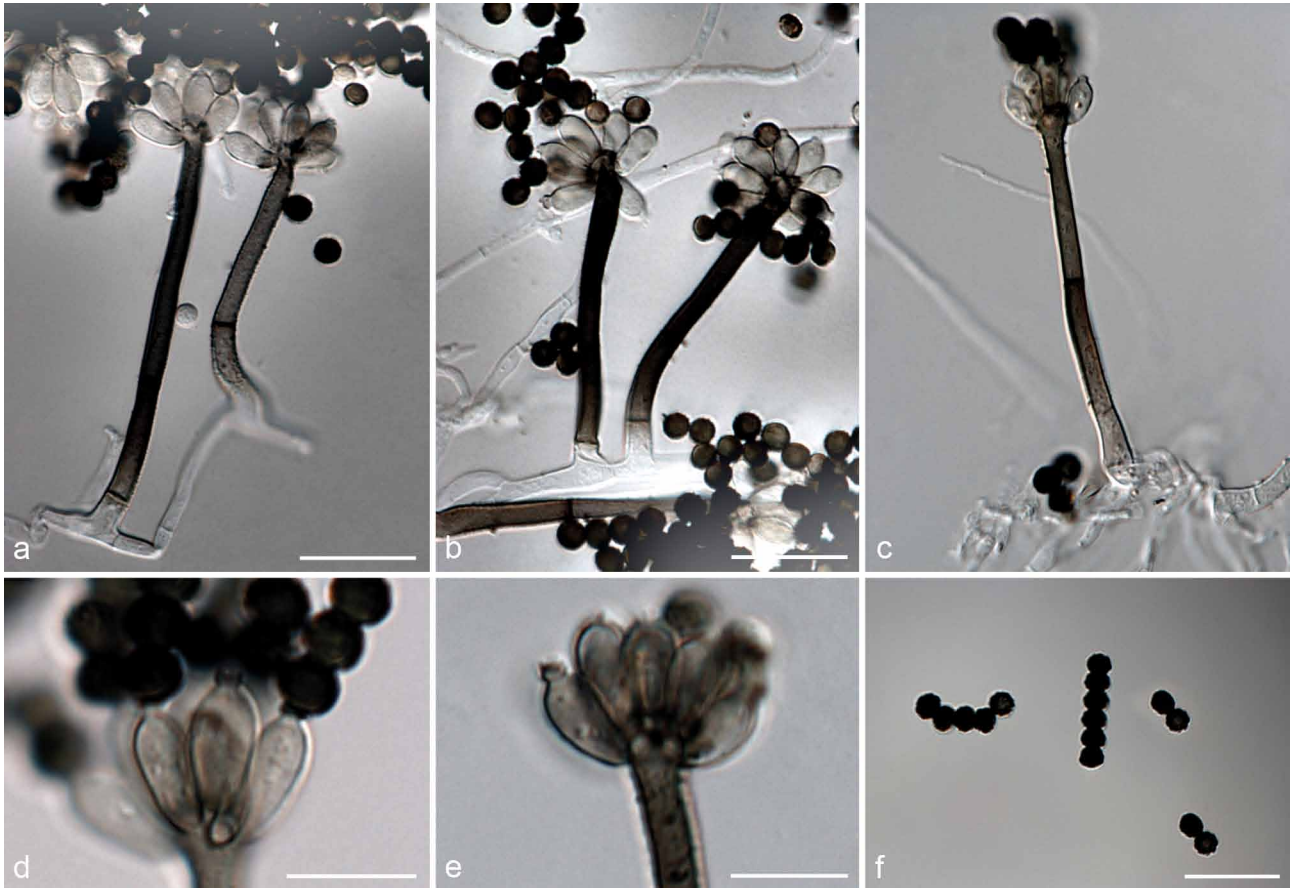


Fig. 36 *Memnoniella echinata* (CBS 216.32). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia in chains. — Scale bars = 10 µm.

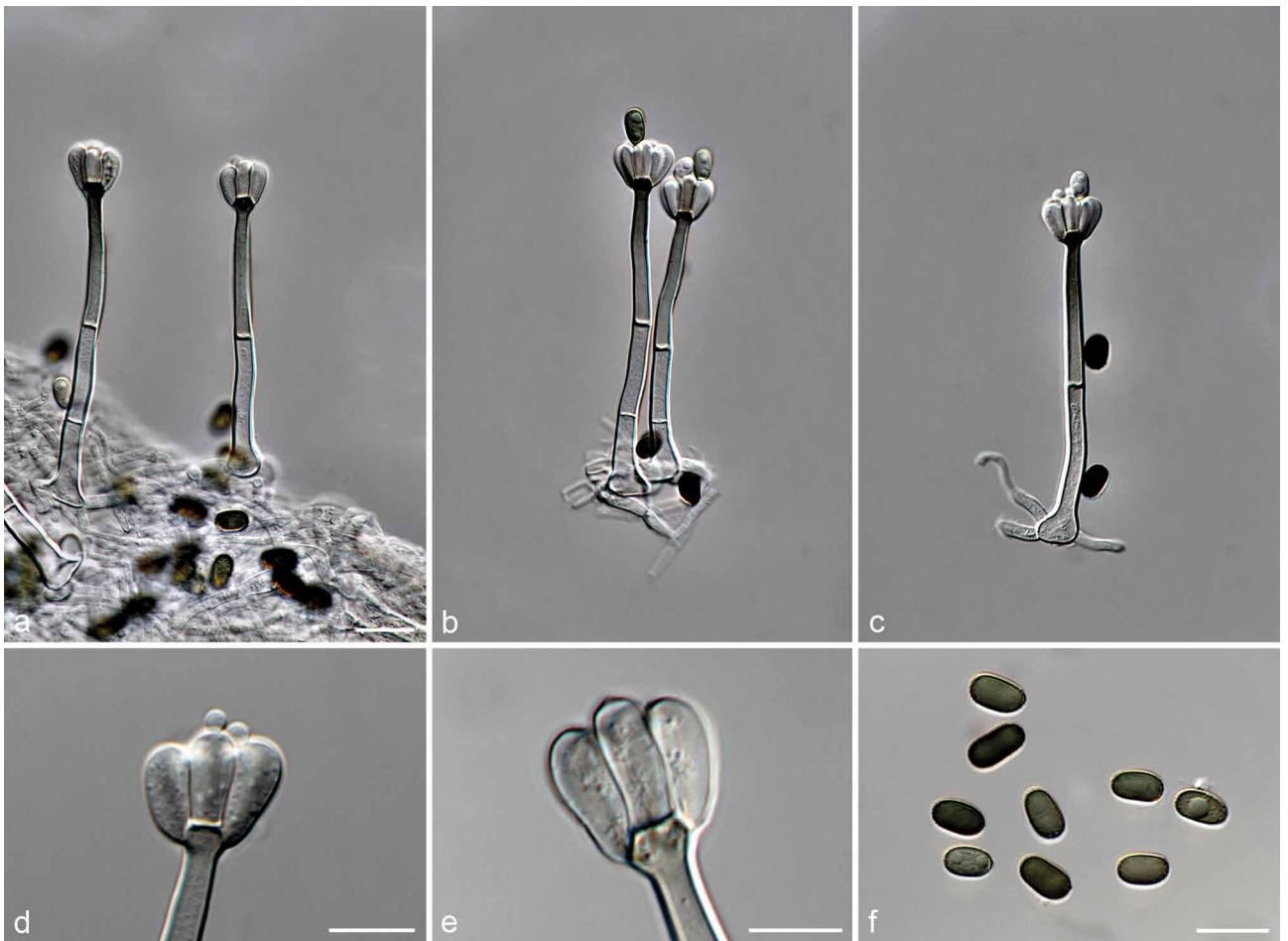


Fig. 37 *Memnoniella ellipsoidea* (CBS 136201). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 20 µm (apply to b–c); d–f = 10 µm.

Notes — *Memnoniella ellipsoidea* formed a well-supported clade closely related to *Mem. brunneoconidiophora* and *Mem. putrefolia* (Fig. 3). For morphological comparisons, see notes under *Mem. brunneoconidiophora*.

***Memnoniella humicola*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816006; Fig. 38

*Etymology.* Name reflects the substrate, soil, from which this fungus was isolated.

*Conidiophores* simple, macronematous, mononematous, single, thick-walled, unbranched, erect, straight to slightly flexuous, hyaline becoming olivaceous brown towards the apex, septate, smooth to slightly verrucose at the apex, 35–70 × 4–6 µm, bearing 6–12 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to subcylindrical, hyaline to olivaceous brown, smooth, 6–9 × 2–4 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, ellipsoidal to reniform, olivaceous brown to dark brown, verrucose, thick-walled, (5–)5.5–6.5(–7) × 2–3 µm (av. 6 × 3 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with immersed mycelium producing a luteous extracellular pigment that diffuse into the media, with abundant conidiophores forming on the surface of the media, carrying slimy olivaceous brown to black conidial masses, reverse on PDA luteous.

*Material examined.* SURINAME, from soil under *Elaeis guineensis*, 1974, J.H. van Emden (holotype CBS H-22449, culture ex-type CBS 463.74).

Notes — *Memnoniella humicola* formed a single lineage in the *Memnoniella* clade (Fig. 3). This species can be distinguished from *Mem. echinata*, its closest phylogenetic neighbour, by ellipsoidal to reniform conidia and shorter conidiophores (up to 70 µm) compared to globose conidia and longer conidiophores (up to 100 µm) of *Mem. echinata*.

***Memnoniella longistipitata*** D.W. Li et al., *Mycotaxon* 85: 254. 2003

≡ *Stachybotrys longistipitata* (D.W. Li et al.) D.W. Li et al., *Fung. Diversity* 71: 57. 2015.

Description and illustrations — See Li et al. (2003) and Wang et al. (2015).

*Material examined.* MALAWI, Mulungusi Valley, Zomba, Zomba Botanical Gardens, from dead wood, G.L. Hennebert & C. Decock, CBS 136197 = MUCL 33065.

Notes — Phylogenetic inference of the ITS sequence data (Fig. 4) showed that CBS 136197 grouped in a well-supported clade that included the ex-type of *Mem. longistipitata* (ATCC 22699; Li et al. 2003). Phylogenetic inference of the combined loci also placed CBS 136197 in the *Memnoniella* clade (Fig. 3) and therefore the species *Mem. longistipitata* is resurrected here.

***Memnoniella oenantes*** (M.B. Ellis) L. Lombard & Crous, *comb. nov.* — MycoBank MB816007

*Basionym.* *Stachybotrys oenantes* M.B. Ellis, *Mycol. Pap.* 125: 29. 1971.

Description and illustrations — See Ellis (1971) and Wang et al. (2015).

*Material examined.* INDIA, Tamil Nadu, west of Madras, from old stem of *Euphorbia tirukalli*, Mar. 1973, W. Gams, CBS 388.73 = ATCC 32255.

Notes — Phylogenetic inference of the ITS sequence data (Fig. 4) showed that isolate CBS 388.73 grouped in a well-supported clade that included the ex-type of *St. oenantes* (ATCC 22844; Ellis 1971, Wang et al. 2015). Phylogenetic inference of the combined loci also placed this isolate in the *Memnoniella* clade (Fig. 3) and therefore a new combination is provided here for *St. oenantes*.

***Memnoniella pseudonilagirica*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816008; Fig. 39

*Etymology.* Name reflects the morphological similarity to *Stachybotrys nilagirica*.

*Conidiophores* simple, macronematous, mononematous, single, thick-walled, unbranched, erect, straight to slightly flexuous, hyaline becoming pale olivaceous brown at the apex, septate, smooth, 150–300 × 9–15 µm, bearing 2–6 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to subcylindrical, hyaline, smooth, 13–20 × 6–11 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, globose, olivaceous brown to dark brown, verrucose, thick-walled, (14–)18–22(–23) × (12–)17–21(–22) µm (av. 20 × 19 µm).

Culture characteristics — Colonies on PDA, OA and CMA with abundant white to aerial mycelium becoming pale luteous

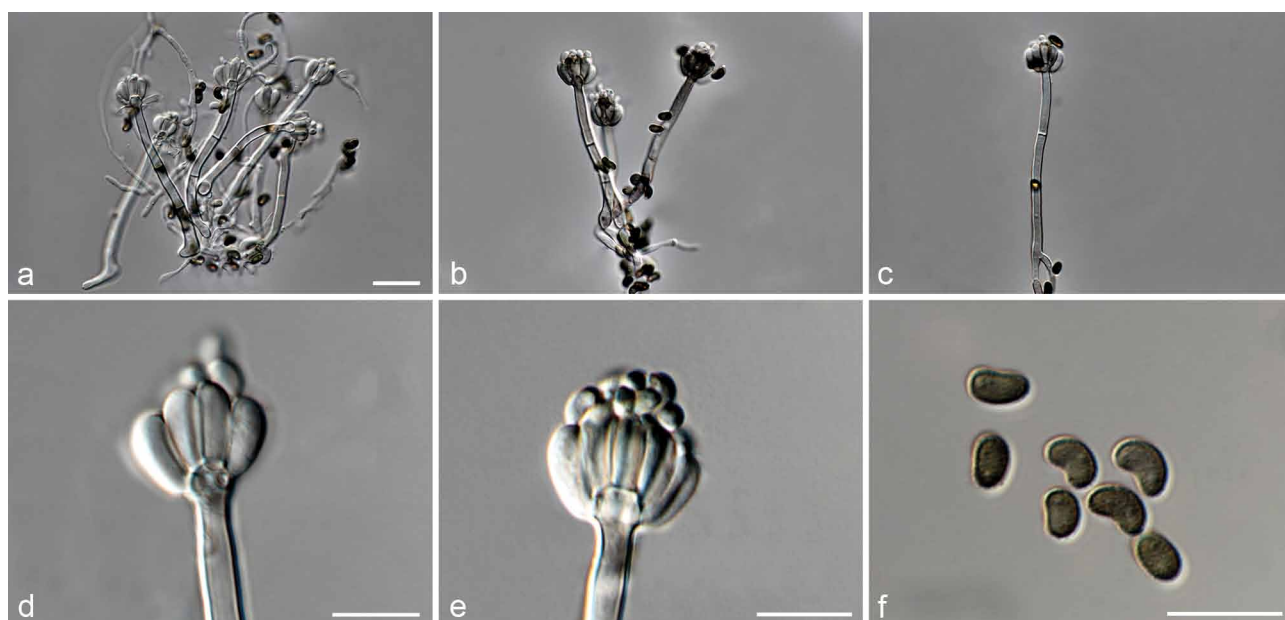


Fig. 38 *Memnoniella humicola* (CBS 463.74). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bar: a = 20 µm (apply to b–c); d–f = 10 µm.





**Fig. 39** *Memnoniella pseudonilagirica* (CBS 136405). a–d. Conidiophores; e. conidiogenous cells; f. conidia. — Scale bars: a = 50  $\mu\text{m}$  (apply to b); c = 20  $\mu\text{m}$  (apply to d, f); e = 10  $\mu\text{m}$ .

to light salmon at the margins, forming concentric rings, with conidiophores forming on the aerial mycelium, carrying slimy olivaceous brown to black conidial masses, reverse on PDA luteous.

*Material examined.* NEPAL, Royal Chitwan National Park, on dead leaf of *Ceiba pentandra*, Dec. 1994, C. Decock (holotype CBS H-22450, culture ex-type CBS 136405 = MUCL 39120).

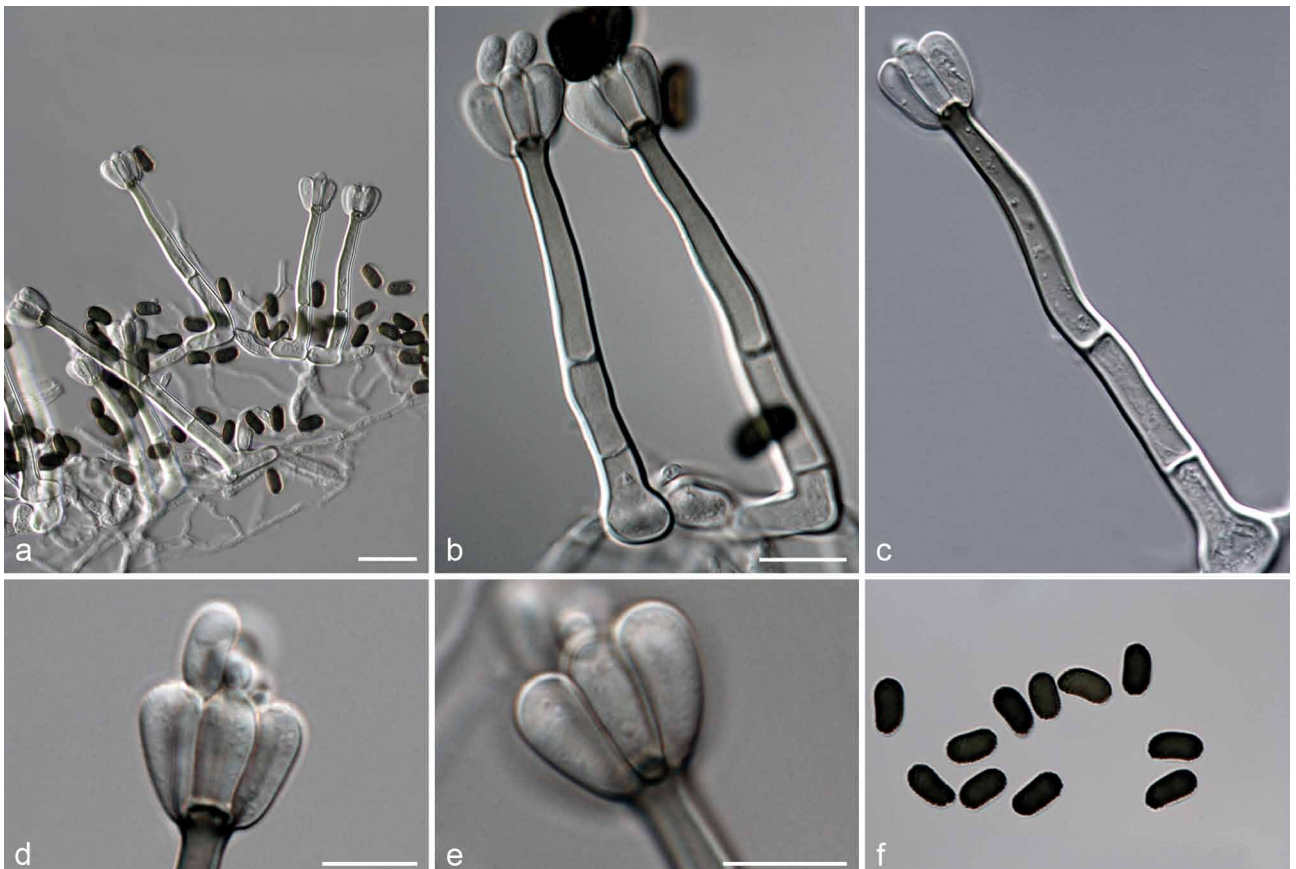
*Notes* — *Memnoniella pseudonilagirica* formed a single lineage in the *Memnoniella* clade (Fig. 3) and is morphologically reminiscent of *St. nilagirica* (Subramanian 1957). It can be distinguished by its longer conidiophores (up to 300  $\mu\text{m}$ )

compared to those of *St. nilagirica* (up to 224  $\mu\text{m}$ ; Subramanian 1957). The conidia of *Mem. pseudonilagirica* ((14–)18–22(–23)  $\times$  (12–)17–21(–22)  $\mu\text{m}$  (av. 20  $\times$  19  $\mu\text{m}$ )) are also smaller than those of *St. nilagirica* (15.4–28.0  $\mu\text{m}$ ; Subramanian 1957).

*Memnoniella putrefolia* L. Lombard & Crous, *sp. nov.* — MycoBank MB816009; Fig. 40

*Etymology.* Name reflects the substrate, decayed leaves, from which this fungus was isolated.

*Conidiophores* simple, macronematous, mononematous, single, thick-walled, unbranched, erect, straight to slightly flexu-



**Fig. 40** *Memnoniella putrefolia* (CBS 101177). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 20  $\mu\text{m}$ ; b = 10  $\mu\text{m}$  (apply to c, f); d–e = 10  $\mu\text{m}$ .



ous, hyaline becoming pale olivaceous brown, 1–2-septate towards the base, smooth, 50–90 × 5–9 µm, bearing 3–8 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to sub-cylindrical, hyaline, smooth, 10–14 × 3–7 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, ellipsoidal to rarely reniform, olivaceous brown to dark brown, verrucose, thick-walled, (8–)9–11 × (4–)4.5–5.5(–6) µm (av. 10 × 5 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with immersed mycelium, pale luteous, with concentric rings of conidiophores on the surface of the media, carrying dry to slimy olivaceous brown to black conidial masses, reverse on PDA luteous with light olivaceous green rings.

*Materials examined.* BRAZIL, Mata Avenca-Santa Rita, from decayed leaf, Sept. 1997, R.F. Castañeda-Ruiz, CBS 136171 = MUCL 41166 = INIFAT C98/65-2. — PUERTO RICO, Calmitillo, on decayed leaf of *Melastomataceae*, 19 June 1998, W. Gams (holotype CBS H-22451, culture ex-type CBS 101177).

Notes — *Memnoniella putrefolia* formed a well-supported clade closely related to *Mem. brunneoconidiophora* and *Mem. ellipsoidea* (Fig. 3). For morphological comparisons, see notes under *Mem. brunneoconidiophora*.

***Myrothecium*** Tode, Fungi Mecklenburgenses Selecti 1: 25. 1790

= *Myxormia* Berk. & Broome, Ann. Mag. Nat. Hist., ser. II, 5: 457. 1850.  
= *Godroniella* P. Karst., Hedwigia 23: 88. 1884.  
= *Myrotheciella* Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 20: 460. 1910.

= *Exotrichum* Syd., Ann. Mycol. 12: 571. 1914.  
= *Starkeyomyces* Agnihothr., J. Indian Bot. Soc. 35: 40. 1956.

*Type species.* *Myrothecium inundatum* Tode.

*Sexual morph* unknown. *Conidiomata* reduced to solitary conidiophores or sporodochial. *Sporodochia* stromatic or non-stromatic, superficial, cupulate, scattered or gregarious, oval or irregular in outline, sometimes with a white setose fringe surrounding an olivaceous green to dark green slimy mass of conidia. *Stroma* well developed, hyaline, of *textura globulosa* and *textura angularis*. *Marginal hyphae* arising from the stroma, straight or curved, thin-walled, irregularly branched. *Setae* arising from the stroma, thin-walled, septate, hyaline, smooth, tapering to an acute apex. *Simple conidiomata* consisting of a conidiogenous cell, sometimes carried on a short aseptate stipe, arising directly from vegetative hyphae, monophialidic or

rarely polyphialidic. *Conidiophores* macronematous, subverticillately or penicillately branched, hyaline, smooth. *Conidiogenous cells* phialidic, hyaline, smooth, cylindrical to subcylindrical, becoming narrowed at the tip, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, ellipsoidal to obovoid, hyaline, smooth, < 5 µm in length, lacking a funnel-shaped mucoid apical appendage.

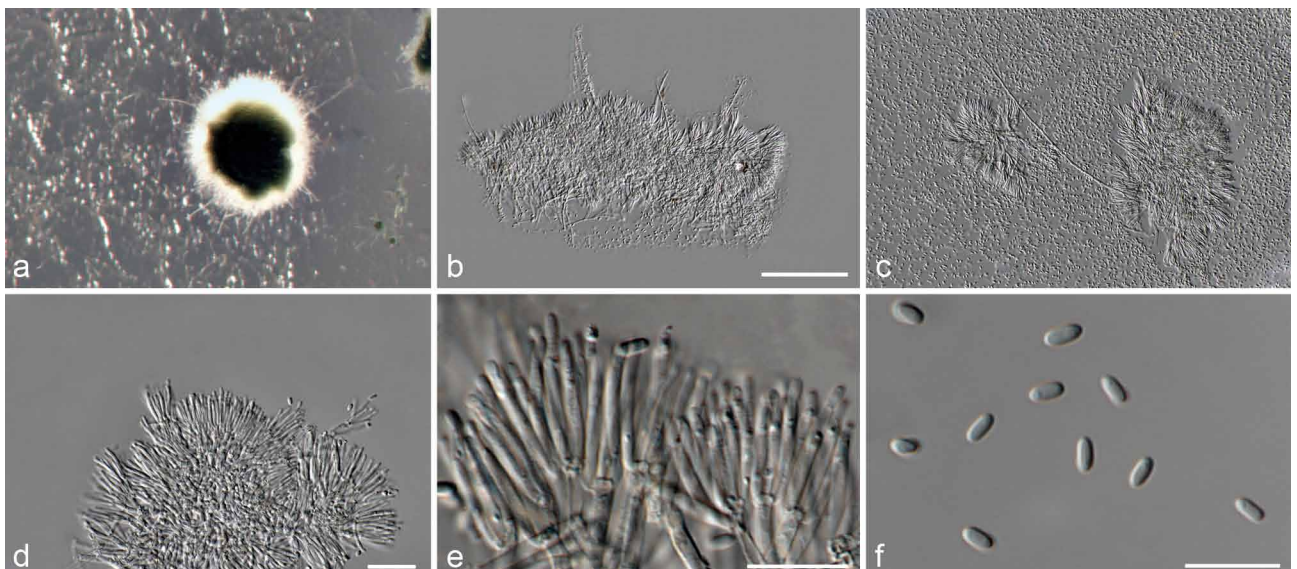
Notes — The broad generic concept of *Myrothecium* sensu Tulloch (1972) was contested by Nag Raj (1993, 1995), who introduced the asexual genera *Xepicula* and *Xepiculopsis* for *Myr. leucotrichum* and *Myr. gramineum*, respectively. *Myrothecium* sensu Tulloch included species unified by sporodochial and synnematos conidiomata bearing green conidial masses, and conidia with or without mucoid appendages (Nag Raj 1995). This concept has resulted in the description of several *Myrothecium* spp. solely based on the green conidial masses produced on the sporodochial and/or synnematos conidiomata (Agarwal 1980, DiCosmo et al. 1980, Rao & De Hoog 1983, Sullia & Padma 1985, Matsushima 1989, 1995, Castañeda & Kendrick 1991, Bohn 1993, Escalona 1997, Seifert et al. 2003, Watanabe et al. 2003, Alves et al. 2010, Jiang et al. 2014, Wu et al. 2014). Phylogenetic inference in this study clearly showed that *Myrothecium* sensu Tulloch includes several genera, and therefore, the generic concept for *Myrothecium* s.str. is narrowed here to only include species with sporodochia or mononematous conidiophores producing conidia smaller than 5 µm in green slimy masses without mucoid appendages.

Tulloch (1972) designated IMI 158855 as neotype of *Myr. inundatum*, although the prologue does not agree with the illustration provided. The setae illustrated in f. 1 of Tulloch (1972) are clearly thick-walled, whereas the prologue indicate thin-walled setae. A similar problem was raised by Nag Raj (1995) for *Myr. prestonii* (now *I. prestonii*). Therefore, to avoid confusion, we select to epitypify *Myr. inundatum* here using CBS 275.48, which morphologically agrees with the prologue of Tulloch (1972).

***Myrothecium inundatum*** Tode, Fungi Mecklenburgenses Selecti 1: 25, t. 5:39. 1790 — Fig. 41

= *Myrothecium fungicola* Peck, Rep. St. Mus. N.Y. 26: 29. 1872.

*Typification.* ENGLAND, Norfolk, Wheatfern, on decaying pileus of *Russula nigricans*, 29 July 1971, E.A. Ellis, IMI 158855 (neotype of *Myr. inundatum* fide Tulloch). — ENGLAND, on *Russula adusta*, Nov. 1948, P.W. Brian (epitype of *Myr. inundatum* designated here, CBS H-14898, MBT204294, culture ex-epitype CBS 275.48 = IMI 008983 = QM 7988).



**Fig. 41** *Myrothecium inundatum* (CBS 275.48). a. Sporodochial conidiomata on SNA; b–d. sporodochia; e. conidiogenous cells; f. conidia. — Scale bars: b = 100 µm (apply to c); d = 20 µm; e–f = 10 µm.

*Ascomatal morph* unknown. *Conidiomata* sporodochial, stromatic, superficial, cupulate, scattered or gregarious, oval to elongate or irregular in outline, 150–850 µm diam, 45–130 µm deep, with a white setose fringe surrounding an olivaceous green agglutinated slimy mass of conidia. *Stroma* well developed, hyaline, of *textura globulosa* and *textura angularis*. *Marginal hyphae* arising from the stroma, straight to curved thin-walled, hyaline, smooth, irregularly branched. *Setae* arising from the stroma, thin-walled, smooth, unbranched, hyaline, septate, 80–200 µm long, 2–4 µm wide, terminating in a blunt apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched or rarely branched, hyaline, septate, smooth, 12–25 × 1–3 µm; primary branches aseptate, unbranched, smooth, 6–11 × 1–2 µm; secondary branches aseptate, unbranched, smooth, 5–7 × 1–2 µm; terminating in a whorl of 2–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline, smooth, straight to slightly curved, 7–25 × 1–3 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, obovoid to ellipsoidal, 3–4 × 1–2 µm (av. 3 × 1 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white aerial mycelium with sporodochia forming on the surface of the medium, covered by slimy herbage to olivaceous green conidial masses, reverse on PDA sienna to buff.

*Additional materials examined.* CANADA, Ontario, Petawawa, from leaf litter under *Populus tremuloides*, Aug. 1969, G.C. Bhat, CBS 616.70; Quebec, Gatineau Park, Lusk Cave Trail, on an old agaric, 17 Sept. 1993, K.A. Seifert, CBS 116539 = AR 2738. — GERMANY, Schwäbische Alb, Sternberg bei Gomadingen, on an old decaying toadstool, 5 Oct. 2006, M. Gube, CBS 120646. — THE NETHERLANDS, Baarn, woods along road to Hilversum, near Hoge Vuursche, on *Russula* sp., 29 July 1973, H.A. van der Aa, CBS 194.74.

Notes — The newly designated epitype (CBS 275.48) of *Myr. inundatum* clustered in a well-supported clade, sister to *Myr. simplex* (Fig. 2). This clade represents the *Myrothecium* s.str. clade.

***Myrothecium simplex* L. Lombard & Crous, sp. nov.** — MycoBank MB816010; Fig. 42

*Etymology.* Name reflects the simple conidiophores produced by this fungus.

*Conidiomata* sporodochial or simple. *Sporodochia* non-stromatic, superficial, scattered, oval or irregular in outline, 30–65 µm diam, 35–100 µm deep, consisting of closely interwoven conidiophores arising from the vegetative hyphae, bearing an olivaceous green to dark green agglutinated slimy mass of conidia. *Simple conidiomata* monophialidic or rarely polyphialidic, consisting of conidiogenous cells arising directly from the vegetative hypha or carried on an aseptate, smooth, hyaline stipe, 5–15 × 2–3 µm. *Conidiophores* consisting of a stipe and a penicillately to subverticillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth, 12–26 × 2–3 µm; primary branches aseptate, unbranched, smooth, 8–15 × 2–3 µm; secondary branches aseptate, unbranched, smooth, 6–10 × 1–3 µm; terminating in a whorl of 2–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline, smooth, straight to slightly curved, 6–15 × 1–3 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, obovoid to ellipsoidal, 3–4 × 1–2 µm (av. 4 × 1 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white aerial mycelium with a floccose to felt appearance with extensive sporulation on the aerial mycelium, covered by slimy herbage to olivaceous green conidial masses, reverse on PDA buff to olivaceous green.

*Materials examined.* JAPAN, Sugadaira, from decaying agaric, 2 Sept. 1993, W. Gams (holotype CBS H-22452, culture ex-type CBS 582.93); University of Tsukuba, Sugadaira Research Center, Daimyojin waterfall, from a rotten basidioma of *Russula nigricans*, 11 Aug. 1997, H.-J. Schroers, W. Gams, T. Gräfenhan & M. Klamer, CBS 100287.

Notes — *Myrothecium simplex* can be distinguished from *Myr. inundatum* by the simple conidiomata formed on the vegetative hyphae and lack of setae.

***Myxospora* L. Lombard & Crous, gen. nov.** — MycoBank MB816011

*Etymology.* Name reflects the slimy conidial masses produced on the conidiomata of these fungi.

*Type species.* *Myxospora masonii* (M.C. Tulloch) L. Lombard & Crous.

*Sexual morph* unknown. *Conidiomata* synnematosus or sporodochial. *Synnemata* cylindrical to pyriform, unbranched, broadening towards the apex, consisting of bundles of parallel, longitudinal, closely compacted hyphae, terminating in whorls of

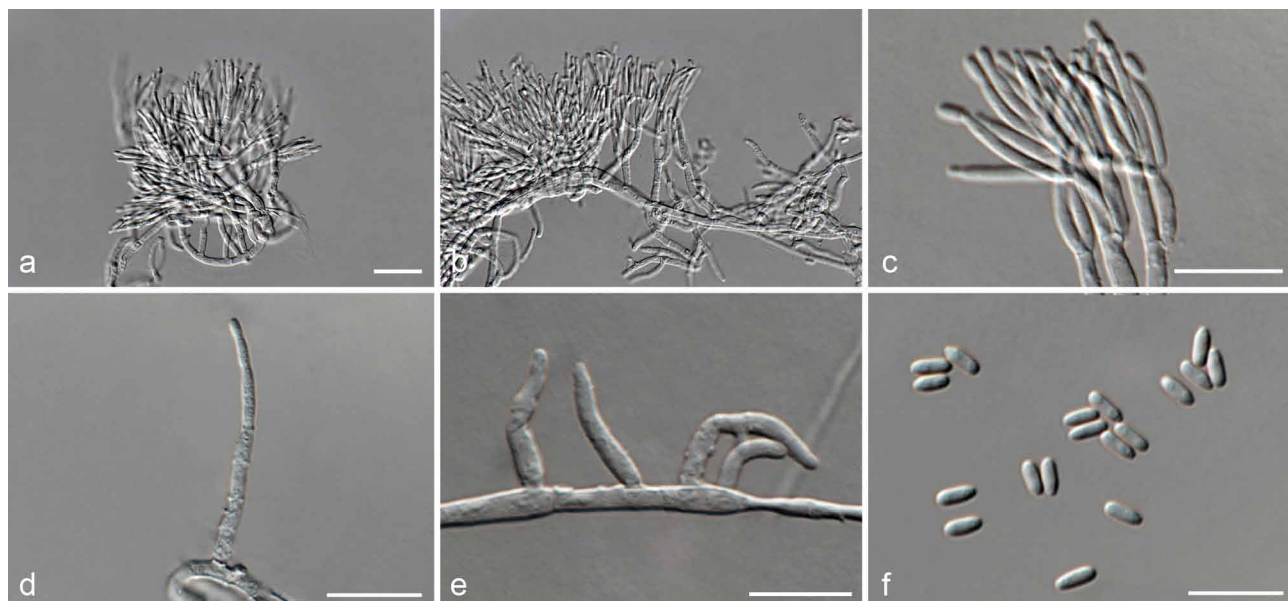


Fig. 42 *Myrothecium simplex* (CBS 582.93). a–b. Sporodochial conidiomata; c. conidiogenous cells; d–e. simple conidiomata; f. conidia. — Scale bar: a = 20 µm (apply to b); c–f = 10 µm.



2–4 conidiogenous cells, covered by an olivaceous green to black slimy mass of conidia with marginal hyphae terminating in hyaline bulbous, verrucose cells and carried on a poorly developed stroma. *Sporodochia* stromatic, superficial, scattered or rarely gregarious, oval or irregular in outline, without a white setose fringe surrounding an olivaceous green to dark green slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* rare, thick-walled, septate, flexuous, subhyaline, tapering to an obtuse apice protruding through the conidial masses. *Conidiophores* macronematous, verticillately or penicillately branched, hyaline, smooth to lightly verrucose. *Conidiogenous cells* phialidic, hyaline, smooth, subcylindrical, becoming narrowed at the tip, with a conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, fusiform, hyaline sometimes becoming pigmented with age, smooth, with an apical hilum lacking a funnel-shaped mucoid apical appendage.

Notes — Nag Raj (1993), following the approach of Rao & Sutton (1975), selected to retain *Myr. masonii* and suggested that *Myrothecium* only accommodates sporodochial and synnematal species. Based on phylogenetic inference in this study, the ex-type (CBS 174.73) of *Myr. masonii* clustered in a well-supported clade distant to the *Myrothecium* s.str. clade. Therefore, the new generic name, *Myxospora* (*Myx.*), is introduced here for this clade and a new combination is provided for *Myr. masonii*. Members of *Myxospora* are characterised by the formation of mostly fusiform conidia, bearing an apical hilum without funnel-shaped mucoid appendages and some species forming synnematal conidiomata.

***Myxospora aptrootii*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816012; Fig. 43

*Etymology.* Named after Dr. André Aptroot, who collected this fungus.

*Conidiomata* synnematos, solitary, 125–200 µm high, 20–45 µm wide at the base, 80–130 µm at the apex, pyriform, unbranched, broadening towards the apex, consisting of bundles of parallel, longitudinal, closely compacted hyphae, terminating in whorls of 2–4 conidiogenous cells, covered by an olivaceous green to black slimy mass of conidia without marginal hyphae terminating in hyaline bulbous, verrucose cells. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Conidiogenous cells* phialidic, subcylindrical, hyaline, smooth, 7–14 × 2–3 µm, with conspicuous collarettes and periclinal thickenings becoming pigmented at the apex. *Conidia* aseptate, smooth, hyaline

becoming pigmented with age, fusiform, 4–5 × 2–3 µm (av. 5 × 2 µm), with an apical hilum, borne in chains.

Culture characteristics — Colonies on PDA, OA and CMA with white to buff aerial mycelium with synnemata forming on the aerial mycelium and surface of the medium covered by slimy olivaceous green conidial masses, reverse on PDA buff to pale luteous.

*Material examined.* CHINA, Hong Kong, from leaf litter, June 1998, A. Aptroot (holotype CBS H-22453, culture ex-type CBS 101263).

Notes — *Myxospora aptrootii* formed a single lineage closely related to *Myx. crassiseta* and *Myx. musae* (Fig. 2). This species produces synnematos conidiomata, not observed for both *Myx. crassiseta* and *Myx. musae*. The synnemata of *Myx. aptrootii* are shorter than those of *Myx. masonii* (150–900 µm; Tulloch 1972) but show some overlap with those of *Myx. graminicola* (80–220 µm). The conidia of *Myx. aptrootii* (4–5 × 2–3 µm (av. 5 × 2 µm)) are slightly smaller than those of *Myx. graminicola* ((5–)6(–7) × 2–3 µm (av. 6 × 2 µm)) and carried in chains, not observed for *Myx. graminicola*.

***Myxospora crassiseta*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816013; Fig. 44

*Etymology.* Name reflects the thick-walled setae formed by this fungus.

*Conidiomata* sporodochial, stromatic, superficial, scattered, rarely gregarious, oval to elongate or irregular in outline, 25–95 µm diam, 25–50 µm deep, without a setose fringe surrounding a green to black agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, smooth, of a *textura angularis*. *Setae* rare, extending through the conidial mass, thick-walled, subhyaline, smooth, septate, 100–185 µm long, 4–6 µm wide, with a blunt obtuse apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth, 10–30 × 2–4 µm; conidiogenous apparatus consists of primary and secondary branches that terminate in 2–4 conidiogenous cells; primary branches aseptate, unbranched, smooth, 6–11 × 2–3 µm; secondary branches aseptate, unbranched, smooth, 6–12 × 2–3 µm. *Conidiogenous cells* phialidic, cylindrical to subcylindrical, hyaline, smooth, 8–21 × 1–2 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, smooth, hyaline becoming pigmented with age, fusiform, 4–6 × 2–3 µm (av. 4 × 2 µm), with an apical hilum.

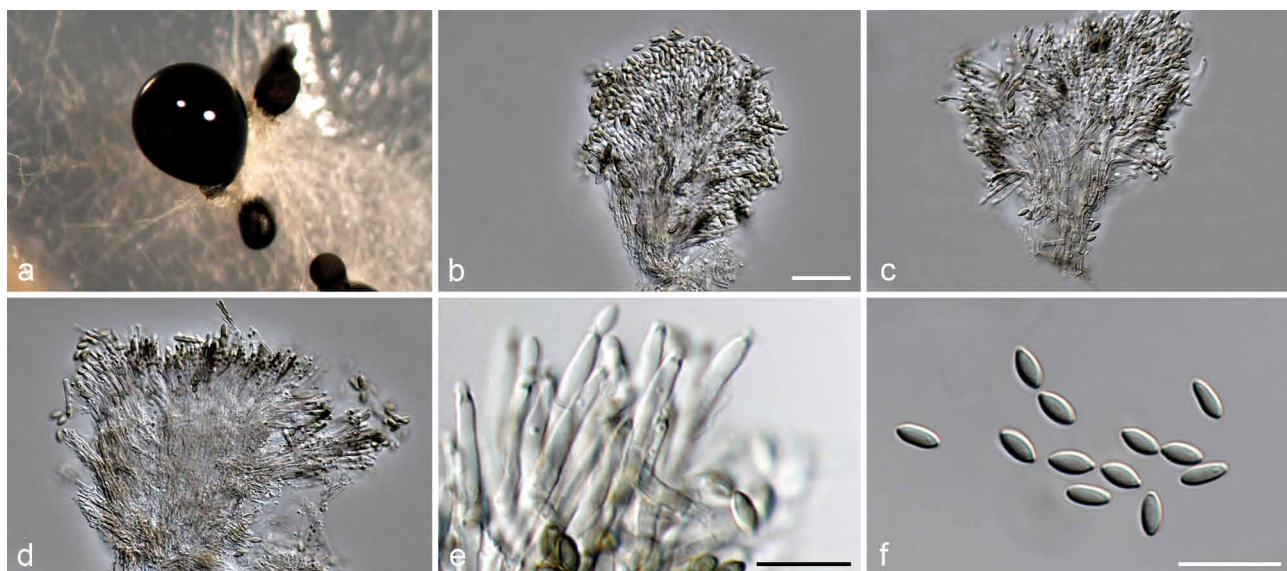


Fig. 43 *Myxospora aptrootii* (CBS 101263). a. Conidiomata on SNA; b–d. synnematos conidiomata; e. conidiogenous cells; f. conidia. — Scale bars: b = 50 µm (apply to c–d); e–f = 10 µm.



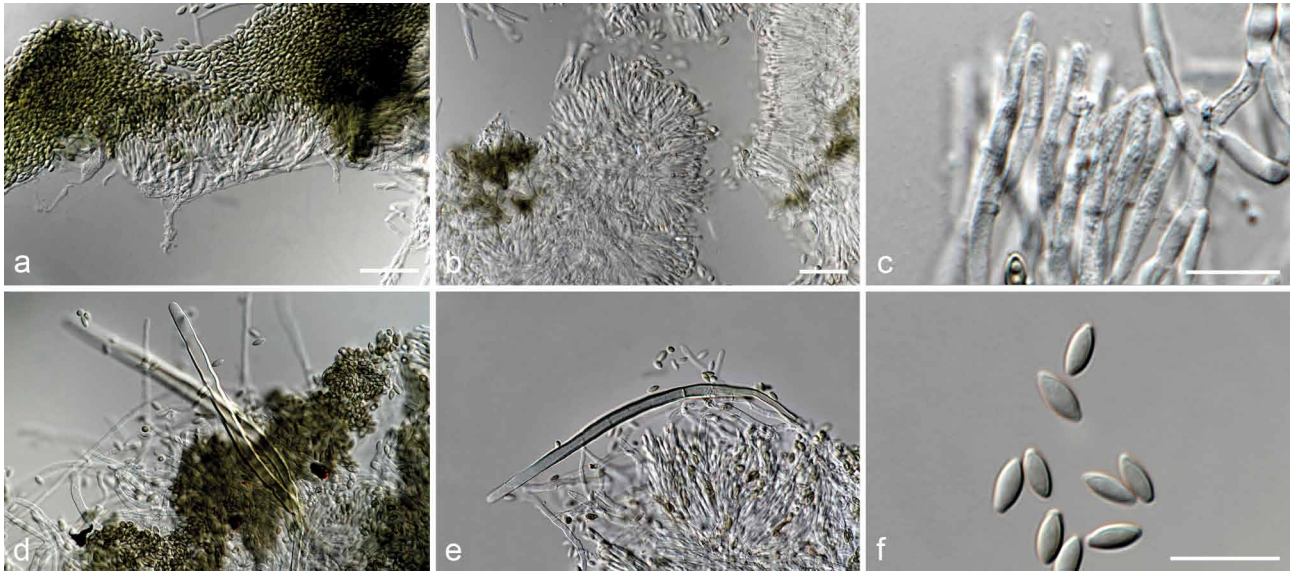


Fig. 44 *Myxospora crassiseta* (CBS 731.83). a–b. Sporodochial conidiomata; c. conidiogenous cells; d–e. setae; f. conidia. — Scale bars: a = 50 µm; b = 20 µm (apply to d–e); c, f = 10 µm.

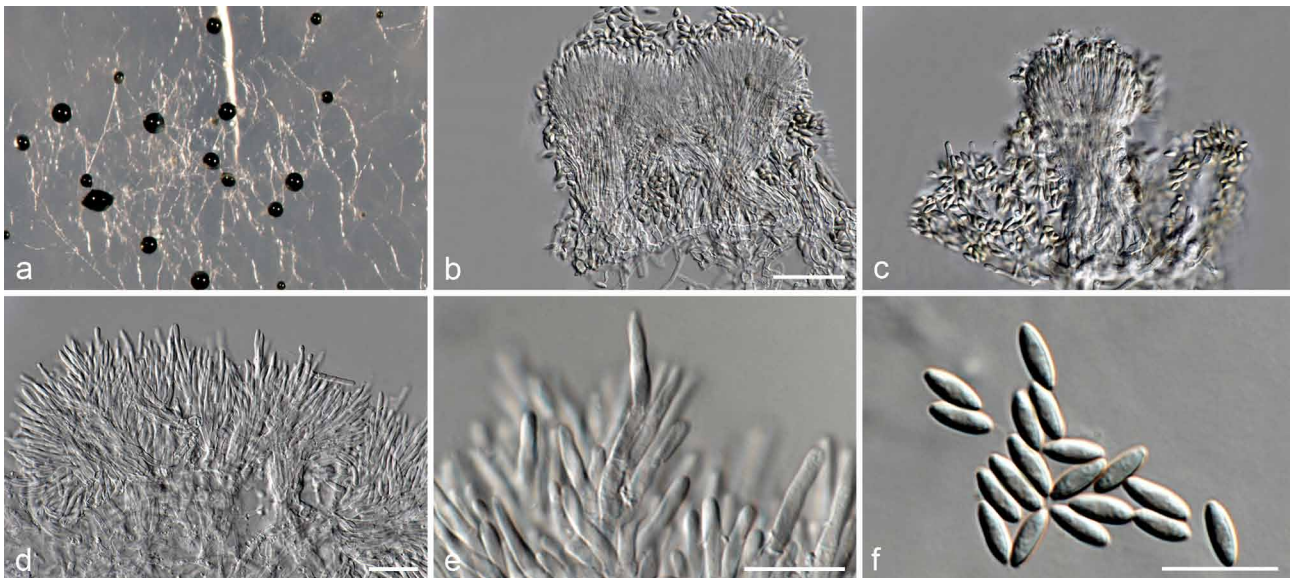


Fig. 45 *Myxospora graminicola* (CBS 116538). a. Conidiomata on SNA; b–d. synnematus conidiomata; e. conidiogenous cells; f. conidia. — Scale bars: b = 50 µm (apply to c); d = 20 µm; e–f = 10 µm.

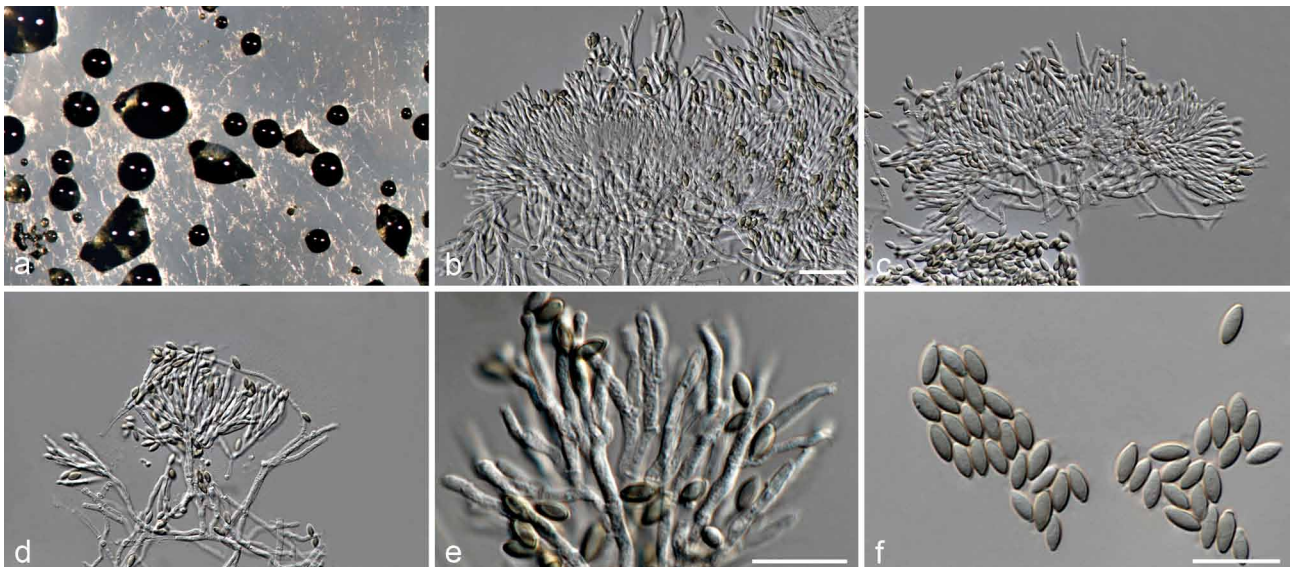


Fig. 46 *Myxospora musae* (CBS 265.71). a. Sporodochial conidiomata on SNA; b–d. sporodochia; e. conidiogenous cells; f. conidia. — Scale bars: b = 20 µm (apply to c–d); e–f = 10 µm.



Culture characteristics — Colonies on PDA, OA and CMA with immersed mycelium with sporodochia forming on the surface of the medium covered by slimy olivaceous green to mouse grey conidial masses, reverse on PDA pale olivaceous green.

*Materials examined.* JAPAN, Kyoto, Daitokujij Temple, from dead twig, 28 Aug. 1983, W. Gams (holotype CBS H-22454, culture ex-type CBS 731.83). — USA, Hawaii, Puna District, Mackenzie State Park, coastal forest, from a black stoma of a *Pyrenomyces* on a dead hardwood branch, 9 June 2003, D. T. Wicklow, CBS 121141 = NRRL 45891.

Notes — *Myxospora crassiseta* formed a highly supported clade closely related to *Myx. aptrootii* and *Myx. musae* (Fig. 2). This species can be distinguished from *Myx. musae* by the formation of thick-walled setae that are projected through the conidial masses. *Myxospora crassiseta* is further distinguished from *Myx. aptrootii* by the formation of sporodochial conidiomata.

***Myxospora graminicola*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816014; Fig. 45

*Etymology.* Name reflects the substrate, decaying grass leaf, from which this fungus was isolated.

*Conidiomata* synnematus, solitary or gregarious, 80–220 µm high, 25–55 µm wide at the base, 45–75 µm at the apex, cylindrical, unbranched, broadening towards the apex, consisting of bundles of parallel, longitudinal, closely compacted hyphae, terminating in whorls of 2–4 conidiogenous cells, covered by an olivaceous green to black slimy mass of conidia with marginal hyphae terminating in hyaline bulbous, verrucose cells, 5–12 × 2–5 µm. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Conidiogenous cells* phialidic, subcylindrical, hyaline, smooth, 6–16 × 1–2 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, smooth, hyaline becoming pigmented with age, fusiform, (5–)6(–7) × 2–3 µm (av. 6 × 2 µm), with an apical hilum.

Culture characteristics — Colonies on PDA, OA and CMA with immersed mycelium pale luteous to buff with synnemata forming on the surface of the medium covered by slimy olivaceous to herbage green conidial masses, reverse on PDA olivaceous green where synnemata form.

*Material examined.* USA, New Jersey, Union County, Scotch Plains and Edison, Clark, Ash Brook Reservation, from decaying grass leaf, 2 Oct. 2000, G. Bills (holotype CBS H-22455, culture ex-type CBS 116538 = A.R. 3507).

Notes — *Myxospora graminicola* formed a single lineage closely related to *Myx. masonii* (Fig. 2). The synnemata of *Myx. graminicola* are shorter than those reported for *Myx. masonii* (150–900 µm; Tulloch 1972) and the conidia of *Myx. masonii* are slightly larger (4.5–9 × 1.5–2.5 µm; Tulloch 1972) than those of *Myx. graminicola*.

***Myxospora masonii*** (M.C. Tulloch) L. Lombard & Crous, *comb. nov.* — MycoBank MB816015

*Basionym.* *Myrothecium masonii* M.C. Tulloch, Mycol. Pap. 130: 21. 1972.

Description and illustration — See Tulloch (1972).

*Material examined.* ENGLAND, Norfolk, Wheatfern Board, on leaves of *Glyceria* sp., 5 June 1971, E.A. Ellis, culture ex-type CBS 174.73 = IMI 158346 = ATCC 24426.

***Myxospora musae*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816016; Fig. 46

*Etymology.* Name reflects the plant host, *Musa* sp., from which this fungus was isolated.

*Conidiomata* sporodochial, stromatic, superficial, scattered, rarely gregarious, oval to elongate or irregular in outline, 35–100

µm diam, 25–65 µm deep, without a setose fringe surrounding a green to black agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, smooth, of a *textura angularis*. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth, 17–30 × 2–3 µm; conidiogenous apparatus consists of primary and secondary branches that terminate in 2–4 conidiogenous cells; primary branches aseptate, unbranched, smooth, 7–14 × 1–2 µm; secondary branches aseptate, unbranched, smooth, 6–10 × 1–2 µm. *Conidiogenous cells* phialidic, cylindrical to subcylindrical, hyaline, smooth, 9–18 × 1–3 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, smooth, hyaline becoming pigmented with age, fusiform, (4–)5(–6) × 2–3 µm (av. 5 × 2 µm), with an apical hilum.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white aerial mycelium with sporodochia forming on the aerial mycelium and surface of the medium covered by slimy olivaceous green conidial masses, reverse on PDA sienna to buff.

*Material examined.* MADAGASCAR, from *Musa* sp., Mar. 1971, E. Laville (holotype CBS H-14937, culture ex-type CBS 265.71 = IMI 155922). — SOUTH AFRICA, Limpopo Province, Agatha, from tar spot lesion on unknown host, 9 Sept. 2014, J. Roux, CPC 25150.

Notes — *Myxospora musae* formed a well-supported clade closely related to *Myx. aptrootii* and *Myx. crassiseta* (Fig. 2). As the only other sporodochial species in this genus thus far, *Myx. musae* can be distinguished from *Myx. crassiseta* by the lack of setae formed in the sporodochia.

***Neomyrothecium*** L. Lombard & Crous, *gen. nov.* — MycoBank MB816017

*Etymology.* Name reflects its morphological similarity to the genus *Myrothecium*.

*Type species.* *Neomyrothecium humicola* L. Lombard & Crous.

*Sexual morph* unknown. *Conidiomata* sporodochial, stromatic, superficial, pulvinate, scattered or gregarious, oval or irregular in outline, covered by an olivaceous green to dark green slimy mass of conidia, lacking a white setose fringe. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* rarely seen, thin-walled, septate, unbranched, straight to flexuous, hyaline, tapering to an acute apice. *Conidiophores* macronematous, penicillately branched, hyaline, smooth. *Conidiogenous cells* phialidic, hyaline, smooth, cylindrical to subcylindrical, straight to slightly curved, with a conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, cylindrical, hyaline, rounded at both ends.

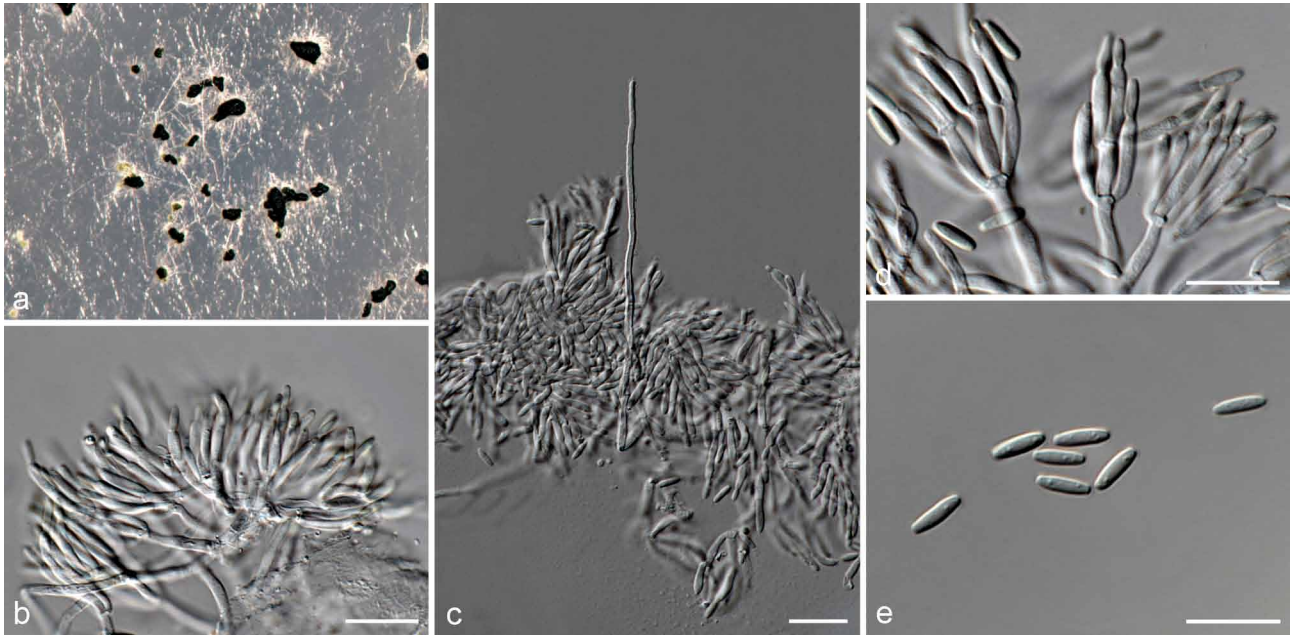
Notes — The monophyletic asexual genus *Neomyrothecium* is established here for a fungal isolate from soil that is morphologically similar to members of *Paramyrothecium* but phylogenetically distinct (Fig. 2). *Neomyrothecium* produces only a few setae in culture, which are multiseptate and unbranched, whereas those of *Paramyrothecium* are 1–3(–4)-septate, and sometimes branched beneath the most apical septum. The pulvinate sporodochia of *Neomyrothecium* lack a white setose fringe compared to the cupulate sporodochia of *Paramyrothecium* with a distinct white setose fringe.

***Neomyrothecium humicola*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816018; Fig. 47

*Etymology.* Name reflects the substrate, soil, from which this fungus was isolated.

*Conidiomata* sporodochial, stromatic, superficial, scattered or gregarious, oval to elongate or irregular in outline, 60–450 µm





**Fig. 47** *Neomyrothecium humicola* (CBS 310.96). a. Sporodochial conidiomata on SNA; b. sporodochia; c. setae; d. conidiogenous cells; e. conidia. — Scale bars: b, d–e = 10  $\mu$ m; c = 20  $\mu$ m.

diam, 50–100  $\mu$ m deep, without a setose fringe surrounding an olivaceous green to black agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, smooth, of a *textura angularis*. *Setae* rarely seen, arising from the basal stroma, thin-walled, hyaline, smooth, straight to flexuous, septate, 85–140  $\mu$ m long, 2–3  $\mu$ m wide, tapering towards an acute apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth, 15–25  $\times$  2–3  $\mu$ m; conidiogenous apparatus consists of a whorl of primary and secondary branches with the terminal branches producing 3–6 conidiogenous cells; primary branches aseptate, hyaline, smooth, 7–15  $\times$  2–3  $\mu$ m; secondary branches aseptate, hyaline, smooth, 5–10  $\times$  2–3  $\mu$ m; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline, smooth, 7–14  $\times$  2  $\mu$ m, with conspicuous collarettes and periclinal thickenings, sometimes covered by an olivaceous green mucoid layer. *Conidia* aseptate, smooth, hyaline, cylindrical, 5–7  $\times$  1–2  $\mu$ m (av. 6  $\times$  2  $\mu$ m), rounded at both ends.

**Culture characteristics** — Colonies on PDA, OA and CMA with abundant white aerial mycelium with sporodochia forming on the surface of the medium covered by slimy olivaceous green conidial masses, reverse on PDA buff.

**Material examined.** PAPUA NEW GUINEA, Madang, Jais Aben, from soil along coral reef coast, Nov. 1995, A. Aptroot (holotype CBS H-22456, culture ex-type CBS 310.96).

***Paramyrothecium*** L. Lombard & Crous, *gen. nov.* — MycoBank MB815988

**Etymology.** Name reflects its morphological similarity to the genus *Myrothecium*.

**Type species.** *Paramyrothecium roridum* (Tode) L. Lombard & Crous.

**Sexual morph** unknown. *Conidiomata* sporodochial, stromatic, superficial, cupulate, scattered or gregarious, oval or irregular in outline, with or without a white setose fringe surrounding an olivaceous green to dark green slimy mass of conidia. *Stroma* poorly or well-developed, hyaline to subhyaline, composed of hyphae disposed in a *textura globulosa* and/or *textura angularis*. *Setae* thin-walled, 1–3(–4)-septate, straight to flexuous, sometimes becoming sinuous above the apical septum, hyaline,

tapering to an acute apice. *Conidiophores* macronematous, penicillately branched, hyaline, smooth. *Conidiogenous cells* phialidic or percurrent, hyaline sometimes becoming darker at the apex, smooth to lightly verrucose, cylindrical to subcylindrical, becoming narrowed at the tip, with a conspicuous collarettes and periclinal thickenings. *Conidia* aseptate to 1-septate, cylindrical to ellipsoidal to obovoid, straight to bent, hyaline to pale green, smooth.

**Notes** — Phylogenetic inference in this study showed that members of this group of fungi formed a highly supported clade distant to the *Myrothecium* s.str. clade (Fig. 2). Therefore, the new generic name, *Paramyrothecium*, is introduced here for this clade. Tulloch (1972) designated Fuckel's Fungi Rhenani no. 166 as neotype of *Myr. roridum*. As *Pa. roridum* (= *Myr. roridum*) is the type species of the genus, and no living material is available for this neotype, we consider it important to designate an epitype for this species. The morphological features of the strain CBS 357.89 best fit the description of *Myr. roridum* provided by Tulloch (1972), and hence is designated as epitype here. Members of *Paramyrothecium* can be distinguished from *Myrothecium* s.str. and the other myrothecium-like genera by their 1–3-septate, thin-walled setae surrounding the sporodochia.

***Paramyrothecium acadense*** (Seifert & G. Sampson)

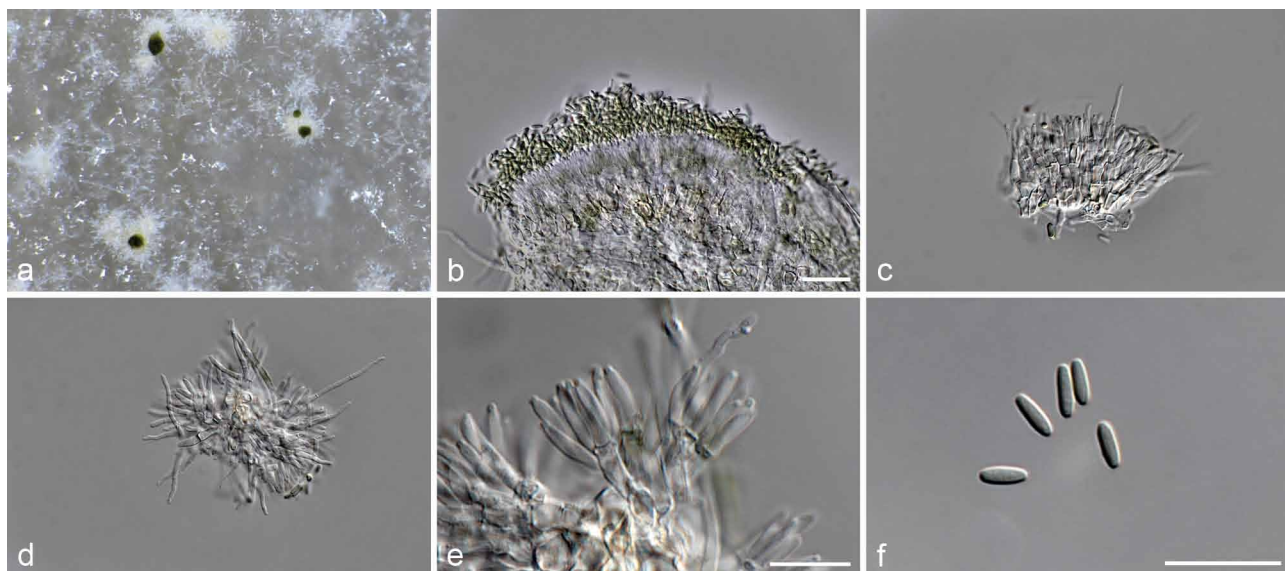
L. Lombard & Crous, *comb. nov.* — MycoBank MB815945

**Basionym.** *Myrothecium acadense* Seifert & G. Sampson, Mycotaxon 87: 320. 2003.

**Description and illustration** — See Seifert et al. (2003).

**Material examined.** CANADA, Nova Scotia, Shubenacadie, from leaves of *Tussilago farfara*, 2 Oct. 1989, G. Sampson, CBS 123.96 = DAOMC 221473 = UAMH 7653 (ex-type strain of *Myr. acadense*).

**Notes** — The ex-type strain (CBS 123.96; Seifert et al. 2003) of *Myr. acadense* clustered in the *Paramyrothecium* clade (Fig. 2), and therefore a new combination is provided for this species in the asexual genus *Paramyrothecium*. *Paramyrothecium acadense* can be distinguished from other species in this genus by the formation of 0–1-septate conidia that are straight or bent, and percurrently extending rather than phialidic conidiogenous cells (Seifert et al. 2003).



**Fig. 48** *Paramyrothecium breviseta* (CBS 544.75). a. Sporodochial conidiomata on SNA; b–d. sporodochia; e. conidiogenous cells; f. conidia. — Scale bars: b = 20  $\mu$ m (apply to c–d); e–f = 10  $\mu$ m.

***Paramyrothecium breviseta*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815946; Fig. 48

*Etymology.* Name reflects the short setae produced by this fungus.

*Conidiomata* sporodochial, stromatic, cupulate, superficial, scattered or rarely gregarious, oval or irregular in outline, 45–100  $\mu$ m diam, 45–70  $\mu$ m deep, with a white setose fringe surrounding an olivaceous green agglutinated slimy mass of conidia. *Stroma* well developed, hyaline to subhyaline, of a *textura globulosa* and *textura angularis*. *Setae* arising from the stroma thin-walled, hyaline, 1–3-septate, straight to flexuous, 25–40  $\mu$ m long, 2–3  $\mu$ m wide, tapering to an acutely rounded apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth, 6–9  $\times$  2–4  $\mu$ m; primary branches aseptate, unbranched, smooth, 5–8  $\times$  2–3  $\mu$ m; secondary branches aseptate, unbranched, smooth, 4–7  $\times$  2–3  $\mu$ m; terminating in a whorl of 3–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline, smooth, straight to slightly curved, 6–11  $\times$  1–2  $\mu$ m, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, cylindrical to ellipsoidal, 4–5  $\times$  1–2  $\mu$ m (av. 5  $\times$  2  $\mu$ m), rounded at both ends.

*Culture characteristics* — Colonies on PDA, OA and CMA with abundant white to rosy buff aerial mycelium with sporodochia forming on the surface of the medium, covered by slimy olivaceous green conidial masses, reverse on PDA rosy buff.

*Material examined.* INDIA, substrate unknown, Feb. 1975, A. Subrahmanian (holotype CBS H-14915, culture ex-type CBS 544.75).

*Notes* — *Paramyrothecium breviseta* formed a single lineage basal to the *Pa. roridum* clade (Fig. 2) and can be distinguished from other species in this genus by the formation of characteristic short setae surrounding the sporodochia.

***Paramyrothecium cupuliforme*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815947; Fig. 49

*Etymology.* Name reflects the cupulate sporodochia produced by this fungus.

*Conidiomata* sporodochial, stromatic, cupulate, superficial, scattered or gregarious, oval or irregular in outline, 75–900  $\mu$ m diam, 45–135  $\mu$ m deep, with a white setose fringe surrounding an olivaceous green to black agglutinated slimy mass of conidia.

*Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* arising from the stroma, thin-walled, hyaline, 1–3-septate, straight becoming sinuous above the apical septum, 45–90  $\mu$ m long, 2–3  $\mu$ m wide, tapering to an acutely rounded apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth, 15–25  $\times$  2–4  $\mu$ m; primary branches aseptate, unbranched, smooth, 8–15  $\times$  2–3  $\mu$ m; secondary branches aseptate, unbranched, smooth, 4–10  $\times$  2–3  $\mu$ m; terminating in a whorl of 3–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline, smooth, straight to slightly curved, 4–11  $\times$  1–3  $\mu$ m, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, cylindrical to ellipsoidal, 6–8  $\times$  1–2  $\mu$ m (av. 7  $\times$  2  $\mu$ m), with a flattened apex and rounded at the base.

*Culture characteristics* — Colonies on PDA, OA and CMA with abundant white to buff aerial mycelium with sporodochia forming on the surface of the medium, covered by slimy olivaceous green to black conidial masses, reverse on PDA buff to pale luteous.

*Materials examined.* NAMIBIA, 30 km west of Maltahole on Highway C19, from surface soil in desert, Apr. 2001, M. Christensen (holotype CBS H-22434, culture ex-type CBS 127789), CBS 126167.

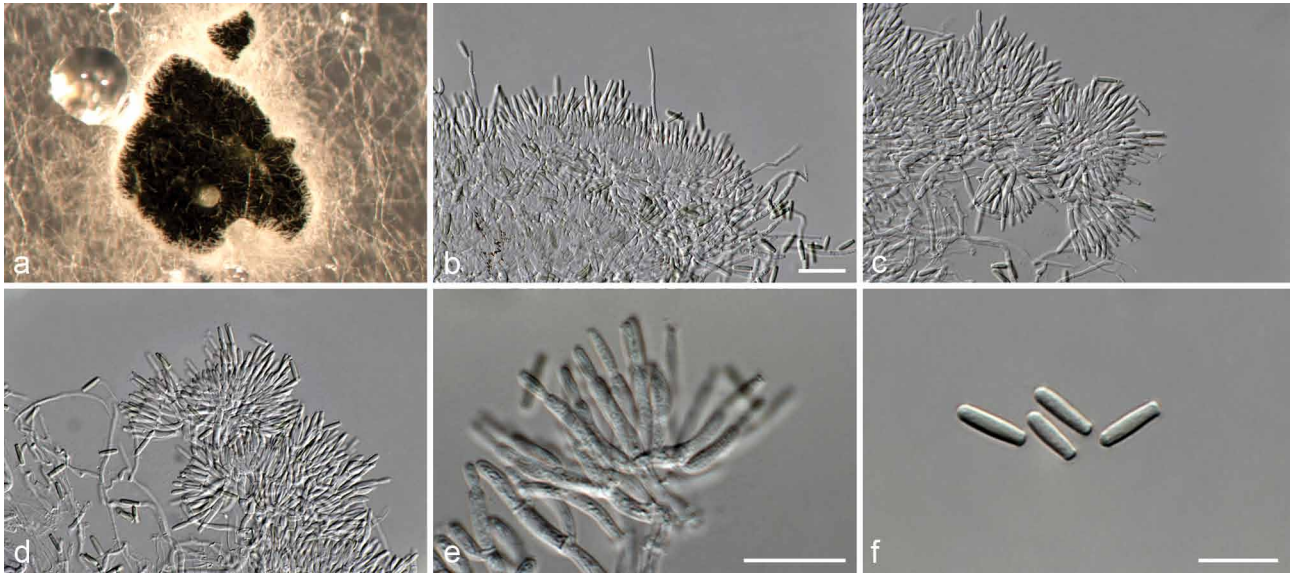
*Notes* — *Paramyrothecium cupuliforme* formed a well-supported clade closely related to *Pa. nigrum* and *Pa. viridisporum* (Fig. 2). This species is morphologically similar to *Pa. humicola*, *Pa. tellicola* and *Pa. terrestris*. The setae of *Pa. cupuliforme* (up to 90  $\mu$ m) are longer than those of *Pa. humicola* (up to 65  $\mu$ m), *Pa. tellicola* (up to 80  $\mu$ m) and *Pa. terrestris* (up to 70  $\mu$ m). Additionally, the conidia of *Pa. cupuliforme* (6–8  $\times$  1–2  $\mu$ m (av. 7  $\times$  2  $\mu$ m)) are slightly larger than those of *Pa. humicola* (6–7  $\times$  1–2  $\mu$ m (av. 6  $\times$  1  $\mu$ m)), but slightly smaller than those of *Pa. tellicola* ((7–)7.5–8.5(–9)  $\times$  1–3  $\mu$ m (av. 8  $\times$  2  $\mu$ m)) and *Pa. terrestris* ((7–)7.5–8.5(–10)  $\times$  1–3  $\mu$ m (av. 8  $\times$  2  $\mu$ m)).

***Paramyrothecium foeniculicola*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815948; Fig. 50

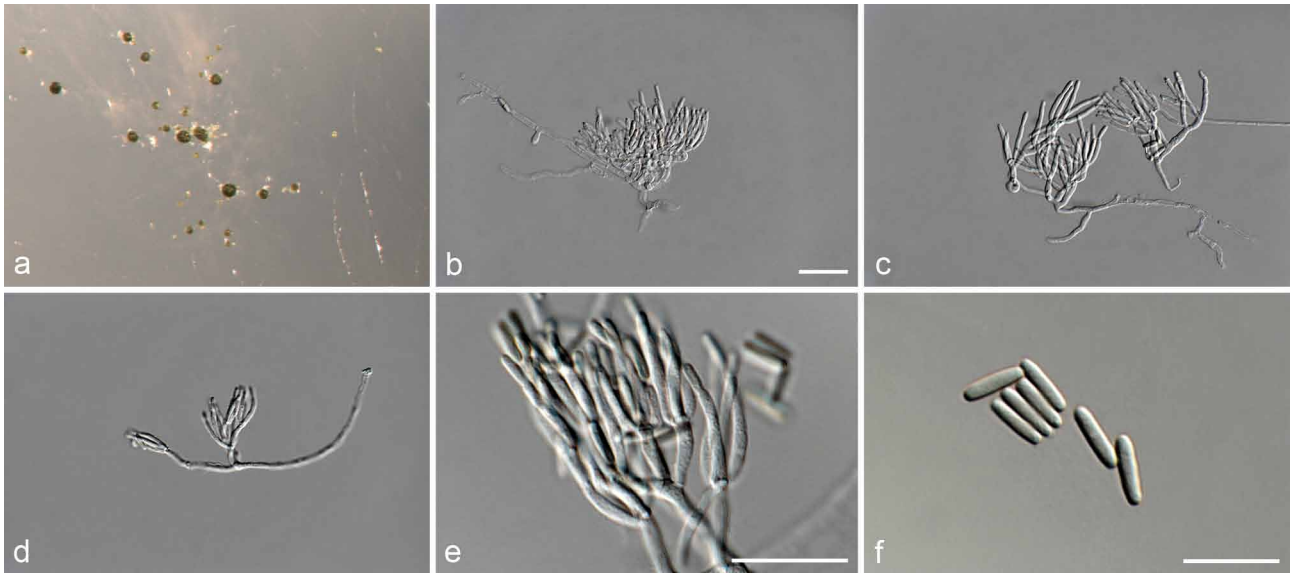
*Etymology.* Name reflects the host genus *Foeniculum*, from which this fungus was isolated.

*Conidiomata* sporodochial, stromatic, superficial, scattered, oval in outline, 25–45  $\mu$ m diam, 30–50  $\mu$ m deep, lacking a white setose fringe surrounding an olivaceous green agglutinated

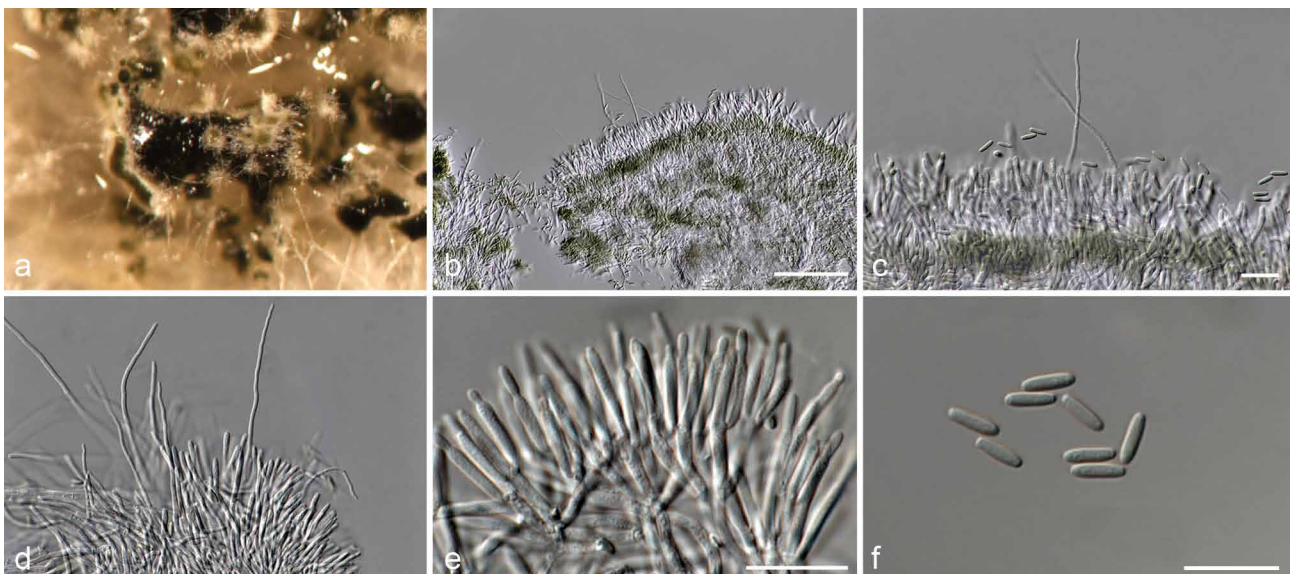




**Fig. 49** *Paramyrothecium cupuliforme* (CBS 127789). a. Sporodochial conidiomata on SNA; b–d. sporodochia; e. conidiogenous cells; f. conidia. — Scale bars: b = 20  $\mu$ m (apply to c–d); e–f = 10  $\mu$ m.



**Fig. 50** *Paramyrothecium foeniculicola* (CBS 331.51). a. Sporodochial conidiomata on SNA; b–d. sporodochia; e. conidiogenous cells; f. conidia. — Scale bars: b = 20  $\mu$ m (apply to c–d); e–f = 10  $\mu$ m.



**Fig. 51** *Paramyrothecium foliicola* (CBS 113121). a. Sporodochial conidiomata on SNA; b–d. sporodochia; e. conidiogenous cells; f. conidia. — Scale bars: b = 20  $\mu$ m (apply to c–d); e–f = 10  $\mu$ m.

slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth,  $7\text{--}17 \times 2\text{--}3 \mu\text{m}$ ; primary branches aseptate, unbranched, smooth,  $5\text{--}11 \times 1\text{--}2 \mu\text{m}$ ; secondary branches aseptate, unbranched, smooth,  $5\text{--}8 \times 1\text{--}2 \mu\text{m}$ ; terminating in a whorl of 3–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline, smooth to lightly verrucose, straight to slightly curved,  $6\text{--}16 \times 1\text{--}2 \mu\text{m}$ , with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, cylindrical to ellipsoidal,  $5\text{--}7 \times 1\text{--}2 \mu\text{m}$  (av.  $6 \times 2 \mu\text{m}$ ), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA rosy buff, with mostly immersed mycelium with sporodochia forming on the surface of the medium, covered by slimy herbage to olivaceous green conidial masses, reverse on PDA rosy buff.

*Material examined.* THE NETHERLANDS, from leaf sheath of *Foeniculum vulgare*, 1951, collector unknown (holotype CBS H-14914, culture ex-type CBS 331.51 = IMI 140051).

Notes — *Paramyrothecium foeniculicola* formed a single lineage in the *Paramyrothecium* clade (Fig. 2). The sporodochia of *Pa. foeniculicola* lack a white setose fringe as was observed for *Pa. parvum* and no setae were observed for either species. The conidia of *Pa. foeniculicola* ( $5\text{--}7 \times 1\text{--}2 \mu\text{m}$  (av.  $6 \times 2 \mu\text{m}$ )) are slightly larger than those of *Pa. parvum* ( $4\text{--}5 \times 1\text{--}2 \mu\text{m}$  (av.  $5 \times 2 \mu\text{m}$ )).

***Paramyrothecium foliicola*** L. Lombard & Crous, sp. nov. — MycoBank MB815949; Fig. 51

*Etymology.* Name reflects the substrate, a rotten leaf, from which this fungus was isolated.

*Conidiomata* sporodochial, stromatic, superficial, cupulate, scattered or gregarious, oval or irregular in outline,  $50\text{--}850 \mu\text{m}$  diam,  $90\text{--}165 \mu\text{m}$  deep, with a white setose fringe surrounding an olivaceous green agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* arising from the stroma thin-walled, hyaline, 1–3-septate, straight becoming sinuous above the apical septum,  $60\text{--}100 \mu\text{m}$  long,  $2\text{--}3 \mu\text{m}$  wide, tapering to an acutely rounded apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes

unbranched, hyaline sometimes covered by a green mucoid layer, septate, smooth,  $15\text{--}25 \times 2\text{--}3 \mu\text{m}$ ; primary branches aseptate, unbranched, smooth,  $8\text{--}15 \times 1\text{--}2 \mu\text{m}$ ; secondary branches aseptate, unbranched, smooth,  $5\text{--}10 \times 2 \mu\text{m}$ ; terminating in a whorl of 3–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline becoming darker at the apex, smooth, straight to slightly curved,  $8\text{--}14 \times 1\text{--}2 \mu\text{m}$ , with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, cylindrical to ellipsoidal,  $5\text{--}6 \times 1\text{--}2 \mu\text{m}$  (av.  $6 \times 1 \mu\text{m}$ ), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white aerial mycelium with sporodochia forming on the aerial mycelium and surface of the medium, covered by slimy olivaceous green to mouse grey conidial masses, producing a rosy buff exudate into the medium, reverse on PDA luteous to rosy buff.

*Materials examined.* BRAZIL, Pista Claudio Coutiño near Pao de Açucar, from rotten leaf of unknown host, 12 Oct. 2002, R.F. Castañeda-Ruiz (holotype CBS H-22435, culture ex-type CBS 113121 = INIFAT C02/104). — CUBA, La Habana, from air, July 1993, R.F. Castañeda, CBS 419.93 = INIFAT C93/60.

Notes — *Paramyrothecium foliicola* formed a highly supported clade closely related but distinct to *Pa. breviseta* and *Pa. roridum* (Fig. 2). This species share several morphological features with *Pa. nigrum* and *Pa. roridum*. The conidiophore stipes of *Pa. foliicola* (up to  $25 \mu\text{m}$  long) are shorter than those of *Pa. nigrum* (up to  $45 \mu\text{m}$  long) and *Pa. roridum* (up to  $40 \mu\text{m}$  long). Furthermore, *Pa. foliicola* produces a rosy buff exudate that diffuses into the growth medium, which was not seen for both *Pa. nigrum* and *Pa. roridum*.

***Paramyrothecium humicola*** L. Lombard & Crous, sp. nov. — MycoBank MB815950; Fig. 52

*Etymology.* Name reflects the substrate, soil, from which this fungus was isolated.

*Conidiomata* sporodochial, stromatic, superficial, cupulate, scattered or gregarious, oval or irregular in outline,  $85\text{--}550 \mu\text{m}$  diam,  $40\text{--}120 \mu\text{m}$  deep, lacking a white setose fringe surrounding an olivaceous green agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* arising from the stroma, thin-walled, smooth, unbranched, straight to flexuous, hyaline, 1–2-septate,  $55\text{--}65 \mu\text{m}$  long,  $2\text{--}3 \mu\text{m}$  wide, terminating in an acute apice. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately

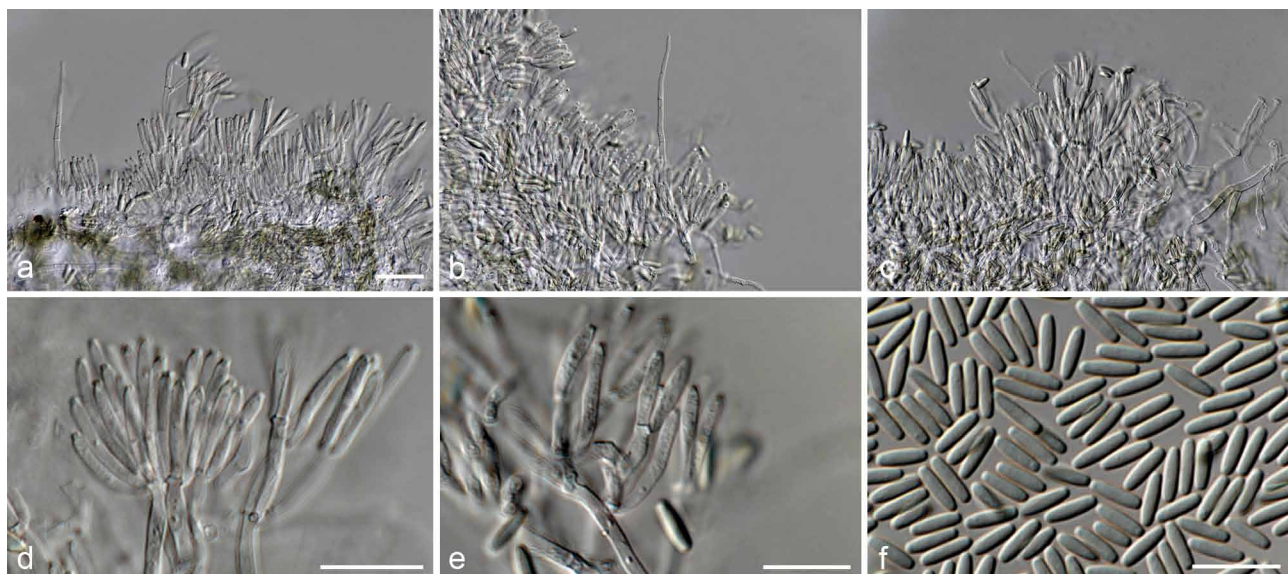
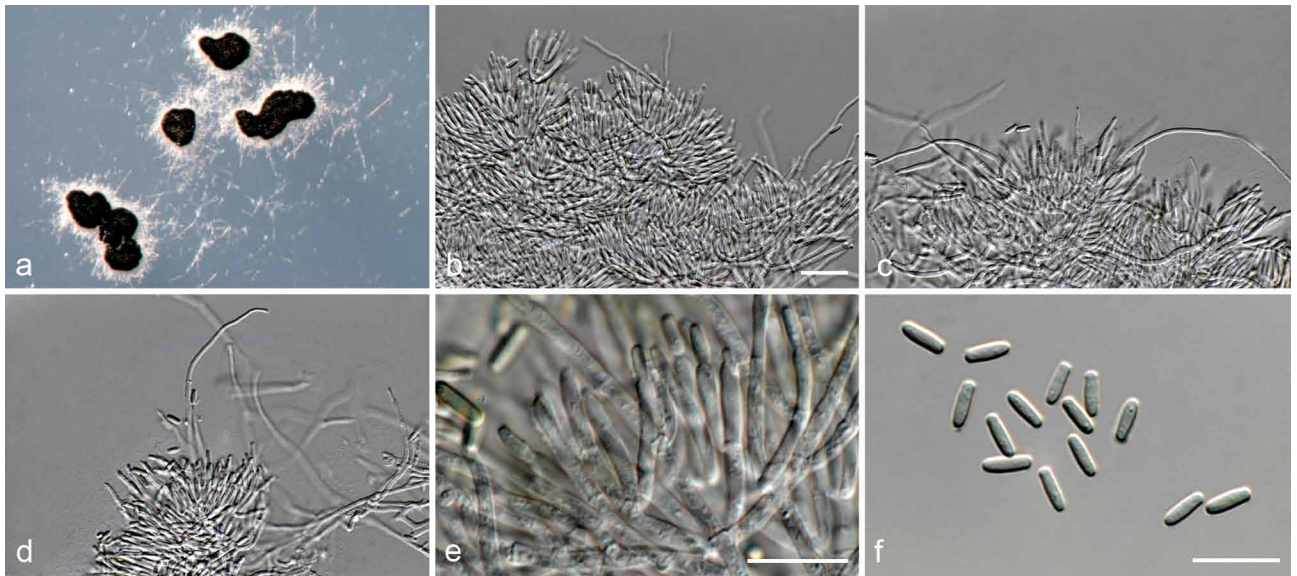
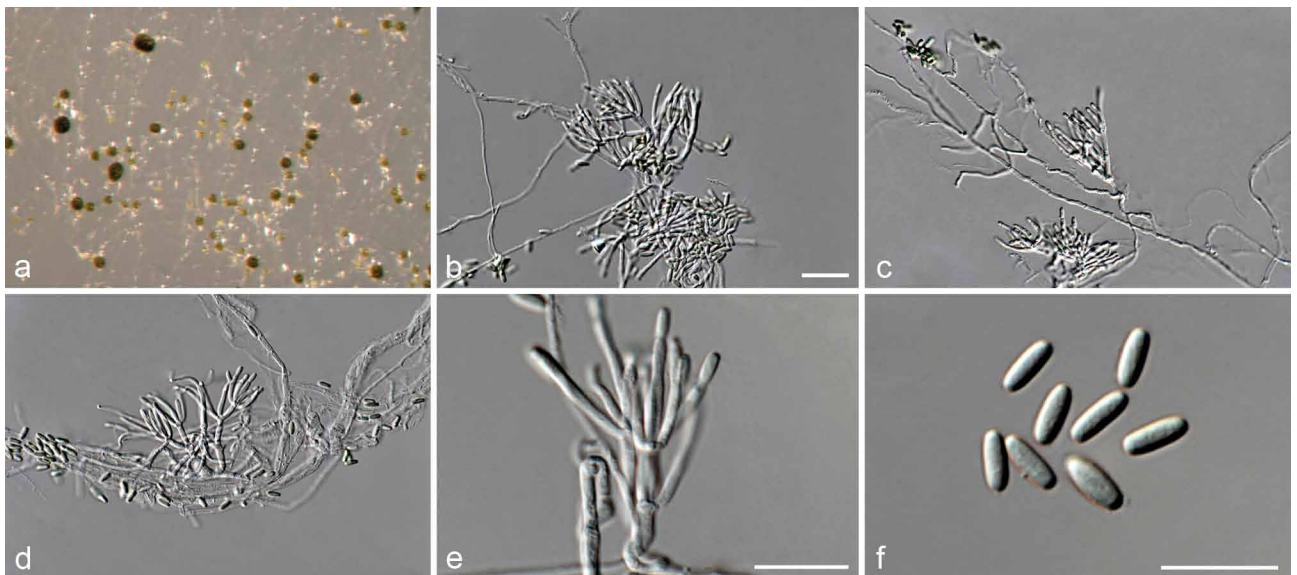


Fig. 52 *Paramyrothecium humicola* (CBS 127295). a–c. Sporodochial conidiomata; d–e. conidiogenous cells; f. conidia. — Scale bars: a =  $20 \mu\text{m}$  (apply to b–c); d, f =  $10 \mu\text{m}$ .

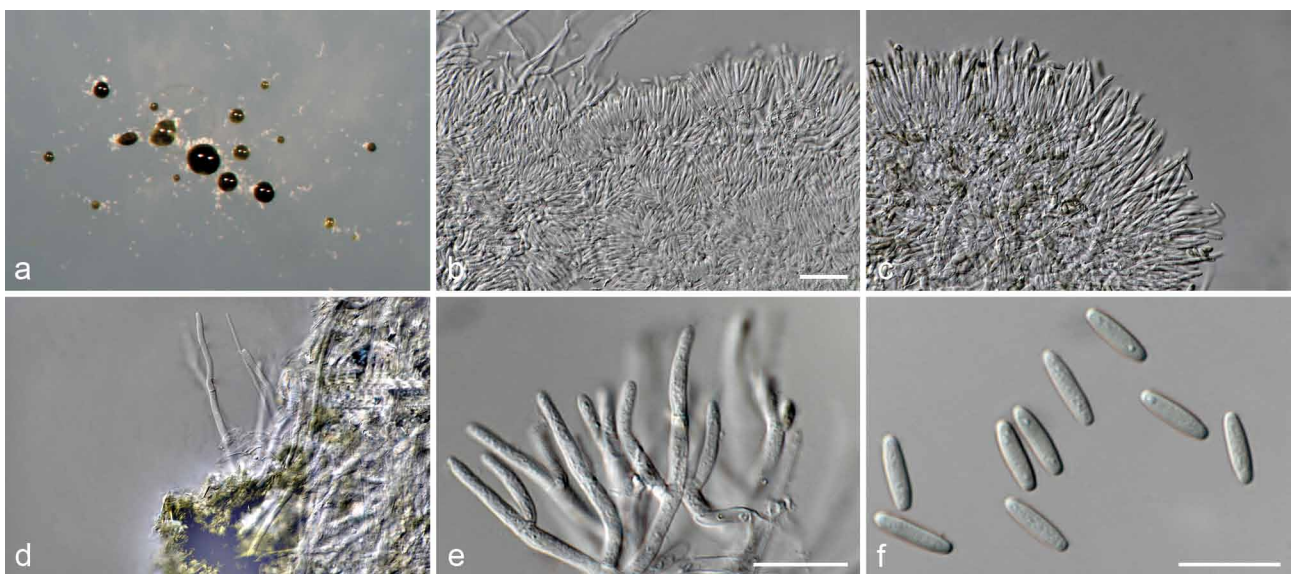




**Fig. 53** *Paramyrothecium nigrum* (CBS 116537). a. Sporodochial conidiomata on SNA; b–d. sporodochia; e. conidiogenous cells; f. conidia. — Scale bars: b = 20  $\mu\text{m}$  (apply to c–d); e–f = 10  $\mu\text{m}$ .



**Fig. 54** *Paramyrothecium parvum* (CBS 257.35). a. Sporodochial conidiomata on SNA; b–d. sporodochia; e. conidiogenous cells; f. conidia. — Scale bars: b = 20  $\mu\text{m}$  (apply to c–d); e–f = 10  $\mu\text{m}$ .



**Fig. 55** *Paramyrothecium roridum* (CBS 357.89). a. Sporodochial conidiomata on SNA; b–c. sporodochia; d. setae; e. conidiogenous cells; f. conidia. — Scale bars: b = 20  $\mu\text{m}$  (apply to c–d); e–f = 10  $\mu\text{m}$ .

branched conidiogenous apparatus; stipes unbranched, hyaline sometimes covered by a pale green mucoid layer, septate, smooth, 12–22 × 2–3 µm; primary branches aseptate, unbranched, smooth, 7–17 × 1–2 µm; secondary branches aseptate, unbranched, smooth, 8–11 × 1–3 µm; terminating in a whorl of 3–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline becoming darker at the apex, smooth, straight to slightly curved, 8–13 × 1–3 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, cylindrical to ellipsoidal, 6–7 × 1–2 µm (av. 6 × 1 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with mostly immersed mycelium with sporodochia forming on the surface of the medium, covered by slimy herbage to olivaceous green conidial masses, reverse on PDA buff.

*Material examined.* USA, Kansas, near Manhattan, Konza Prairie Research Natural Area, long term ecological research site, from soil collected in tallgrass prairie, 1986, *M. Christensen* (holotype CBS H-22436, culture ex-type CBS 127295).

Notes — *Paramyrothecium humicola* formed a single lineage basal to the *Pa. parvum* clade (Fig. 2). This species is easily distinguished from *Pa. parvum* by the lack of setae formed surrounding the sporodochia of *Pa. parvum*. The conidia of *Pa. humicola* (6–7 × 1–2 µm (av. 6 × 1 µm)) are also slightly larger than those of *Pa. parvum* (4–5 × 1–2 µm (av. 5 × 2 µm)).

***Paramyrothecium nigrum* L. Lombard & Crous, sp. nov.** — MycoBank MB815951; Fig. 53

*Etymology.* Name reflects the black conidial masses produced on the sporodochia by this fungus.

*Conidiomata* sporodochial, stromatic, superficial, scattered or gregarious, oval or irregular in outline, 50–850 µm diam, 55–165 µm deep, with a white setose fringe surrounding black, rarely olivaceous green agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* arising from the stroma thin-walled, hyaline, 1–3-septate, straight becoming sinuous above the apical septum, 60–100 µm long, 2–3 µm wide, tapering to an acutely rounded apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth, 25–45 × 2–4 µm; primary branches aseptate, unbranched, smooth, 9–16 × 2–3 µm; secondary branches aseptate, unbranched, smooth, 7–13 × 1–3 µm; terminating in a whorl of 3–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline, smooth to slightly verrucose, straight to slightly curved, 8–13 × 1–2 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, cylindrical to ellipsoidal, 5–6 × 1–2 µm (av. 6 × 2 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white aerial mycelium with sporodochia forming on the surface of the medium in concentric rings, covered by slimy black, rarely olivaceous green, conidial masses, reverse on PDA pale luteous.

*Material examined.* SPAIN, Mallorca, Es Verger, from soil, 2001, *G. Bills* (holotype CBS H-22437, culture ex-type CBS 116537 = A.R. 3783).

Notes — *Paramyrothecium nigrum* formed a single lineage closely related to *Pa. cupuliforme*, *Pa. foeniculicola* and *Pa. viridisporum* (Fig. 2). Morphologically this species can be distinguished from the latter three species by their setae (up to 100 µm), which are longer than those of *Pa. cupuliforme* (up to 90 µm) and shorter than those of *Pa. viridisporum* (up to 140 µm), whereas *Pa. foeniculicola* did not produce any setae surrounding its sporodochia.

***Paramyrothecium parvum* L. Lombard & Crous, sp. nov.** — MycoBank MB815952; Fig. 54

*Etymology.* Name reflects the small conidia produced by this fungus.

*Conidiomata* sporodochial, stromatic, superficial, scattered, oval in outline, 25–50 µm diam, 35–65 µm deep, lacking a white setose fringe surrounding an olivaceous green agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline sometimes covered by a pale green mucoid layer, septate, smooth, 12–26 × 2–4 µm; primary branches aseptate, unbranched, smooth, 5–12 × 1–3 µm; secondary branches aseptate, unbranched, smooth, 5–11 × 1–2 µm; terminating in a whorl of 3–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline, smooth, straight to slightly curved, 7–23 × 1–2 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, cylindrical to ellipsoidal, 4–5 × 1–2 µm (av. 5 × 2 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA buff to pale luteous, with mostly immersed mycelium with sporodochia forming on the surface of the medium, covered by slimy olivaceous green conidial masses, reverse on PDA buff.

*Materials examined.* FRANCE, from dune sand, Mar. 1942, *F. Moreau*, CBS 142.42 = IMI 155923 = MUCL 7582. — UK, Shropshire, Wellington, from *Viola* sp., Mar. 1935, *N.C. Preston* (holotype CBS H-14907, culture ex-type CBS 257.35 = IMI 140049).

Notes — Phylogenetic inference in this study showed that *Pa. parvum* formed a well-supported clade closely related to *Pa. humicola* (Fig. 2). See note under *Pa. humicola* for morphological differences.

***Paramyrothecium roridum* (Tode) L. Lombard & Crous, comb. nov.** — MycoBank MB815989; Fig. 55

*Basionym.* *Myrothecium roridum* Tode, *Fungi Mecklenburgenses Selecti* 1: 25, t. 5: 38. 1790.

= *Myrothecium advena* Sacc., *Ann. Mycol.* 6: 560. 1908.

= *Myrotheciella catenuligera* Speg., *Anales Mus. Nac. Hist. Nat. Buenos Aires* 20: 460. 1910.

= *Exothecium leucomelas* Syd., *Ann. Mycol.* 12: 571. 1914.

≡ *Myrothecium leucomelas* (Syd.) Höhn., *Mitt. Bot. Inst. Tech. Hochsch. Wien* 2: 95. 1925.

= *Myrothecium fragosianum* Sacc., *Not. Mycol.* 22: 162. 1917.

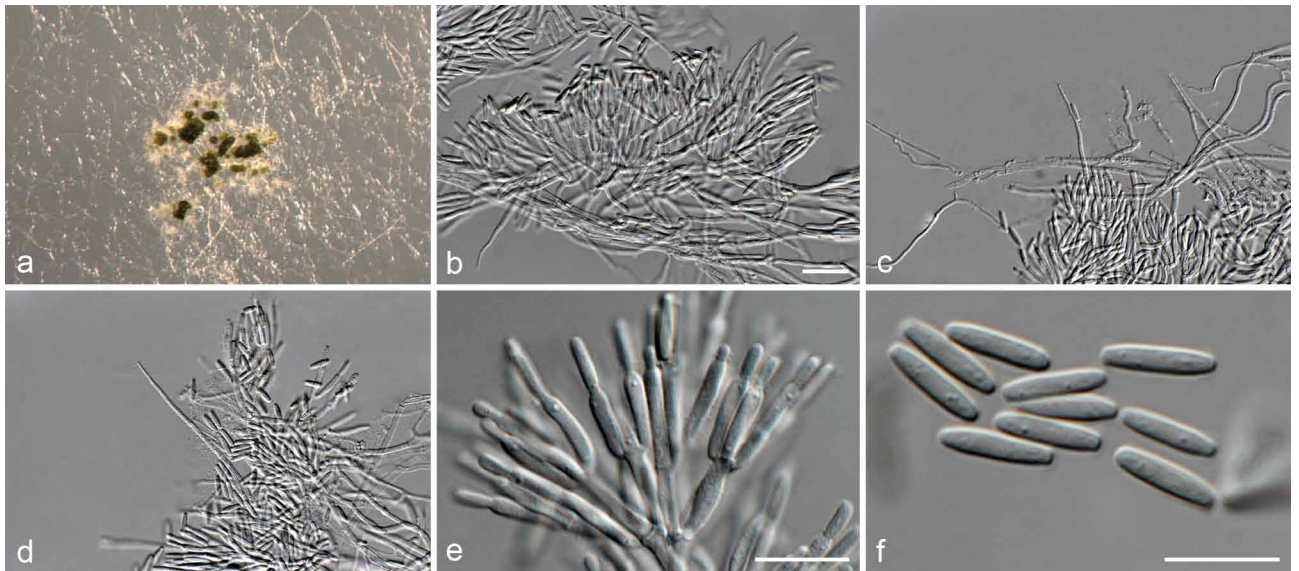
? = *Hymenospsis tenuis* Petch, *Ann. Roy. Bot. Gard. (Peradeniya)* 10: 178. 1927.

= *Myrothecium roridum* Tode var. *eichhorniae* Ponnappa, *Hyacinth Control Journal* 8: 18. 1970.

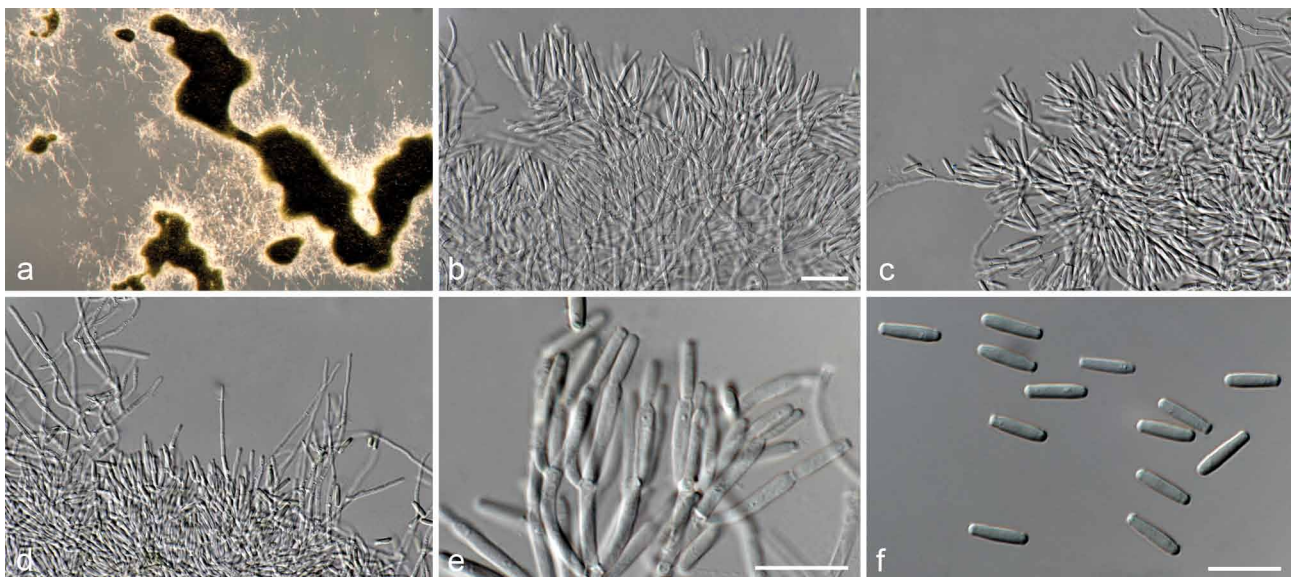
*Typification.* Herb. K on *Allium sativum*, *Fuckel's Fungi Rhenani* no. 166 (neotype fide Tulloch). — ITALY, Bologna, on *Gardenia* sp., Sept. 1989, *G. Giunchi* (epitype of *D. roridum* designated here, CBS H-22438, MBT204246, culture ex-epitype CBS 357.89).

*Conidiomata* sporodochial, stromatic, superficial, cupulate, scattered or rarely gregarious, oval in outline, 20–100 µm diam, 100–210 µm deep, with a white setose fringe surrounding an olivaceous green agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* arising from the stroma thin-walled, hyaline, 1–3(–4)-septate, smooth, straight to flexuous becoming sinuous above the apical septum, 60–100 µm long, 2–6 µm wide, tapering to an acutely rounded apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth, 15–40 × 2–4 µm; primary branches aseptate, unbranched, smooth, 10–20 × 2–3 µm; secondary branches aseptate, unbranched, smooth, 6–20 × 2–3 µm; terminating in a whorl of 3–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical,

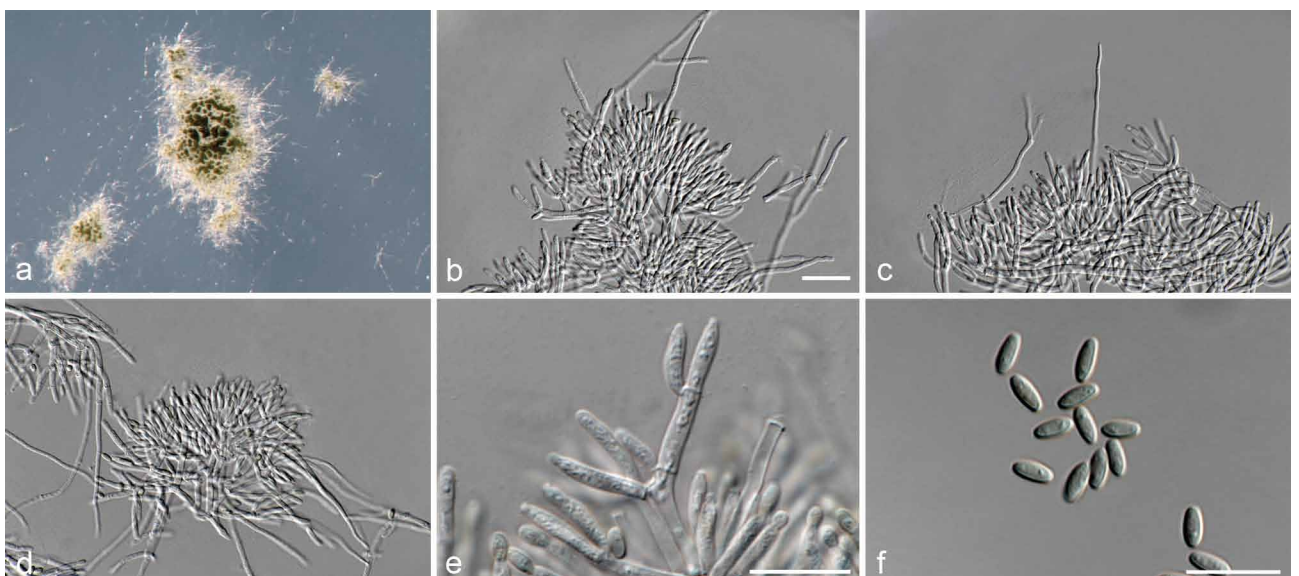




**Fig. 56** *Paramyrothecium tellicola* (CBS 478.91). a. Sporodochial conidiomata on SNA; b–c. sporodochia; e. conidiogenous cells; f. conidia. — Scale bars: b = 20  $\mu$ m (apply to c–d); e–f = 10  $\mu$ m.



**Fig. 57** *Paramyrothecium terrestris* (CBS 564.86). a. Sporodochial conidiomata on SNA; b–d. sporodochia; e. conidiogenous cells; f. conidia. — Scale bars: b = 20  $\mu$ m (apply to c–d); e–f = 10  $\mu$ m.



**Fig. 58** *Paramyrothecium viridisporum* (CBS 873.85). a. Sporodochial conidiomata on SNA; b–d. sporodochia; e. conidiogenous cells; f. conidia. — Scale bars: b = 20  $\mu$ m (apply to c–d); e–f = 10  $\mu$ m.

hyaline becoming darkly pigmented at the collarettes, smooth, straight to slightly curved,  $7\text{--}33 \times 2\text{--}3 \mu\text{m}$ , with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, cylindrical to ellipsoidal,  $(5\text{--})6.5\text{--}7.5(-8) \times 2 \mu\text{m}$  (av.  $7 \times 2 \mu\text{m}$ ), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white to pale luteous aerial mycelium with sporodochia forming on the surface of the medium, covered by slimy olivaceous green conidial masses, reverse on PDA pale luteous.

*Additional materials examined.* COLOMBIA, Chinchina, Caldas, from twig of *Coffea* sp., Aug. 1950, O. Urhan, CBS 372.50 = IMI 140050. — THE NETHERLANDS, from water from nursery, Apr. 1992, E.S. van Reenen-Hoekstra, CBS 212.92.

Notes — The ex-epitype strain (CBS 357.89) designated here for *Pa. roridum* clustered in a well-supported clade closely related to *Pa. breviseta* and *Pa. foliicola* (Fig. 2). For morphological differences see notes under *Pa. breviseta* and *Pa. foliicola*.

***Paramyothecium tellicola*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815953; Fig. 56

*Etymology.* Name reflects the substrate, soil, from which this fungus was isolated.

*Conidiomata* sporodochial, stromatic, superficial, cupulate, scattered or gregarious, oval or irregular in outline,  $45\text{--}750 \mu\text{m}$  diam,  $80\text{--}165 \mu\text{m}$  deep, with a white setose fringe surrounding an olivaceous green to mouse grey agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* arising from the stroma, sometimes branching at the basal septum, thin-walled, hyaline, 1–3-septate, smooth, straight becoming sinuous above the apical septum, tapering to an acutely rounded apex,  $45\text{--}80 \mu\text{m}$  long,  $2\text{--}3 \mu\text{m}$  wide. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth,  $15\text{--}30 \times 2\text{--}4 \mu\text{m}$ ; primary branches aseptate, unbranched, smooth,  $10\text{--}17 \times 1\text{--}3 \mu\text{m}$ ; secondary branches aseptate, unbranched, smooth,  $7\text{--}11 \times 1\text{--}3 \mu\text{m}$ ; terminating in a whorl of 3–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline, smooth, straight to slightly curved,  $7\text{--}17 \times 1\text{--}3 \mu\text{m}$ , with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, cylindrical to ellipsoidal,  $(7\text{--})7.5\text{--}8.5(-9) \times 1\text{--}3 \mu\text{m}$  (av.  $8 \times 2 \mu\text{m}$ ), with a flattened apex and rounded at the base.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white to rosy buff aerial mycelium with sporodochia forming on the aerial mycelium and on the surface of the medium, covered by slimy olivaceous green to mouse grey conidial masses, reverse on PDA pale luteous to buff.

*Material examined.* TURKEY, Canakkale-Ezine, from soil, 1991, G. Turhan (holotype CBS H-22439, culture ex-type CBS 478.91).

Notes — *Paramyothecium tellicola* formed a distinct single lineage basal to the *Pa. terrestris* clade (Fig. 2). The setae of *Pa. tellicola* (up to  $80 \mu\text{m}$ ) are longer than those of *Pa. terrestris* (up to  $70 \mu\text{m}$ ).

***Paramyothecium terrestris*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815954; Fig. 57

*Etymology.* Name reflects the substrate, soil, from which this fungus was isolated.

*Conidiomata* sporodochial, stromatic, superficial, cupulate, scattered or gregarious, oval or irregular in outline,  $20\text{--}750 \mu\text{m}$  diam,  $70\text{--}145 \mu\text{m}$  deep, with a white setose fringe surrounding an olivaceous green to black agglutinated slimy mass of co-

nidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* arising from the stroma thin-walled, hyaline, 1–3-septate, smooth to slightly verrucose, straight becoming sinuous above the apical septum, tapering to an acutely rounded apex,  $35\text{--}70 \mu\text{m}$  long,  $2\text{--}3 \mu\text{m}$  wide. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth,  $15\text{--}30 \times 2\text{--}3 \mu\text{m}$ ; primary branches aseptate, unbranched, smooth,  $10\text{--}25 \times 1\text{--}3 \mu\text{m}$ ; secondary branches aseptate, unbranched, smooth,  $5\text{--}12 \times 1\text{--}3 \mu\text{m}$ ; terminating in a whorl of 3–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline, smooth, straight to slightly curved,  $7\text{--}12 \times 2\text{--}3 \mu\text{m}$ , with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, cylindrical to ellipsoidal,  $(7\text{--})7.5\text{--}8.5(-10) \times 1\text{--}3 \mu\text{m}$  (av.  $8 \times 2 \mu\text{m}$ ), with a flattened apex and rounded at the base.

Culture characteristics — Colonies on PDA, OA and CMA with sparse white to buff aerial mycelium with sporodochia forming on the surface of the medium, covered by slimy olivaceous green to black conidial masses, reverse on PDA pale luteous to buff.

*Materials examined.* TURKEY, Canakkale-Ezine, from soil under *Lycopersicon esculentum*, 1986, G. Turhan (holotype CBS H-22440, culture ex-type CBS 564.86), CBS 566.86; Basliquesir-Aksabal, from soil beneath *Helianthus annuus*, 1986, G. Turhan, CBS 565.86; from soil, 1985, G. Turhan, CBS 872.85.

Notes — Phylogenetic inference showed that *Pa. terrestris* formed a highly supported clade, closely related to the single lineage representing *Pa. tellicola* (Fig. 2). For morphological differences, see notes under *Pa. tellicola*.

***Paramyothecium viridisporum*** L. Lombard & Crous, *sp. nov.* — MycoBank MB815955. Fig. 58

*Etymology.* Name reflects the pale green conidia produced by this fungus.

*Conidiomata* sporodochial, cupulate, stromatic, superficial, scattered or gregarious, oval or irregular in outline,  $100\text{--}900 \mu\text{m}$  diam,  $30\text{--}85 \mu\text{m}$  deep, with a white setose fringe surrounding an olivaceous green agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* arising from the stroma thin-walled, unbranched, hyaline, 1–3-septate, straight becoming sinuous above the apical septum, tapering to an acutely rounded apex  $60\text{--}140 \mu\text{m}$  long,  $2\text{--}3 \mu\text{m}$  wide. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth,  $15\text{--}35 \times 2\text{--}3 \mu\text{m}$ ; primary branches aseptate, unbranched, smooth,  $8\text{--}17 \times 2\text{--}3 \mu\text{m}$ ; secondary branches aseptate, unbranched, smooth,  $5\text{--}9 \times 1\text{--}2 \mu\text{m}$ ; terminating in a whorl of 3–6 conidiogenous cells; conidiogenous cells phialidic, cylindrical to elongate doliform, hyaline, smooth, straight to slightly curved,  $6\text{--}12 \times 3\text{--}5 \mu\text{m}$ , with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, obovoid to ellipsoidal,  $3\text{--}5 \times 2 \mu\text{m}$  (av.  $5 \times 2 \mu\text{m}$ ), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white aerial mycelium with sporodochia forming on the surface of the medium in concentric rings, covered by slimy mouse grey to olivaceous green conidial masses, reverse on PDA white to pale luteous.

*Materials examined.* TURKEY, from soil, 1985, G. Turhan (holotype CBS H-22441, culture ex-type CBS 873.85); Usak-Sükranıye, from soil under *Cicer arietinum*, 1986, G. Turhan, CBS 563.86. — USA, Wyoming, Rock Springs, DOE site, 11 km west of Rock Springs, from soil in sagebrush grassland, 1978, M. Christensen, CBS 125821; from soil in bunchgrass rhizosphere, 1978, M. Christensen, CBS 125835; Grand Teton National Park, from soil in sagebrush grasslands, 1966, J.S. States, CBS 126942; near Dubois, from soil in desert grassland, 1997, M. Christensen, CBS 127843; 6 miles north and west of Hanna, from soil in strip mine area, 1976, M. Christensen, CBS 127785.



Notes — *Paramyrothecium viridisporum* produced the longest setae (up to 140 µm) distinguishing it from other species in the genus. Additionally, this species is also characterised by ob-ovoid to ellipsoidal pale green conidia, not seen for the other species. Phylogenetic inference in this study showed that *Pa. viridisporum* formed a well-supported clade closely related to *Pa. cupuliforme* and *Pa. nigrum* (Fig. 2).

***Parasarcopodium*** Mel'nik et al., Mycol. Progr. 3: 22. 2004

Description and illustration — See Mel'nik et al. (2004).

Type species. *Parasarcopodium ceratocaryi* Mel'nik et al., Mycol. Progr. 3: 24. 2004.

Notes — This monotypic genus, based on *Parasarcopodium ceratocaryi*, was initially classified as a member of the *Bionectriaceae* (Mel'nik et al. 2004) based on sequences data of the 18S small subunit rDNA gene (SSU) and LSU gene regions. However, phylogenetic inference in this study placed the ex-type strain (CBS 110664) in the *Stachybotriaceae* (Fig. 1), which include a much larger sampling of taxa. Therefore, *Parasarcopodium* should be considered as a member of the *Stachybotriaceae*.

***Parvothecium*** L. Lombard & Crous, gen. nov. — MycoBank MB816019

Etymology. Name reflects the characteristic small sporodochia formed in culture by this fungus.

Type species. *Parvothecium terrestre* L. Lombard & Crous.

Sexual morph unknown. *Conidiomata* sporodochial, stromatic, superficial, scattered or rarely gregarious, oval or irregular in outline, covered by an olivaceous green to dark green slimy mass of conidia. *Stroma* well developed, hyaline, of a *textura angularis*. *Setae* rarely seen, thin-walled, septate, flexuous, hyaline, tapering to an obtuse apice. *Conidiophores* macronematous, penicillately branched, hyaline, smooth to verrucose. *Conidiogenous cells* phialidic, hyaline, smooth to verrucose, cylindrical, becoming narrowed at the tip, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, ellipsoidal to asymmetrically ellipsoidal, hyaline becoming pigmented with age, smooth, sometimes with a slightly curved acute apex and a narrow truncate base.

Notes — The monotypic genus, *Parvothecium*, is introduced here for a well-supported clade, closely related but distinct from the *Virgatospora* and *Septomyrothecium* s.str. clades and the single lineage representing *Inaequalispora prestonii* (Fig. 2). Morphologically, *Parvothecium* is similar to *Inaequalispora*, but can be distinguished by thin-walled setae and a verrucose conidiogenous apparatus compared to the thick-walled setae and smooth conidiogenous apparatus of *Inaequalispora* (Tulloch 1972, Nag Raj 1995).

***Parvothecium terrestre*** L. Lombard & Crous, sp. nov. — MycoBank MB816020; Fig. 59

Etymology. Name reflects the substrate, soil, from which this fungus was isolated.

*Conidiomata* sporodochial, stromatic, superficial, scattered, rarely gregarious, oval to elongate or irregular in outline, 45–85 µm diam, 50–100 µm deep, without a setose fringe surrounding a green to black agglutinated slimy mass of conidia. *Stroma* well developed, hyaline, smooth to verrucose, of a *textura angularis*. *Setae* rare, arising from the basal stroma, thin-walled, hyaline, smooth, flexuous, septate, 100–135 µm long, 2–3 µm wide, narrowing to an obtuse apice. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth to verrucose, 25–50 × 2–4 µm; conidiogenous apparatus consists of a whorl of 3–5 primary branches terminating in 3–6 conidiogenous cells; primary branches aseptate, unbranched, smooth to verrucose, 10–18 × 2–3 µm; conidiogenous cells phialidic, cylindrical, hyaline, smooth to verrucose, 8–15 × 1–2 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, smooth, hyaline becoming pigmented with age, ellipsoidal to asymmetrically ellipsoidal, 4–5 × 2–3 µm (av. 4 × 2 µm), sometimes with a slightly curved acute apex and a narrow truncate base.

Culture characteristics — Colonies on PDA, OA and CMA with mostly immersed aerial mycelium and sporodochia forming on the surface of the medium, covered by slimy olivaceous green to black conidial masses, reverse on PDA pale olivaceous green.

Materials examined. BRAZIL, Pará, Capitão Poço, c. 200 km east of Belém, Experimental Station Embrapa, from soil in virgin forest, Feb. 1989, L. Pfening (holotype CBS H-4380, culture ex-type CBS 198.89). — CUBA, Habana,



Fig. 59 *Parvothecium terrestre* (CBS 198.89). a. Sporodochial conidiomata on SNA; b. sporodochia; c. setae; d. conidiogenous cells; e. conidia. — Scale bars: b = 20 µm; c–e = 10 µm.

Santiago de las Vegas, from leaf litter of *Andira inermis*, 9 July 1987, R.F. Castañeda, CBS 534.88 = INIFAT C87/234.

***Peethambara*** Subram. & Bhat, Rev. Mycol. (Paris) 42: 52. 1978 — Fig. 60

= *Putagraivam* Subram. & Bhat, Proc. Indian Acad. Sci., B, 87: 103. 1978.

Description and illustration — See Subramanian & Bhat (1978a, b), Seifert 1985 and Rossman et al. (1999).

*Type species. Peethambara sundara* Subram. & Bhat, Rev. Mycol. (Paris) 42: 52. 1978.

= *Putagraivam sundarum* Subram. & Bhat, Proc. Indian Acad. Sci., B, 87: 103. 1978.

≡ *Didymostilbe sundara* (Subram. & Bhat) Seifert, Stud. Mycol. 27: 140. 1985.

Notes — Phylogenetic inference in this study placed the ex-type (CBS 646.77) of *P. sundara* in a well-supported clade, distantly related to the *Didymostilbe* clade and *Virgatospora* clade containing the second species, *P. spirostriata* as *V. echinofibrosa* (Fig. 2). Therefore, the sexual genus *Peethambara* is considered monotypic here. *Peethambara* and its asexual morph, *Putagraivam*, both contain a single species, however, the latter generic name is less commonly used in literature. Therefore, we choose to retain *Peethambara* and regard *Putagraivam* as synonym.

***Septomyrothecium*** Matsush., Bull. Natl. Sci. Mus. Tokyo 14: 469. 1971

?= *Nectria septomyrothecii* Samuels, Brittonia 40: 326. 1988.

*Type species. Septomyrothecium uniseptatum* Matsush., Bull. Natl. Sci. Mus. Tokyo 14: 470. 1971.

Description and illustration — See Matsushima (1971a, b), Samuels (1988) and Decock et al. (2008).

Notes — The genus *Septomyrothecium*, based on *S. uniseptatum* (Matsushima 1971a, b), is distinguished from *Myrothecium* s.str. by long dichotomously branched hyphoid extensions extending beyond the conidial masses, and some species producing 1-septate conidia (Matsushima 1971a, b, Decock et al. 2008). This genus includes two additional species, i.e. *S. maraitense* and *S. setiramosum* (Decock et al. 2008) of which the latter along with *M. dimorphum* (Watanabe et al. 2003) probably represents another new genus. Both these fungi produce mostly unbranched and thick-walled hypoid extensions that terminates in a group of 3–6 short protuberances (Castañeda 1986, Watanabe et al. 2003). However, no sequences or strains for both species were available during this study and their classification remains unresolved. Samuels (1988) was able to link the sexual morph *Nectria septomyrothecii* to *S. uniseptatum* based on morphology. However, the ex-type strain of this sexual morph is no longer viable (Samuels 1988) to confirm this connection.

***Sirastachys*** L. Lombard & Crous, *gen. nov.* — MycoBank MB816021

*Etymology.* Name reflects the characteristic rope-like (Greek = sira) synnematosus hyphae formed in culture by these fungi.

*Type species. Sirastachys phaeospora* L. Lombard & Crous.

*Sexual morph* unknown. *Synnemata* cylindrical, hyaline, slender to robust, straight to curved, consisting of bundles of parallel, longitudinal, closely compacted hyphae. *Conidiophores* arising laterally from synnemata, macronematous, mononematous, erect, solitary or in groups, unbranched or branched, thin-

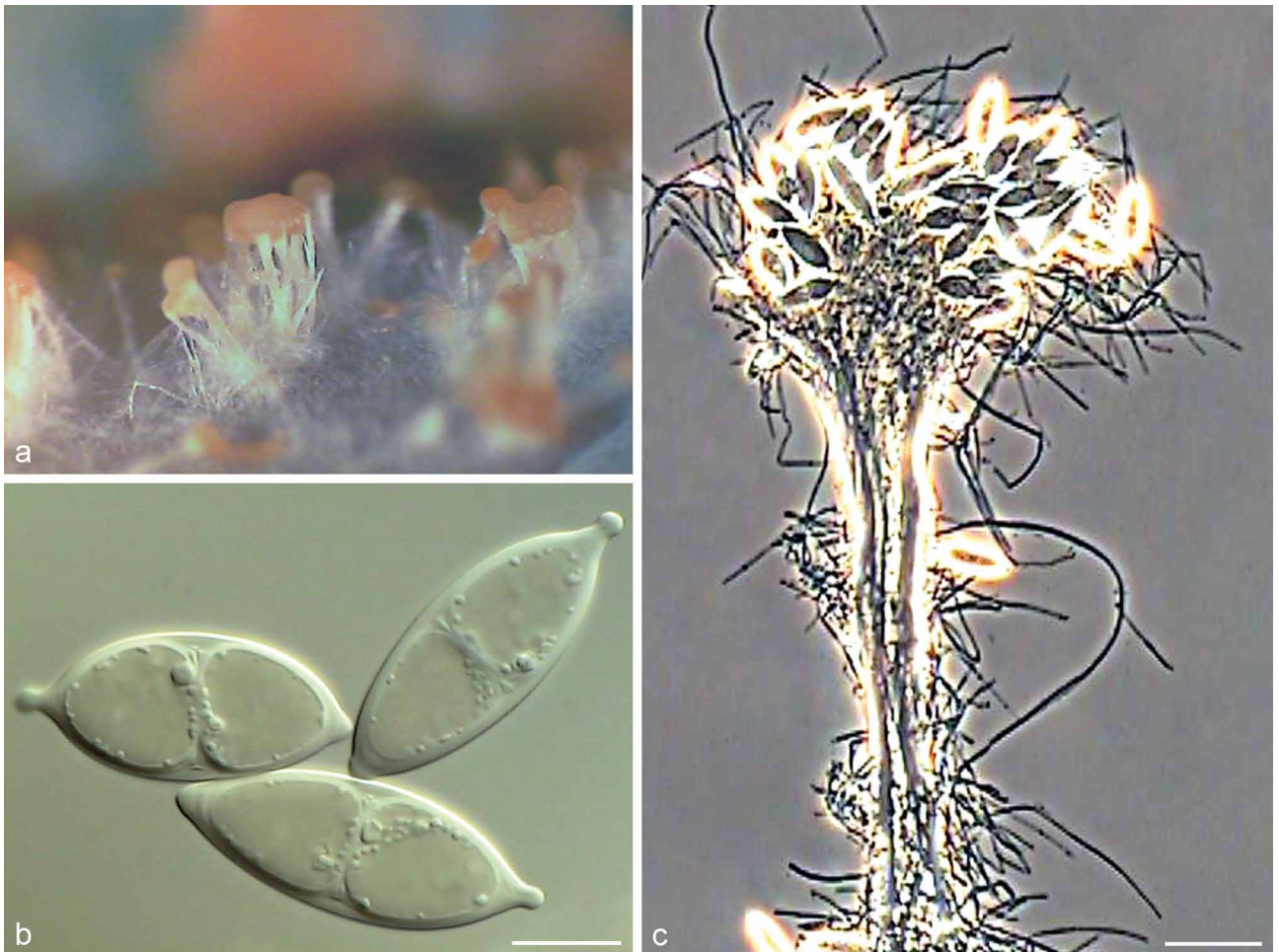


Fig. 60 *Peethambara sundara* (CBS 521.96). a. Synnemata on substrate; b. conidia; c. synnemata. — Scale bars: b = 10 µm; c = 50 µm.



walled or thick-walled, hyaline to pale olivaceous, smooth to verrucose, 1–3-septate, with an apical cluster of 6–12 conidiogenous cells. *Conidiogenous cells* phialidic, elongate doliiform to clavate to subclavate, smooth to slightly verrucose, hyaline to pale olivaceous, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline to pale olivaceous brown to dark brown, smooth to verrucose, ellipsoidal to obovoid to cylindrical, rounded at both ends.

Notes — The new asexual genus *Sirastachys* (*Si.*) is established here for a group of stachybotrys-like fungi characterised by the formation of synnemata in culture from which the conidiophores arise laterally. Phylogenetic inference in this study showed that members of this genus formed a well-supported clade distantly related to the *Stachybotrys* s.str. clade (Fig. 3). ITS sequence data placed the ex-type strain (ATCC 32451; Matsushima 1975, Wang et al. 2015) of *St. longispora* within the *Sirastachys* clade (Fig. 4), and therefore a new combination is provided for this species here.

***Sirastachys castanedae*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816022; Fig. 61

*Etymology.* Name honours eminent Cuban mycologist Dr. R.F. Castañeda, who collected the type of this fungus.

*Synnemata* cylindrical, hyaline, slender, straight to curved, consisting of bundles of parallel, longitudinal, closely compacted hyphae, 10–15 µm diam. *Conidiophores* macronematous, mononematous, single or in groups, unbranched or rarely branched once, erect, straight, 2–3(–4)-septate, thin-walled, smooth to verrucose, hyaline to olivaceous brown towards the apex, 45–90 × 3–5 µm, bearing a whorl of 4–8 conidiogenous cells. *Conidiogenous cells* terminal, elongate doliiform to clavate, hyaline to subhyaline, smooth to verrucose, 7–12 × 3–4 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* acrogenous, aseptate, obovoid, verrucose, darkly olivaceous to dark brown, (4–)4.5–5.5(–6) × 2–3 µm (av. 5 × 3 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white to pale luteous aerial mycelium forming



Fig. 61 *Sirastachys castanedae* (CBS 136403). a–b. Conidiophores; c. conidiogenous cells; d. conidia. — Scale bars: a = 20 µm (apply to b); c–d = 10 µm.

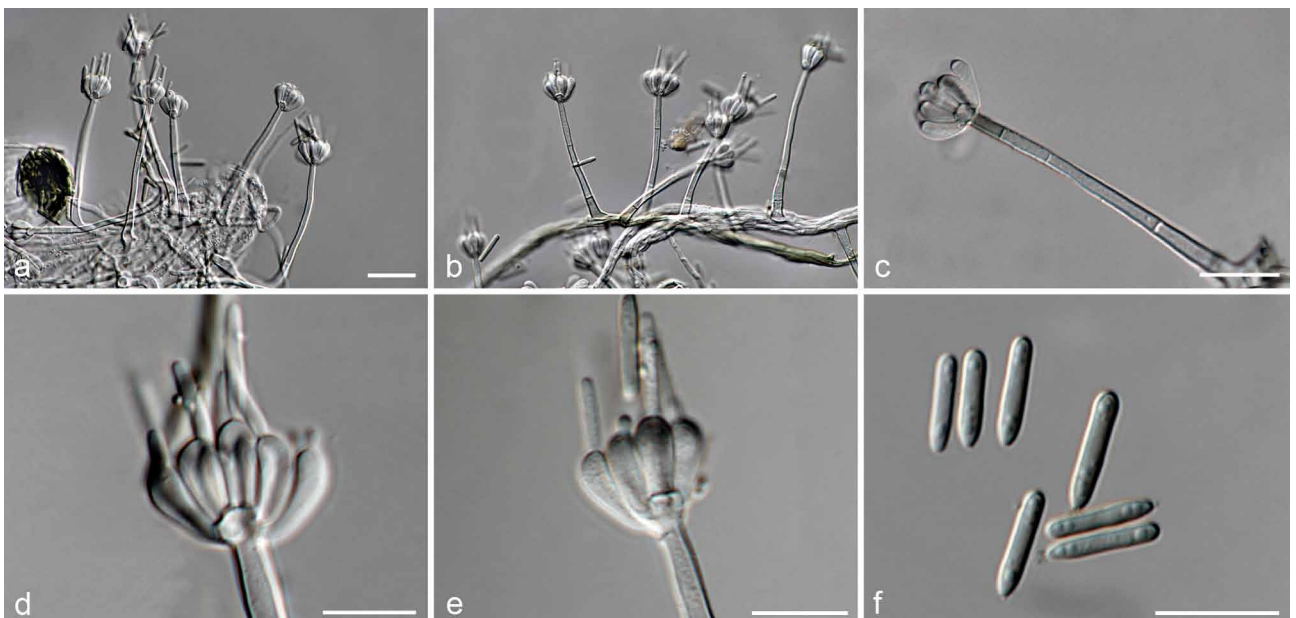


Fig. 62 *Sirastachys cylindrospora* (CBS 136166). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 10 µm (apply to b); c–f = 10 µm.

synnemata and immersed mycelium, buff to pale luteous, with abundant conidiophores forming on the synnemata, bearing slimy olivaceous green to mouse grey conidial masses, reverse on PDA pale luteous to sienna.

**Materials examined.** CANADA, Ontario, Aberfoyle, from soil under *Thuja occidentalis*, July 1964, G.C. Bhatt, CBS 531.69 = IMI 144477. – IRAN, West Azerbaijan Province, Urmia, from *Morus* sp., 2010, M. Arzanlou, CPC 20737. – SPAIN, from decaying leaf, July 1996, R.F. Castañeda-Ruiz (holotype CBS H-22457, culture ex-type CBS 136403 = MUCL 39994); from decaying leaf, July 1996, R.F. Castañeda-Ruiz, CBS 164.97.

**Notes** — *Sirastachys castaneda* formed a highly supported clade closely related to *Si. cylindrospora* and *Si. pseudolongispora* (Fig. 3). The conidiophores of *Si. castaneda* (up to 90 µm) are longer than those of *Si. cylindrospora* (up to 50 µm) and *Si. pseudolongispora* (up to 55 µm). The conidia of *Si. castaneda* ((4–)4.5–5.5(–6) × 2–3 µm (av. 5 × 3 µm)) are smaller than those of *Si. cylindrospora* ((7–)8.5–9.5(–10) × 2–3 µm (av. 9 × 2 µm)) and *Si. pseudolongispora* ((8–)9.5–10.5(–11) × 2 µm (av. 10 × 2 µm)).

***Sirastachys cylindrospora*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816023; Fig. 62

**Etymology.** Name reflects the cylindrical conidia produced by this fungus.

**Synnemata** cylindrical, hyaline, slender, straight to curved, consisting of bundles of parallel, longitudinal, closely compacted hyphae, 10–15 µm diam. **Conidiophores** macronematous, mononematous, single or in groups, unbranched, erect, straight, 2–3-septate, thin-walled, smooth, hyaline, 35–50 × 3–5 µm, bearing a whorl of 4–8 conidiogenous cells. **Conidiogenous cells** terminal, elongate doliiform to clavate, hyaline, smooth, 6–8 × 3–4 µm, with conspicuous collarettes and periclinal thickenings. **Conidia** acrogenous, aseptate, cylindrical, straight, hyaline, (7–)8.5–9.5(–10) × 2–3 µm (av. 9 × 2 µm), rounded at both ends.

**Culture characteristics** — Colonies on PDA, OA and CMA with abundant white aerial mycelium forming synnemata and immersed mycelium, buff to pale luteous, with abundant conidiophores forming on the synnemata, bearing slimy olivaceous green conidial masses, reverse on PDA pale luteous to sienna.

**Materials examined.** BRAZIL, from decaying leaf, Sept. 1997, R.F. Castañeda-Ruiz (holotype CBS H-22458, culture ex-type CBS 136166 = MUCL 41106 = INIFAT C98/42), CBS 136546 = MUCL 41088 = INIFAT C98/30.

**Notes** — *Sirastachys cylindrospora* formed a highly supported clade closely related to *Si. castaneda* and *Si. pseudolongispora* (Fig. 3). However, this species shares several morphological features with *Si. pseudolongispora*, and can be distinguished by the conidiophores that remain hyaline, where as those of *Si. pseudolongispora* become olivaceous brown towards the apex.

***Sirastachys longispora*** (Matsush.) L. Lombard & Crous, *comb. nov.* — MycoBank MB816024

**Basionym.** *Stachybotrys longispora* Matsush., Icon. Microfung. Matsush. Lect.: 145. 1975.

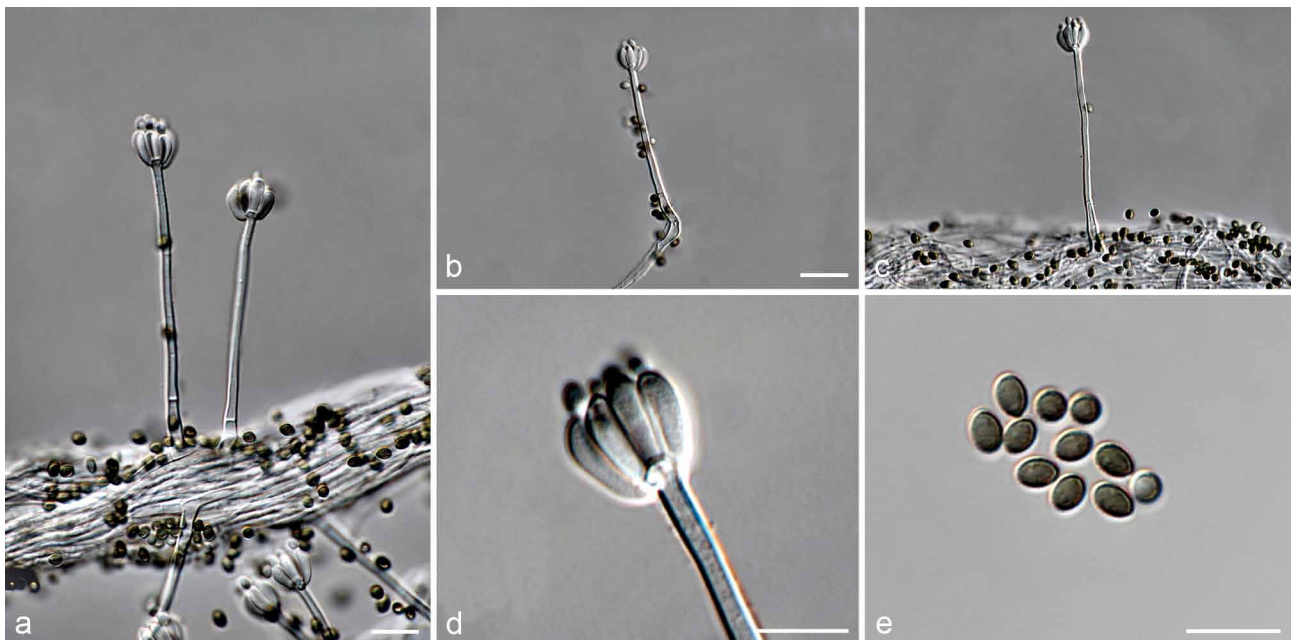
**Description and illustration** — See Matsushima (1975) and Wang et al. (2015).

**Notes** — The conidiophores of *Si. longispora* (up to 75 µm; Matsushima 1975) are longer than those of *Si. cylindrospora* and *Si. pseudolongispora* (both up to 50 µm). Furthermore, the conidia of *Si. longispora* are longer (8.8–12 × 2–2.4 µm; Matsushima 1975) than those of *Si. cylindrospora* and *Si. pseudolongispora*.

***Sirastachys pandanicola*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816025; Fig. 63

**Etymology.** Name reflects the host genus *Pandanus* from which this fungus was isolated.

**Synnemata** cylindrical, hyaline, robust, straight to curved, consisting of bundles of parallel, longitudinal, closely compacted hyphae, 15–45 µm diam. **Conidiophores** macronematous, mononematous, single or in groups, unbranched, erect, straight, 1–3-septate, thin-walled, smooth, hyaline, 55–75 × 3–5 µm, bearing a whorl of 4–8 conidiogenous cells. **Conidiogenous cells** terminal, elongate doliiform to clavate, hyaline, smooth, 6–9 × 2–4 µm, with conspicuous collarettes and periclinal thickenings. **Conidia** acrogenous, aseptate, obovoid to ellipsoidal, verrucose, darkly olivaceous, 3–4 × 2–3 µm (av. 4 × 2 µm), rounded at both ends.



**Fig. 63** *Sirastachys pandanicola* (CBS 136545). a–c. Conidiophores; d. conidiogenous cells; e. conidia. — Scale bar: a, d, e = 10 µm; b = 20 µm (apply to c).



Culture characteristics — Colonies on PDA, OA and CMA with abundant white aerial mycelium forming synnemata, with abundant conidiophores forming on the synnemata, bearing slimy olivaceous green conidial masses, reverse on PDA buff to pale luteous.

*Material examined.* SINGAPORE, MacRitchie Nature Reserve, from decaying leaf of *Pandanus* sp., 2008, O. Laurence (holotype CBS H-22459, culture ex-type CBS 136545 = MUCL 49906).

Notes — *Sirastachys pandanicola* formed a single lineage basal to the *Si. phaeospora* clade (Fig. 3). This species can be distinguished from *Si. phaeospora* by its shorter (up to 45 µm) conidiophores compared to those of *Si. phaeospora* (up to 65 µm).

***Sirastachys phaeospora*** L. Lombard & Crous, sp. nov. — MycoBank MB816026; Fig. 64

*Etymology.* Name reflects the dark brown conidia produced by this fungus.

*Synnemata* cylindrical, hyaline, slender to robust, straight to curved, consisting of bundles of parallel, longitudinal, closely compacted hyphae, 10–65 µm diam. *Conidiophores* macro-nematous, mononematous, single or in groups, unbranched or branched once, erect, straight, 1–2(–3)-septate, thin-walled, smooth to verrucose, hyaline, 40–65 × 3–5 µm, bearing a whorl of 4–8 conidiogenous cells. *Conidiogenous cells* terminal, elongate doliiform to clavate, hyaline, smooth to slightly verrucose, 7–9 × 2–4 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* acrogenous, aseptate, obovoid to ellipsoidal, verrucose, darkly olivaceous to dark brown, 4–5 × 2–3 µm (av. 4 × 3 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with abundant aerial mycelium forming synnemata and immersed mycelium, ochreous to amber, with abundant conidiophores forming on the synnemata, bearing slimy mouse grey conidial masses, reverse on PDA ochreous to sienna.

*Materials examined.* BRAZIL, Mata Atlântica, João Pessoa, from decaying leaf of unknown host, Sept. 1997, R.F. Castañeda-Ruiz, CBS 136167 = MUCL

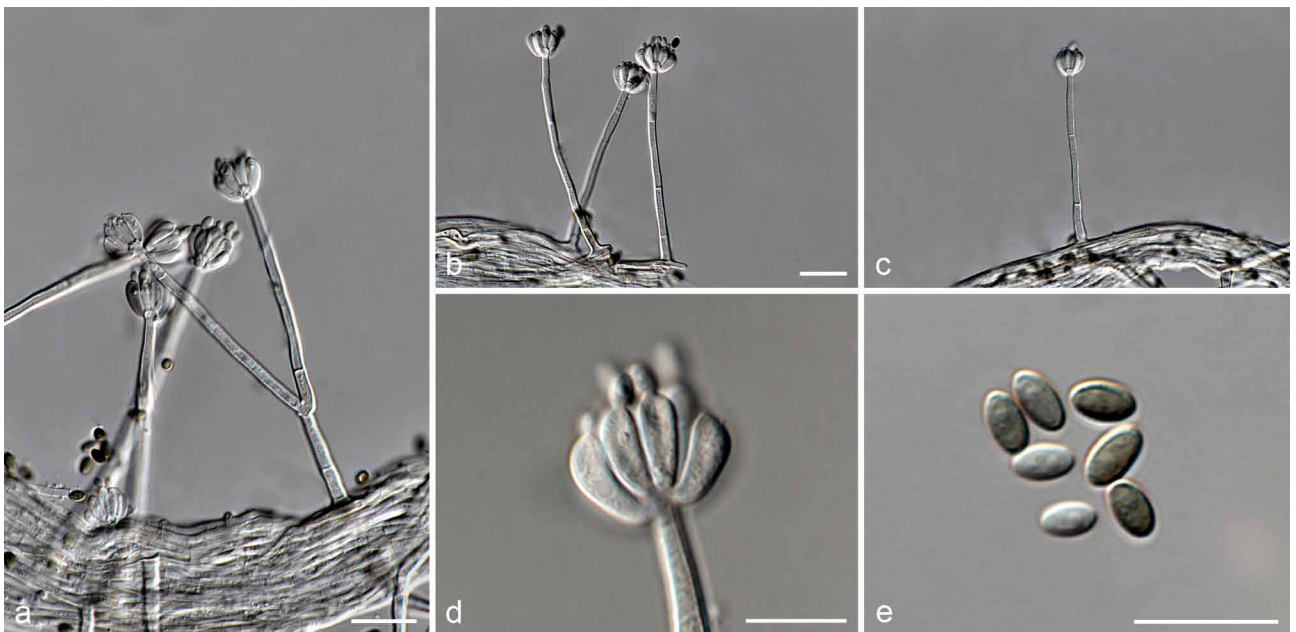


Fig. 64 *Sirastachys phaeospora* (CBS 100155). a–c. Conidiophores; d. conidiogenous cells; e. conidia. — Scale bars: a, d–e = 10 µm; b = 20 µm.



Fig. 65 *Sirastachys phyllophila* (CBS 136169). a–b. Conidiophores; c. conidiogenous cells; d. conidia. — Scale bars = 10 µm.

41195; Rio Tinto, from decaying leaf of unknown host, Sept. 1997, R.F. Castañeda-Ruiz, CBS 136185 = MUCL 41191. — CUBA, Trinidad, from decaying leaves in rain forest, Jan. 1996, J. Guarro (holotype CBS H-22460, culture ex-type CBS 100155). — SOUTH AFRICA, Western Cape Province, from *Cycas* sp., 1 Jan. 2008, P.W. Crous, CPC 16092, 16093. — THE NETHERLANDS, Wageningen, from soil, Apr. 1975, J.A. Stalpers, CBS 253.75.

Notes — *Sirastachys phaeospora* formed a well-supported clade closely related to *Si. pandanicola* (Fig. 3). For morphological differences see notes under *Si. pandanicola*.

***Sirastachys phyllophila*** L. Lombard & Crous, sp. nov. — MycoBank MB816027; Fig. 65

*Etymology.* Name reflects the substrate, plant debris (Greek = phyllophilus), from which this fungus was isolated.

*Synnemata* not observed. *Conidiophores* macronematous, mononematous, single or in groups, unbranched, erect, straight, 1–3-septate, thick-walled, smooth to slightly verrucose, hyaline, 80–150 × 3–5 µm, bearing a whorl of 6–12 conidiogenous cells. *Conidiogenous cells* terminal, elongate doliiform to clavate, hyaline, smooth to slightly verrucose, 7–11 × 2–4 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* acrogenous, aseptate, ellipsoidal, verrucose, darkly olivaceous, 4–5 × 2–3 µm (av. 5 × 2 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with immersed mycelium, pale luteous, with abundant conidiophores forming on the surface of the medium, bearing slimy mouse grey conidial masses, reverse on PDA sienna to luteous.

*Materials examined.* SPAIN, from decaying leaves, July 1996, R.F. Castañeda (holotype CBS H-22461, culture ex-type CBS 136169 = MUCL 39919), CBS 173.97.

Notes — *Sirastachys phyllophila* formed a highly supported clade (Fig. 3) and is the only species for which no synnemata were observed in culture. Additionally, *Si. phyllophila* produced the longest conidiophores (up to 150 µm) compared to the other species in this genus.

***Sirastachys pseudolongispora*** L. Lombard & Crous, sp. nov. — MycoBank MB816028; Fig. 66

*Etymology.* Name reflects the morphological similarity to *Sirastachys longispora*.

*Synnemata* cylindrical, hyaline, slender to robust, straight to curved, consisting of bundles of parallel, longitudinal, closely compacted hyphae, 10–55 µm diam. *Conidiophores* macronematous, mononematous, single or in groups, unbranched or branched, erect, straight, 1–2-septate, thin-walled, smooth to slightly verrucose, hyaline or olivaceous brown becoming paler towards the base, 35–50 × 3–5 µm, bearing a whorl of 4–8 conidiogenous cells. *Conidiogenous cells* terminal, elongate doliiform to clavate, hyaline to olivaceous brown, smooth to verrucose, 6–8 × 3–4 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* acrogenous, aseptate, cylindrical, smooth, hyaline to olivaceous brown, (8–)9.5–10.5(–11) × 2 µm (av. 10 × 2 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with abundant aerial mycelium forming synnemata and immersed mycelium, ochreous to sienna, centre brown vinaceous, with abundant conidiophores forming on the synnemata, bearing slimy olivaceous green to mouse grey conidial masses, producing a pale luteous exudate diffusing into the media, reverse on PDA ochreous to sienna.

*Materials examined.* CUBA, Trinidad, from decaying leaves in rain forest, Jan. 1996, J. Guarro (holotype CBS H-22462, culture ex-type CBS 100154); La Habana, from leaf litter, 6 May 1993, R.F. Castañeda, CBS 417.93 = INFAT C93/213-3.

Notes — *Sirastachys pseudolongispora* formed a well-supported clade (Fig. 3) and is the only species that produced a pale luteous extracellular pigment into the media.

***Smaragdiniseta*** L. Lombard & Crous, gen. nov. — MycoBank MB816029

*Etymology.* Name reflects the characteristic emerald green setae surrounding the sporodochia.

*Type species.* *Smaragdiniseta bisetosa* (V.G. Rao & de Hoog) L. Lombard & Crous.

*Sexual morph* unknown. *Conidiomata* sporodochial, stromatic, superficial, cupulate, scattered to gregarious, oval to elongate or irregular in outline, surrounded by two types of setae inclosing an olivaceous green to dark green slimy mass of conidia. *Stroma* well developed, hyaline, of *textura globulosa* or *textura angularis*. *Type I setae* compacted, thick-walled, verrucose, emerald green. *Type II setae* originating from the marginal hyphae, hyaline, septate, thick-walled, smooth to lightly verru-

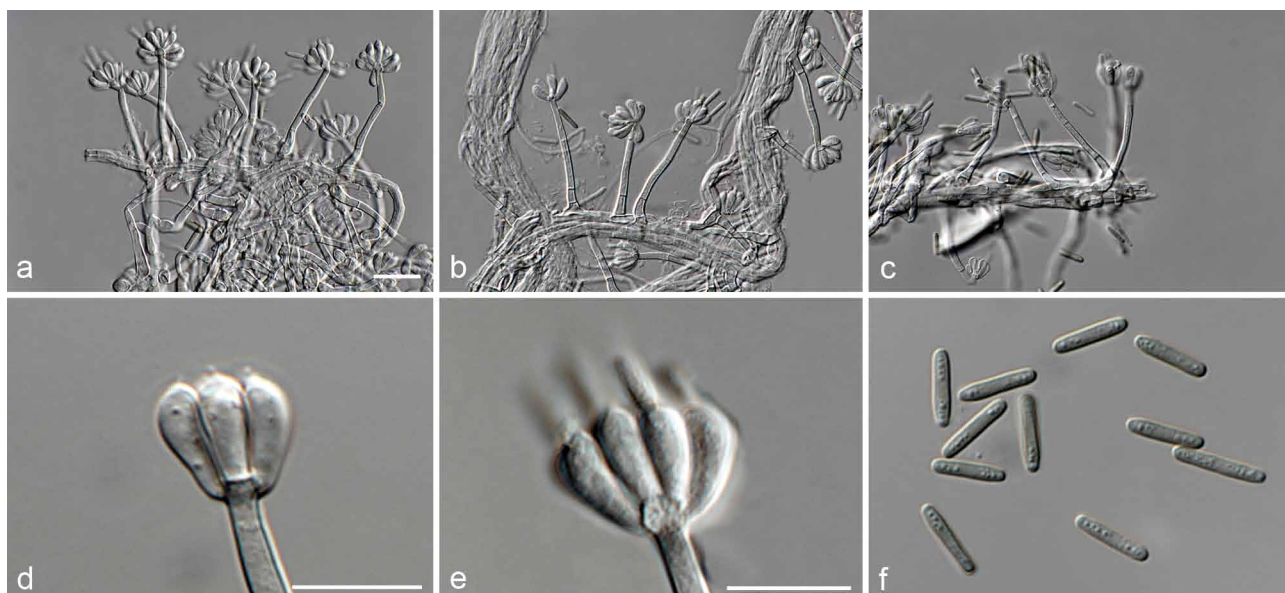


Fig. 66 *Sirastachys pseudolongispora* (CBS 100154). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 10 µm (apply to b–c); d–f = 10 µm.



cose, tapering to an obtuse apice, soon becoming overgrown by setae of the first type. *Conidiophores* macronematous, irregularly, verticillately or penicillately branched, hyaline, smooth. *Conidiogenous cells* phialidic, hyaline, smooth, cylindrical, becoming narrowed at the tip, without conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, obclavate to narrowly ellipsoidal, hyaline, smooth (adopted from Rao & De Hoog 1983).

Notes — Based on phylogenetic inference in this study, the ex-type strain (CBS 459.82) of *Myr. bisetosum* formed a single lineage sister to the *Albifimbria* clade, distant to the *Myrothecium* s.str. clade (Fig. 1, 2). Therefore, the monotypic genus *Smaragdinisetia* is introduced here and *Myr. bisetosum* is provided with a new combination below. *Smaragdinisetia* can be distinguished from members of *Albifimbria* by the formation of two types of setae and conidia lacking a funnel-shaped mucoid apical appendage.

***Smaragdinisetia bisetosa*** (V.G. Rao & de Hoog) L. Lombard & Crous, *comb. nov.* — MycoBank MB816030

*Basionym.* *Myrothecium bisetosum* V.G. Rao & de Hoog, *Persoonia* 12: 99. 1983.

Description and illustration — See Rao & De Hoog (1983).

*Material examined.* INDIA, Adilabad, Pranheeta Valley, on inner side of rotten bark, 16 Jan. 1981, V. Rao & A.C. Rao, ex-type CBS 459.82 (sterile).

***Stachybotrys*** Corda, *Icon. Fungorum* 1: 21. 1837

= *Gliobotrys* Höhn., *Sber. Akad. Wiss. Wien Math.-naturw. Kl., Abt I*, 111: 1048. 1902.

= *Hyalobotrys* Pidopl., *Mykrobiol. Zh. Kiev* 9, 2–3: 55. 1948.

= *Hyalostachybotrys* Sriniv., *J. Indian Bot. Soc.* 37: 340. 1958.

= *Ornatipora* K.D. Hyde, Goh, J.E. Taylor & J. Fröhl., *Mycol. Res.* 103: 1432. 1999.

*Type species.* *Stachybotrys chartarum* (Ehrenb.) S. Hughes.

*Ascomata* perithecial, superficial except at the base, stromatic, solitary or occasionally in pairs, subglobose to obpyriform, black, surface glabrous, papillate ostiolar region without periphyses, with setae irregularly arranged over the surface. *Ascomatal wall* consisting of a single layer of *textura angularis*. *Setae* erect, irregularly flexuous, brown fading towards the apex, thick-walled, septate, smooth or verrucose, with a rounded apex, infrequently branching towards the apex, sometimes developing into fertile conidiophores. *Asci* clavate, 8-spored, apex rounded to nearly truncate with a refractive apical ring. *Ascospores* cylindrical, 1-septate, subhyaline, verrucose, with slightly tapering apices, surrounded by a thick mucoid sheath (adapted from Hyde et al. 1999, Whitton et al. 2012). *Conidiophores* macronematous, mononematous, erect, solitary or in groups, unbranched or branched, thin-walled, hyaline to olivaceous brown, smooth or verrucose, 1–2(–4)-septate, with 3–12 conidiogenous cells radiating from the apex. *Conidiogenous cells* phialidic, subcylindrical to clavate to fusiform to elongate doliiform, smooth to verrucose, hyaline to olivaceous brown, with conspicuous collarettes. *Conidia* aseptate, initially hyaline becoming olivaceous brown to dark brown, smooth to verrucose, thick-walled, ellipsoidal to globose to fusiform to limoniform, rounded at both ends or with an apical hilum.

Notes — Phylogenetic inference in this study clearly illustrates the polyphyletic nature of *Stachybotrys* s.l., resulting in the segregation of this genus into 10 genera, which is also supported by morphological observations. Therefore, the generic concept for *Stachybotrys* s.str. is restricted to include only species characterised by conidiophores branching at the basal

septum and the formation of thick-walled conidia sometimes bearing ornamentations. *Stachybotrys chartarum* is the type species of the genus, for which no living type material presently exists. Hughes (1958) was able to study the holotype of *Stilbospora chartarum* (= *St. chartarum*; Ehrenberg 1818) lodged at UPS, which can no longer be located at UPS (I.O. Iburguren, pers. comm.). However, a slide made by Hughes, of Ehrenberg's holotype material, was located at DAOM and preserved as DAOM 51026. This slide was studied and compared with CBS 182.80, an isolate obtained from cheese wrapping in the Netherlands. The structures observed in the type slide were identical to those observed in CBS 182.80. Hence, we designate CBS 182.82 as epitype for *St. chartarum*.

***Stachybotrys aloeticola*** L. Lombard & Crous, *Persoonia* 32: 283. 2014

Description and illustrations — See Crous et al. (2014).

*Materials examined.* SOUTH AFRICA, Eastern Cape Province, Grahamstown, on *Aloe* sp., 26 July 2011, P.W. Crous, CBS 137940 = CPC 19705 (ex-type of *Stachybotrys aloeticola*), CBS 137941 = CPC 19706.

Notes — *Stachybotrys aloeticola* formed a highly supported clade closely related to *St. reniformis* (Fig. 3).

***Stachybotrys chartarum*** (Ehrenb.) S. Hughes, *Canad. J. Bot.* 36: 812. 1958 — Fig. 67

= *Stilbospora chartarum* Ehrenb., *Sylv. Mycol. Berol.*: 9, 21. 1818.

= *Oidium chartarum* (Ehrenb.) Link, *Linn. Spec. Plant.* IV, 6: 124. 1824.

= *Oospora chartarum* (Ehrenb.) Wallr., *Fl. Crypt. Germ.* 2: 184. 1833.

= *Stachybotrys atra* Corda, *Icon. Fungorum* 1: 21. 1837.

= *Synsporium biguttatum* Preuss, *Klotzsch. Herb. Vivum. Mycol. No.* 1285. 1849.

= *Memnonium sphaerospermum* Fuckel, *Symb. Mycol.*: 358. 1870.

(for more synonymies see Wang et al. 2015)

*Typification.* GERMANY, Leipzig, C.G. Ehrenberg, in *charta emporetica putrida; domi*, 1818 (UPS, holotype of *Stilbospora chartarum* – missing; slide of holotype ex-UPS = DAOM 51026). – THE NETHERLANDS, from cheese wrapping, 1980, collector unknown (epitype of *Stilbospora chartarum* designated here, CBS H-18496, MBT204311, culture ex-epitype CBS 182.80).

*Ascomata* not observed. *Conidiophores* macronematous, mononematous, single or in groups, thin-walled, unbranched or branched, erect, straight to slightly flexuous, subhyaline to olivaceous brown, 1–3(–4)-septate, smooth, 40–110 × 3–6 µm, bearing 3–6 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to subclavate, subhyaline to olivaceous brown, smooth, 9–14 × 3–6 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, ellipsoidal to subcylindrical, thick-walled, olivaceous brown to dark brown, verrucose, (8–)8.5–9.5(–11) × (3–)3.5–4.5(–5) µm (av. 9 × 4 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with immersed mycelium, buff to pale luteous, with conidiophores forming on the surface of the medium, carrying slimy mouse grey to black conidial masses, reverse on PDA rosy vinaceous to salmon.

*Additional materials examined.* BELGIUM, Fagnolles, from wall-paper, 1990, G.L. Hennebert, CBS 136189 = MUCL 30782; Hacquegnies, from mouldy wall-paper in moist house, Aug. 1963, G.L. Hennebert, CBS 136174 = MUCL 21588, CBS 136163 = MUCL 3820; Heverlee, from humid soil in greenhouse, June 1971, B. Desai, CBS 136161 = MUCL 18140; Leuven, from cardboard in garden, Aug. 1961, V. Estienne, CBS 136400 = MUCL 2538; from mouldy wall-paper in house, Sept. 1956, V. Estienne, CBS 136159 = MUCL 308; Louvian-la-Neuve, from gyproc plate, May 1986, G.L. Hennebert, CBS 136186 = MUCL 28869. – CANADA, Ontario, Toronto, Manulife Centre, from mouldy drywall, Nov. 1996, J. Scott, CBS 136172 = MUCL 40562; Ottawa, from *Anthracobia* sp., date and collector unknown, CBS 136188 = MUCL 2443; Québec, substrate unknown, Feb. 1970, G. Ola'h, CBS 136176 = MUCL 15918. – CUBA, from leaf litter, 1996, R.F. Castañeda-Ruiz, CBS 492.96. – DEN-



**Fig. 67** *Stachybotrys chartarum*. a–c. DAOM 51026. a. Conidiophore; b. conidia; c. conidiogenous cells. — d–i. CBS 182.80; d–h. Conidiophores; i. conidia. — Scale bars: a–c = 10  $\mu$ m (apply to g–h); d = 20  $\mu$ m (apply to e–f); i = 10  $\mu$ m.

MARK, Copenhagen, from paint, May 1992, collector unknown, CBS 109288; from building material, 20 Jan. 1997, K.F. Nielsen, CBS 109289. — ENGLAND, Birmingham, from cotton fabric, 1960, R.M. Everett, CBS 101146. — FINLAND, Helsinki, from water-damaged fibre board, 2001, J. Peltola, CBS 109563; from water-damaged gypsum liner board, CBS 109561, CBS 109562; Kuopio, from building material, 20 Mar. 2000, A. Hyvärinen, CBS 109292. — FRANCE, from sand dune, 1942, F. Moreau, CBS 177.42. — NORWAY, Tromsø, from air, 1992, A.-L. Klodiusen, CBS 215.92. — SPAIN, Poblet, Tarragona, from submerged rotten leaf, 3 Nov. 2002, R.F. Castañeda-Ruiz, CBS 112541. — SWITZERLAND, from soil, 1948, S. Blumer, CBS 485.48. — THE NETHERLANDS, from wilting *Clematis* sp., Mar. 1949, I. de Boer, CBS 363.49; from house, June 2005, J. Houbraken, CBS 119370. — USA, Ohio, Cleveland, from a house, 29 Oct. 1999, J. Simpson, CBS 109287, CBS 109290.

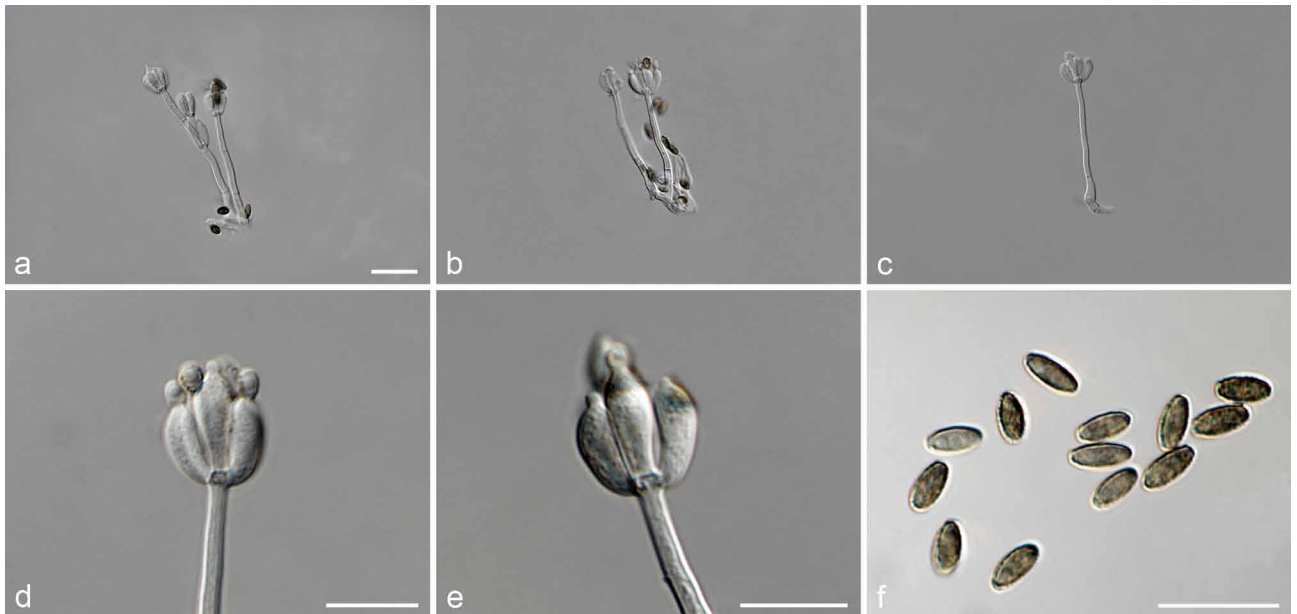
**Notes** — *Stachybotrys chartarum* formed a highly supported clade closely related to *St. chlorohalonata* (Fig. 3).

***Stachybotrys chlorohalonata*** B. Andersen & Thrane, Mycologia 95: 1228. 2003

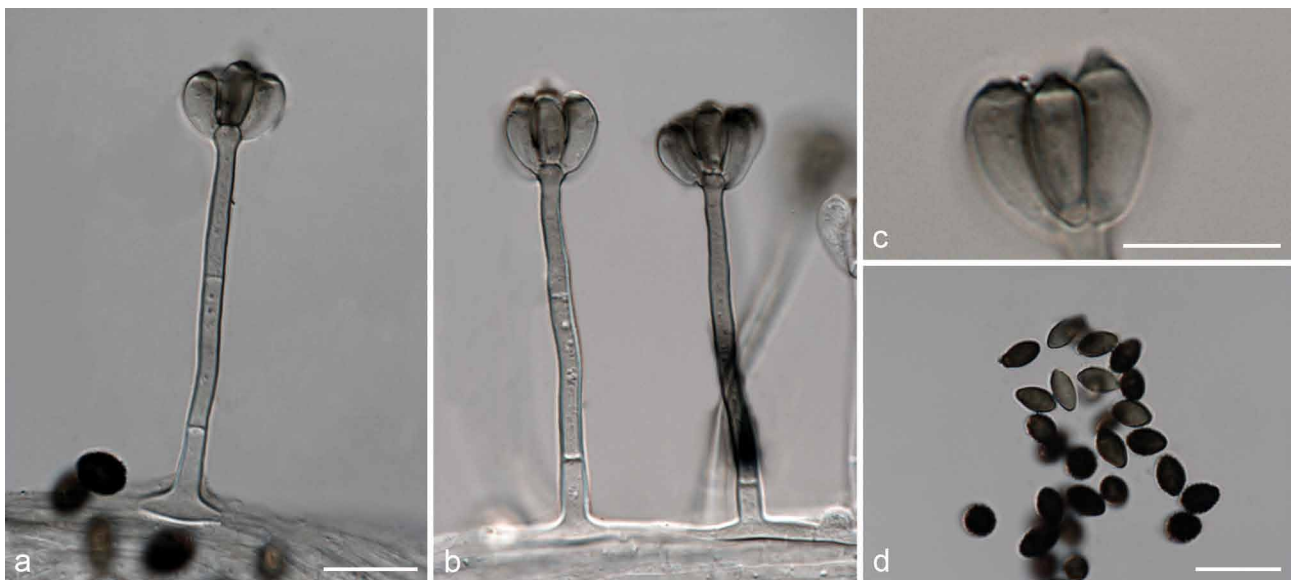
**Description and illustrations** — See Andersen et al. (2003).

**Materials examined.** BELGIUM, Gent, from soil, J. van Holder, CBS 136160 = MUCL 258. — CANADA, Ontario, Scarborough, Hildenboro Square, North of Finch, west of Warden Ave., from wood, paper and tile, 9 Dec. 1988, R.S. Khan, CBS 251.89. — DENMARK, Copenhagen, from building material, 20 Jan. 1997, K.F. Nielsen, CBS 109283; Lyngby, Technical University of Denmark, contamination on Petri dish, June 2000, B. Andersen, CBS 109281; Sjælland, from cardboard on gypsum board, Oct. 1997, K.F. Nielsen, CBS 109285 = IBT 9467 (ex-type culture of *Stachybotrys chlorohalonata*). — FINLAND, Jokioinen, Masku, from plastic of insulation wall in play room of day-care-centre, 1994, A. Hyvärinen, CBS 127.94. — ITALY, from paper, July 1937, O. Verona, CBS 330.37, CBS 328.37 = ATCC 18844. — NAMIBIA, South east of Swakopmund, near Gobabeb, from desert sand, 7 Jan. 1986, J.C. Krug, CBS 250.89. — PORTUGAL, Vilarinho, from plant debris, Nov. 2007, J. Capilla, R.F. Castañeda-Ruiz & C. Silvera, CBS 122763. — SINGAPORE, Bukit Timah Nature Reserve, from decayed wood, 2008, O. Laurence, CBS 136158 = MUCL 49910. — THE NETHERLANDS, from raw flax fibre, June 1946, R. Bok, CBS 222.46 = ATCC 18842. — TUNISIA, Sfax, Centre de Biotechnologie de Sfax, from contaminated paper in laboratory, Jan. 1995, A. Gargouri, CBS 608.94. — USA, substrate unknown, June 1935, N.F. Conant, CBS 341.35 = ATCC 18847 = MUCL 9477; New York, Ithaca, Campus of Cornell University, from rhizosphere of *Triticum aestivum*, 1962, J.W. Jooste, CBS





**Fig. 68** *Stachybotrys dolichophialis* (DAOM 227011). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 20  $\mu\text{m}$  (apply to b–c); d–f = 10  $\mu\text{m}$ .



**Fig. 69** *Stachybotrys limonispora* (CBS 128809). a–b. Conidiophores; c. conidiogenous cells; d. conidia. — Scale bars: a = 10  $\mu\text{m}$  (apply to b); c–d = 10  $\mu\text{m}$ .



**Fig. 70** *Stachybotrys phaeophialis* (KAS 525). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 10  $\mu\text{m}$  (apply to b); c–f = 10  $\mu\text{m}$ .

136194 = MUCL 4311; Wisconsin, from soil in willow-cottonwood forest, 1962, *M. Christensen*, CBS 129226.

Notes — Phylogenetic inference in this study agreed with the results obtained by Andersen et al. (2003), recognising *St. chlorohalonata* as a distinct species from *St. chartarum* (Fig. 3).

***Stachybotrys dolichophialis*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816031; Fig. 68

*Etymology.* Name reflects the elongated central conidiogenous cell characteristic of this fungus.

*Ascomata* not observed. *Conidiophores* macronematous, mononematous, single or in groups, thin-walled, unbranched, erect, straight to slightly flexuous, hyaline, 1–3-septate, smooth, 30–55 × 2–5 µm, bearing 4–12 conidiogenous cells with the central conidiogenous cell extending above the rest. *Conidiogenous cells* phialidic, clavate to subclavate, hyaline, smooth, 7–11 × 3–4 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, ellipsoidal to fusiform, thick-walled, olivaceous brown to dark brown, verrucose, (5–)5.5–6.5(–7) × 2–3 µm (av. 6 × 3 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white aerial mycelium forming concentric rings, with conidiophores forming on the aerial mycelium and surface of the medium, carrying slimy mouse grey to black conidial masses, reverse on PDA amber in the centre becoming pale luteous towards the margins.

*Material examined.* SOUTH AFRICA, KwaZulu-Natal, near KwamboNambi, from soil, 26 Jan. 1996, K.A. Seifert (holotype CBS H-22463, culture ex-type DOAMC 227011).

Notes — *Stachybotrys dolichophialis* formed a well-supported clade closely related to *St. chartarum* and *St. chlorohalonata* (Fig. 3). This species is characterised by the elongated central conidiogenous cell that extend above the rest, distinguishing it from the other species in the genus (McKenzie 1991, Pinruan et al. 2004, Wang et al. 2015).

***Stachybotrys limonispora*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816032; Fig. 69

*Etymology.* Name reflects the limoniform conidia produced by this fungus.

*Ascomata* not observed. *Conidiophores* macronematous, mononematous, single or in groups, thin-walled, unbranched, erect, straight to slightly flexuous, hyaline to subhyaline, 1–3-septate, smooth, 40–75 × 3–7 µm, bearing 3–6 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to subclavate, hyaline to subhyaline, smooth, 8–14 × 4–7 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, ellipsoidal to limoniform, thick-walled, olivaceous brown to dark brown, verrucose, (6–)6.5–7.5(–9) × 3–4 µm (av. 7 × 4 µm), rounded at the base with an apical hilum.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white aerial mycelium becoming immersed at the margins, with conidiophores forming on the aerial mycelium and surface of the medium, carrying slimy mouse grey to black conidial masses, reverse on PDA sienna to amber.

*Materials examined.* INDIA, Jaipur, Rajasthan, from twig of *Quisqualis indica*, Dec. 1971, G.L. Hennebert, CBS 136165 = MUCL 18730. — USA, Kansas, near Manhattan, Konza Prairie Research Area, Long-term Ecological Research site, from soil in tallgrass prairie, 1986, *M. Christensen* (holotype CBS H-22464, culture ex-type CBS 128809).

Notes — *Stachybotrys limonispora* is closely related to *St. subcylindrospora* (Jie et al. 2013) based on phyloge-

netic inference of the ITS sequence data (Fig. 4) but can be distinguished by the formation of characteristic limoniform conidia ((6–)6.5–7.5(–9) × 3–4 µm (av. 7 × 4 µm)) that are smaller than the cylindrical to subcylindrical conidia of *St. subcylindrospora* ((9.7–)11.6–13.8(–14.7) × (2.9–)3.8–4.6(–5) µm; Jie et al. 2013).

***Stachybotrys microspora*** (B.L. Mathur & Sankhla) S.C. Jong & E.E. Davis, Mycotaxon 3: 448. 1976

≡ *Stachybotrys atra* Corda var. *microspora* B.L. Mathur & Sankhla, Sci. & Cult. 32: 93. 1966.

Description and illustrations — See Jong & Davis (1976) and Wang et al. (2015).

*Material examined.* SUDAN, White Nile Island, from soil in *Mangifera* field, Mar. 1979, B.P.R. Vittal, CBS 186.79.

Notes — Phylogenetic inference of the ITS sequence data placed CBS 186.79 in a well-supported clade that included the epitype strain (ATCC 18852; Jong & Davis 1976) of *St. microspora* (Fig. 4), which was confirmed by morphological observations.

***Stachybotrys pallescens*** Y.L. Jiang & T.Y. Zhang, Mycosystema 28: 646. 2009

Description and illustrations — See Jiang & Zhang (2009).

Notes — Phylogenetic inference placed the ex-type strain (HGUP 0146; Jiang & Zhang 2009) of *St. pallescens* in the *Stachybotrys* s.str. clade (Fig. 1).

***Stachybotrys phaeophialis*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816033; Fig. 70

*Etymology.* Name reflects the darkly pigmented conidiogenous cells characteristic of this fungus.

*Ascomata* not observed. *Conidiophores* macronematous, mononematous, single or in groups, thin-walled, unbranched or branched once, erect, straight to slightly flexuous, hyaline to subhyaline, 1–3-septate, smooth to slightly verrucose, 20–40 × 3–4 µm, bearing 3–6 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to subclavate, subhyaline to pale olivaceous brown, smooth, 6–9 × 3–4 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, ellipsoidal to fusiform, thick-walled, olivaceous brown to dark brown, verrucose, (6–)6.5–7.5(–9) × 3–4 µm (av. 7 × 4 µm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with sparse white aerial mycelium, consisting mostly of immersed mycelium, buff to pale luteous, with conidiophores forming on the aerial mycelium and surface of the medium, carrying slimy mouse grey to black conidial masses, reverse on PDA sienna in the centre becoming pale luteous towards the margins.

*Material examined.* CHINA, specific location uncertain, from seed of unidentified herb imported into Canada, 1998, G.P. White no. M98-063a (CBS H-22465, culture ex-type = KAS 525).

Notes — *Stachybotrys phaeophialis* is phylogenetically closely related to *St. dolichophialis* (Fig. 3) and can be distinguished by their shorter conidiophores (up to 40 µm) terminating in subhyaline to pale olivaceous brown conidiogenous cells. The conidiophores of *St. dolichophialis* (up to 55 µm) terminate in hyaline conidiogenous cells.



***Stachybotrys reniformis*** Tubaki, Trans. Mycol. Soc. Japan 4: 86. 1963

?= *Stachybotrys nephrospora* Hansf., Proc. Linn. Soc. London 155: 44. 1943.

?= *Stachybotrys sinuatophora* Matsush., Bull. Natl. Sci. Mus., Tokyo 14: 476. 1971.

Description and illustrations — See Jong & Davis (1976) and Wang et al. (2015).

*Materials examined.* NEPAL, Narayani, Royal Chitwan National Park, from dead twig, C. Decock, CBS 136198 = MUCL 39087. — PAPUA NEW GUINEA, Central Province, Varirata National Park near Port Moresby, from soil in dry forest remnants, Oct. 1995, A. Aptroot, CBS 976.95.

Notes — Phylogenetic inference of the ITS sequence data placed both CBS 976.95 and CBS 136198 in a well-supported clade which included the ex-type strain (ATCC 18839) of *St. reniformis* (Fig. 4; Jong & Davis 1976). Jong & Davis (1976) synonymised both *St. nephrospora* and *St. sinuatophora* under *St. reniformis*. However, Wang et al. (2015) concluded, after examination of the various type materials, that these three species are not conspecific. Presently, there is no living type material available for *St. nephrospora* and no sequence data for the type (ATCC 22706; Jong & Davis 1976) of *St. sinuatophora* to determine whether these three species are truly conspecific or not.

***Stachybotrys subcylindrospora*** C.Y. Jie et al., Mycol. Progr. 12: 695. 2013

Description and illustration — See Jie et al. (2013).

Notes — Phylogenetic inference of the ITS sequence data (Fig. 4) placed the ex-type strain (HGUP 0201; Jie et al. 2013) of *St. subcylindrospora* in the *Stachybotrys* s.str. clade.

***Stachybotrys subreniformis*** Q.R. Li & Y.L. Jiang, Mycotaxon 115: 171. 2011

Description and illustrations — See Li & Jiang (2011).

Notes — Phylogenetic inference of the ITS sequence data showed that the ex-type strain (HGUP 1051; Li & Jiang 2011) of *St. subreniformis* is closely related to *St. chartarum* and *St. chlorohalonata* (Fig. 4).

***Stachybotrys subsylvatica*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816034; Fig. 71

*Etymology.* Name reflects the environment, soil in a woodland, from which this fungus was collected.

*Ascomata* not observed. *Conidiophores* macronematous, mononematous, single or in groups, thin-walled, unbranched, erect, straight to slightly flexuous, hyaline to subhyaline, 1–4-septate, smooth, 30–65 × 3–5 μm, bearing 3–6 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to subclavate, subhyaline to pale olivaceous brown at the apex, smooth, 6–11 × 4–6 μm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, ellipsoidal to limoniform, thick-walled, olivaceous brown to dark brown, verrucose, (5–)5.5–6.5(–7) × 3–4 μm (av. 6 × 4 μm), rounded at both ends.

Culture characteristics — Colonies on PDA, OA and CMA with mostly immersed mycelium, buff to pale luteous, with conidiophores forming on the surface of the medium, carrying slimy olivaceous green to mouse grey conidial masses, reverse on PDA pale luteous.

*Material examined.* NAMIBIA, Halali Rest Camp, south of Dolomite Hill, S19°02.189' E16°28.378', from soil in *Colophospermum mopane* woodland, Apr. 2001, M. Christensen (holotype CBS H-22466, culture ex-type CBS 126205).

Notes — *Stachybotrys subsylvatica* formed a single lineage closely related to *St. microspora* (Fig. 3) from which it can be distinguished by their slightly smaller conidia ((5–)5.5–6.5(–7) × 3–4 μm (av. 6 × 4 μm)) compared to those of *St. microspora* (6–8 × 5–5 μm; Jong & Davies 1976). The conidiophores of *St. subsylvatica* (up to 65 μm) are also longer than those reported for *St. microspora* (up to 55 μm; Jong & Davies 1976).

***Striatibotrys*** L. Lombard & Crous, *gen. nov.* — MycoBank MB816035

*Etymology.* Name reflects the characteristic striate conidia produced by these fungi.

*Type species.* *Striatibotrys eucylindrospora* (D.W. Li) L. Lombard & Crous.

*Ascomata* perithecial, scattered, subglobose to obpyriform, non-stromatic, totally immersed in host tissue, with only rounded papillate apex with setae protruding at surface of periderm, orange, not changing in KOH, completely covered by thick-walled

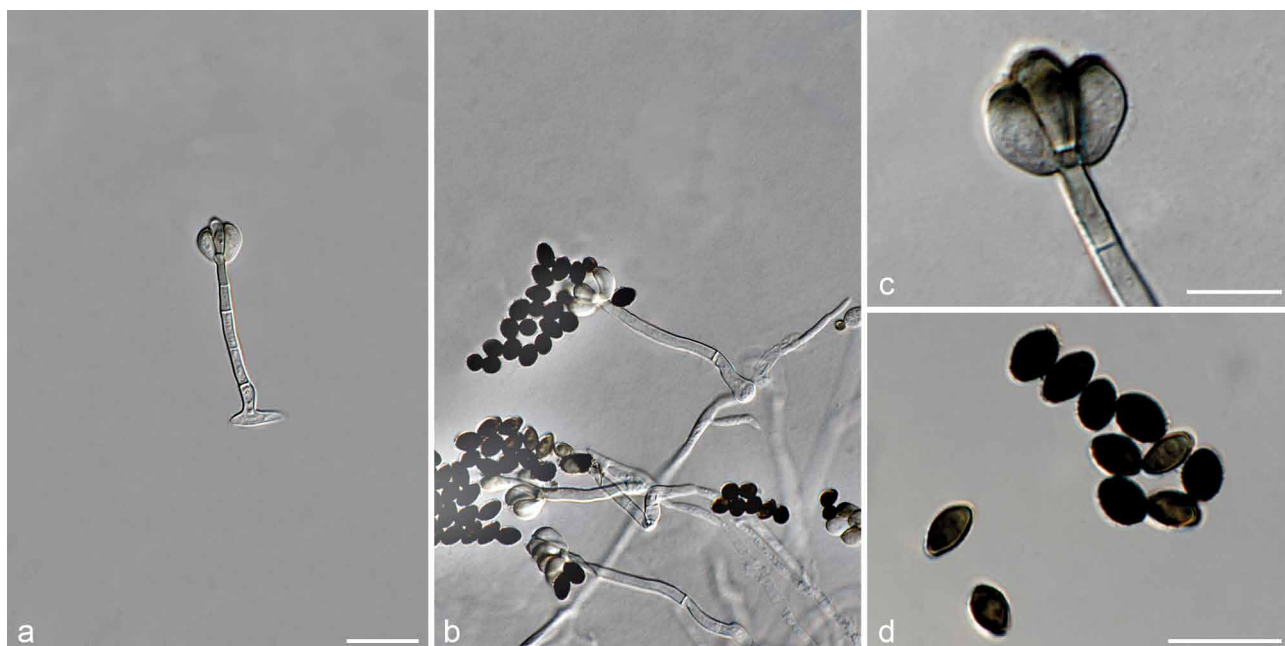


Fig. 71 *Stachybotrys subsylvatica* (CBS 126205). a–b. Conidiophores; c. conidiogenous cells; d. conidia. — Scale bars: a = 10 μm (apply to b); c–d = 10 μm.

intertwined hyphae, except at ostiolar region. *Setae* erect, hyaline, cylindrical, thick-walled, 1–2-septate, with rounded apex. *Ascomatal wall* consisting of a single layer of *textura globulosa*. *Asci* clavate, 8-spored, apex rounded to nearly truncate with a refractive apical ring. *Ascospores* ellipsoidal to fusiform, rounded at both ends, hyaline becoming orange en masse, verrucose. Paraphyses branched containing numerous oily droplets (adapted from Crous et al. 2013). *Conidiophores* macronematous, mononematous, erect, solitary or in groups, unbranched or branched once, thin-walled, hyaline to subhyaline with apex becoming olivaceous brown, smooth with the apex becoming verrucose, 1–5-septate, with an apical cluster of 3–6 conidiogenous cells. *Conidiogenous cells* phialidic, clavate to subclavate, smooth to slightly verrucose, hyaline to pale olivaceous brown, with conspicuous collarettes. *Conidia* aseptate, pale olivaceous to dark brown, smooth, longitudinally striate, ellipsoidal to subcylindrical to fusiform, rounded at the base with an apical hilum.

**Notes** — Phylogenetic inference in this study placed several stachybotrys-like fungi characterised by the formation of longitudinally striate conidia in a highly supported clade, distinct from the *Stachybotrys* s.str. clade (Fig. 1, 3). This clade also included the ex-type strains of *St. eucylindrospora* (CBS 203.61 = ATCC 18851; Li 2007) and *St. oleronensis* (CBS 137258; Crous et al. 2013), for which new combinations are provided in the newly established genus *Striatibotrys* (*Stri.*).

***Striatibotrys atypica*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816036; Fig. 72

**Etymology.** Name reflects the atypical morphology of this fungus.

**Ascomata** not observed. **Conidiophores** simple, macronematous, mononematous, single or in groups, thin-walled, unbranched, erect, straight, hyaline to subhyaline, 1-septate near the base, smooth, 20–40 × 3–4 μm, bearing 3–6 conidiogenous cells. **Conidiogenous cells** phialidic, subclavate with central cell becoming swollen and subglobose, hyaline to subhyaline, smooth, 6–10 × 3–6 μm, with conspicuous collarettes. **Conidia** acrogenous, aseptate, ellipsoidal to subcylindrical, olivaceous brown to dark brown, smooth, rarely longitudinally striate, (6–)7–9(–10) × 3–4 μm (av. 8 × 3 μm), with a rounded base and apical hilum.

**Culture characteristics** — Colonies on PDA, OA and CMA with immersed mycelium, buff to pale luteous, with conidiophores forming on the surface of the medium, carrying slimy mouse grey to black conidial masses, reverse on PDA buff to pale luteous.

**Material examined.** FRANCE, Domain Le Fraysse, from *Iris* sp., 16 July 2010, P.W. Crous (holotype CBS H-22468, culture ex-type CBS 141059 = CPC 18423).

**Notes** — *Striatibotrys atypica* formed a highly supported clade closely related to *Stri. oleronensis* (Fig 3). This species is morphologically an atypical species in this genus, rarely producing longitudinally striate conidia and having a central conidiogenous cell that becomes swollen.

***Striatibotrys eucylindrospora*** (D.W. Li) L. Lombard & Crous, *comb. nov.* — MycoBank MB816037

**Basionym.** *Stachybotrys eucylindrospora* D.W. Li, *Mycologia* 99: 333. 2007.

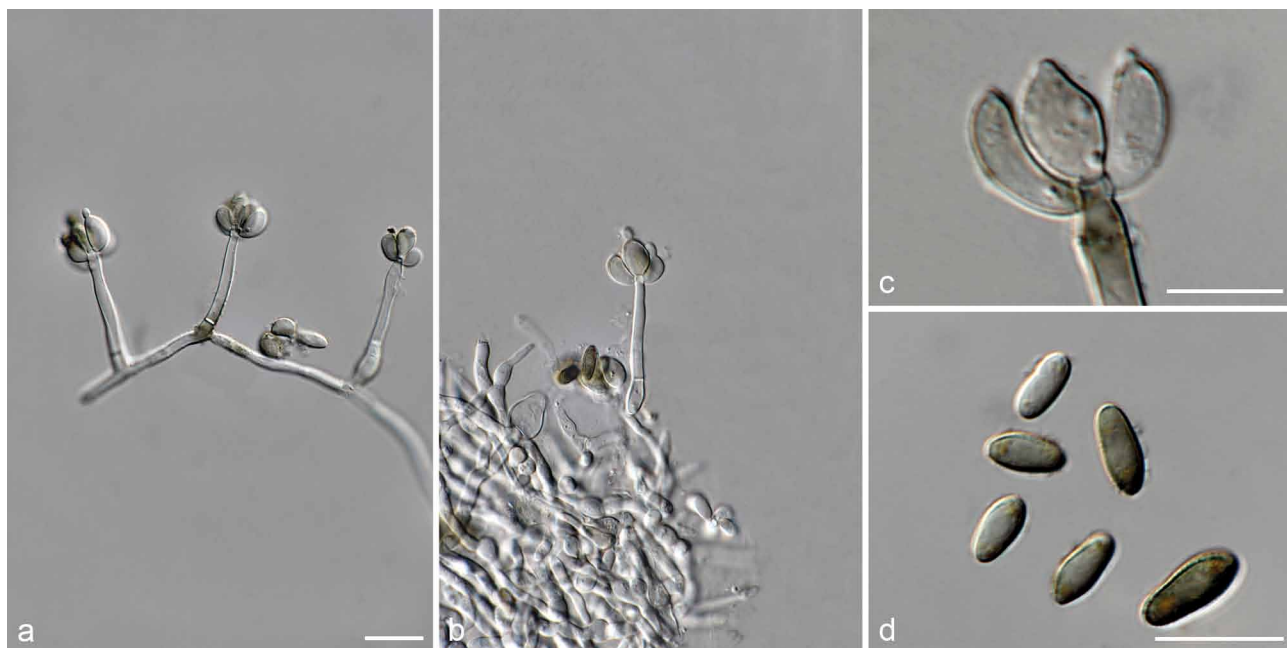
**Description and illustrations** — See Li (2007).

**Materials examined.** CANADA, Ontario, Guelph, from soil under *Thuja occidentalis*, Nov. 1960, G.L. Barron, CBS 203.61 = ATCC 18851 = IMI 085334 = MUCL 9483 (ex-type of *Stachybotrys eucylindrospora*); Aberfoyle area, from soil in a cedar forest, July 1964, G.C. Bhatt, CBS 136547 = MUCL 15039. — TURKEY, Izmir, Bornova, substrate unknown, 1972, collector unknown, CBS 949.72. — USA, New York, Ithaca, from plant debris, May 1962, G.L. Hennebert, CBS 136399 = MUCL 4251.

***Striatibotrys humicola*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816038; Fig. 73

**Etymology.** Name reflects the substrate, soil, from which this fungus was isolated.

**Ascomata** not observed. **Conidiophores** simple, macronematous, mononematous, single or in groups, thin-walled, unbranched, erect, straight to slightly flexuous, hyaline to subhyaline, 1-septate towards the base, smooth, 35–55 × 4–5 μm, bearing 3–6 conidiogenous cells. **Conidiogenous cells** phialidic, clavate, hyaline to subhyaline, smooth, 7–12 × 3–5 μm, with conspicuous collarettes. **Conidia** acrogenous, aseptate, fusiform, olivaceous brown to dark brown, smooth, longitudinally striate, (7–)7.5–8.5(–10) × (3–)3.5–4.5(–5) μm (av. 8 × 4 μm), with a rounded base and apical hilum.



**Fig. 72** *Striatibotrys atypica* (CBS 141059). a–b. Conidiophores; c. conidiogenous cells; d. conidia. — Scale bars: a = 20 μm (apply to b); c–d = 10 μm.





Fig. 73 *Striatibotrys humicola* (CBS 102408). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 10  $\mu$ m (apply to b–c); d–f = 10  $\mu$ m.

Culture characteristics — Colonies on PDA, OA and CMA with sparse white to pale luteous aerial mycelium, consisting mostly of immersed mycelium producing luteous exudates diffusing into the medium and luteous droplets forming on the aerial mycelium; conidiophores forming on the aerial mycelium and surface of the medium, carrying slimy mouse grey to black conidial masses, reverse on PDA sienna in the centre becoming luteous towards the margins.

*Material examined.* USA, Wyoming, Laramie, from soil, 1999, *M. Christensen* (holotype CBS H-22469, culture ex-type CBS 102408).

*Notes* — *Striatibotrys humicola* formed a single lineage in the *Striatibotrys* clade (Fig. 3). The conidiophores of *Stri. humicola* (up to 55  $\mu$ m) are shorter than those of *Stri. eucylindrospora* (up to 200  $\mu$ m; Li 2007), *Stri. rhabdospora* and *Stri. yuccae* (both up to 70  $\mu$ m).

*Striatibotrys oleronensis* (Lechat et al.) L. Lombard & Crous, *comb. nov.* — MycoBank MB816039

*Basionym.* *Stachybotrys oleronensis* Lechat et al., *Persoonia* 31: 283. 2013.

*Description and illustrations* — See Crous et al. (2013).

*Material examined.* FRANCE, Charente Maritime, Île d'Oléron, Saint Trojan, on leaf of *Iris pseudacorus*, 16 Apr. 2012, *M. Hairaud*, CBS 137258 = CIRM BRFM MH 160412 (ex-type of *Stachybotrys oleronensis*).

*Notes* — All attempts to induce the formation of the asexual morph of this fungus on the media defined in this study failed.

*Striatibotrys rhabdospora* L. Lombard & Crous, *sp. nov.* — MycoBank MB816040; Fig. 74

*Etymology.* Name reflects the longitudinally striate conidia produced by this fungus.

*Ascomata* not observed. *Conidiophores* simple, macronematous, mononematous, single or in groups, thin-walled, unbranched

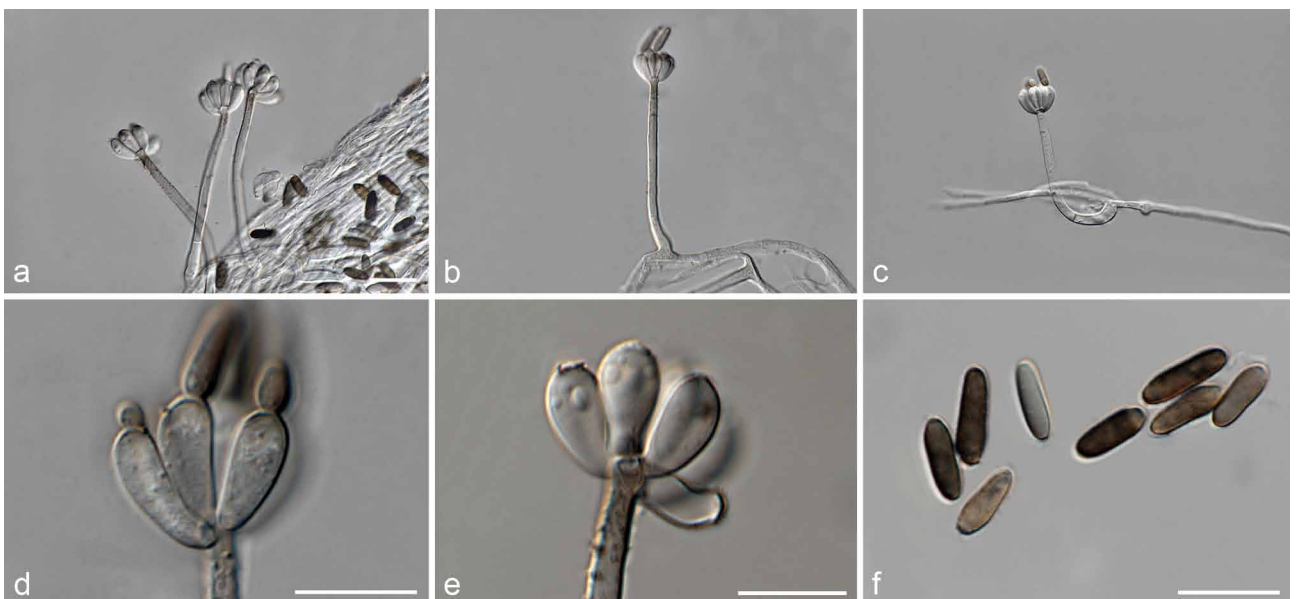


Fig. 74 *Striatibotrys rhabdospora* (CBS 528.80). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 20  $\mu$ m (apply to b–c); d–f = 10  $\mu$ m.

or branched once, erect, straight to slightly flexuous, smooth and hyaline at the base becoming subhyaline to pale olivaceous brown and verrucose at the apex, 1–2-septate, 50–70 × 4–6 µm, bearing 3–6 conidiogenous cells. *Conidiogenous cells* phialidic, clavate, hyaline to subhyaline, smooth, 8–10 × 4–6 µm, with conspicuous collarettes. *Conidia* acrogenous, aseptate, ellipsoidal to subcylindrical, olivaceous brown to dark brown, smooth, longitudinally striate, (9–)9.5–10.5(–11) × 3–4 µm (av. 10 × 3 µm), with a rounded base and apical hilum.

**Culture characteristics** — Colonies on PDA, OA and CMA with sparse white aerial mycelium, consisting of mostly immersed mycelium producing luteous exudates diffusing into the medium with conidiophores forming on the surface of the medium, carrying slimy mouse grey to black conidial masses, reverse on PDA luteous to pale luteous.

**Materials examined.** BELGIUM, Heverlee, from asbestos cement tile on building roof, Mar. 1969, G.L. Hennebert, CBS 136395 = MUCL 22116. — GERMANY, Kiel-Kitzeberg, Schleswig-Holstein, from soil under *Triticum* sp., K.H. Domsch, CBS 136168 = MUCL 6030; from soil, Oct. 1980, I.J. Kapoor (holotype CBS H-18492, culture ex-type CBS 528.80). — SPAIN, Asturias, Picos de Europa, Covadonga, from plant debris, Oct. 2006, A. Mercado & C. Silveira, CBS 121801 = FMR 9485. — SWITZERLAND, Flüeli, Schüpberg, from soil with *Trichophaea woolhopeia*, 14 Oct. 2005, H. Meier, CBS 119043. — USA, New York, Labrador Lake, from petiole of *Caltha palustris*, Apr. 1961, G.L. Hennebert, CBS 136396 = MUCL 2012.

**Notes** — *Striatobotrys rhabdospora* formed a well-supported clade (Fig. 3) and is morphologically similar to *Stri. yuccae*, but can be distinguished by the abundant luteous exudates produced in culture by *Stri. rhabdospora* which was not seen for *Stri. yuccae*.

***Striatobotrys yuccae*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816041; Fig. 75

**Etymology.** Name reflects the host genus *Yucca*, from which this fungus was isolated.

**Ascomata** not observed. **Conidiophores** simple, macronematous, mononematous, single or in groups, thin-walled, unbranched, erect, straight to slightly flexuous, hyaline to subhyaline, 1–2-septate, smooth to slightly verrucose at the apex, 40–70 × 3–6 µm, bearing 3–6 conidiogenous cells. **Conidiogenous cells** phialidic, clavate, hyaline to subhyaline, smooth, 7–11 × 3–5 µm, with conspicuous collarettes. **Conidia** acrogenous, aseptate, ellipsoidal to subcylindrical, olivaceous brown to dark

brown, smooth, longitudinally striate, 9–9.5(–11) × 3–4 µm (av. 9 × 3 µm), with a rounded base and apical hilum.

**Culture characteristics** — Colonies on PDA, OA and CMA with sparse white aerial mycelium, consisting mostly of immersed mycelium with conidiophores forming on the surface of the medium, carrying slimy mouse grey to black conidial masses, reverse on PDA mouse grey.

**Material examined.** THE NETHERLANDS, Baarn, Cantonspark, from old leaf of *Yucca flaccida*, Apr. 1968, W. Gams (holotype CBS H-22470, culture ex-type CBS 390.68).

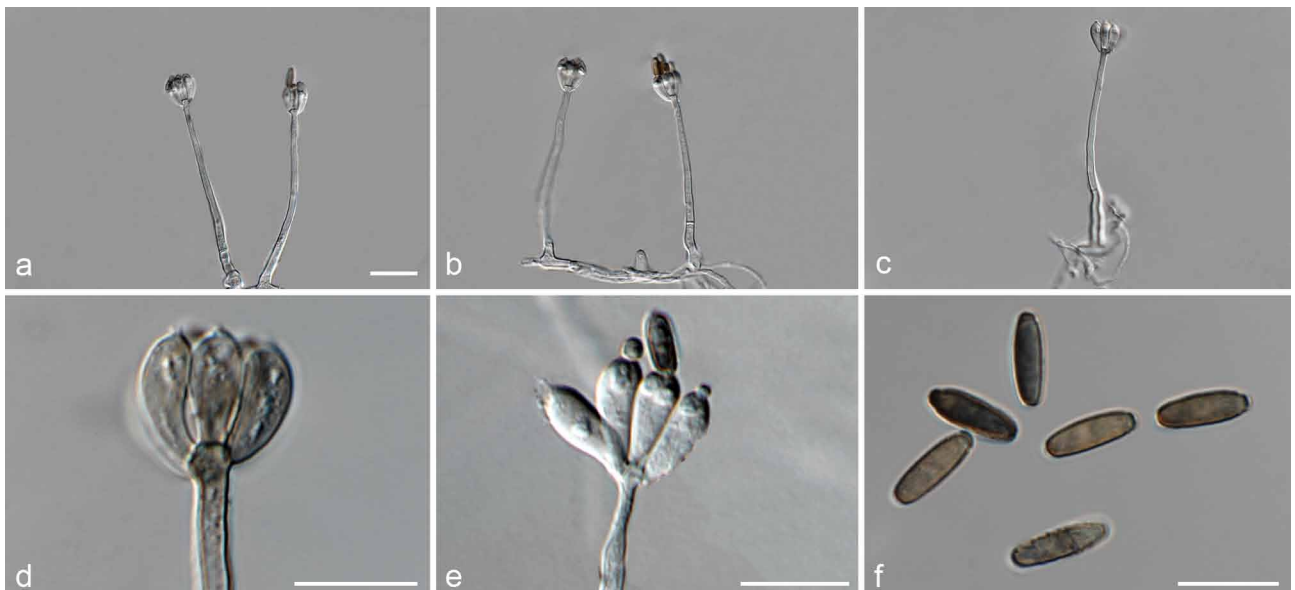
**Notes** — *Striatobotrys yuccae* formed a single lineage in the *Striatobotrys* clade with *Stri. humicola* as its closest phylogenetic neighbour (Fig. 3). The conidiophores of *Stri. yuccae* (up to 70 µm) are longer than those of *Stri. humicola* (up to 55 µm). Additionally, the conidia of *Stri. yuccae* (9–9.5(–11) × 3–4 µm (av. 9 × 3 µm)) are slightly longer than those of *Stri. humicola* ((7–)7.5–8.5(–10) × (3–)3.5–4.5(–5) µm (av. 8 × 4 µm)).

***Striaticonidium*** L. Lombard & Crous, *gen. nov.* — MycoBank MB816042

**Etymology.** Name reflects the characteristic striate conidia produced by these fungi.

**Type species.** *Striaticonidium cinctum* (Corda) L. Lombard & Crous.

**Sexual morph** unknown. **Conidiomata** synnematosus or sporodochial or reduced to simple conidiophores. **Synnemata** cylindrical to pyriform, unbranched, broadening towards the apex, consisting of bundles of parallel, longitudinal, closely compacted hyphae, terminating in whorls of 2–4 conidiogenous cells, covered by an olivaceous green to black slimy mass of conidia. Marginal hyphae of synnemata olivaceous green, verrucose, sinuous, terminating in a blunt apex. **Sporodochia** stromatic, superficial, scattered or gregarious, oval or irregular in outline, with a white to grey setose fringe surrounding an olivaceous green to dark green slimy mass of conidia. **Stroma** poorly- or well-developed, hyaline, of *textura globulosa* or *textura angularis*. **Simple conidiophores** consisting of conidiogenous cells arising directly from vegetative hypha, solitary or rarely in groups. **Setae** short, thin-walled, septate, sinuous, subhyaline to olivaceous green, verrucose, with an obtuse apice. **Conidiophores** macronematous, verticillately or penicillately branched, hyaline, smooth to verrucose. **Conidiogenous cells** phialidic, hyaline, smooth, cylindrical to subcylindrical, with conspicu-



**Fig. 75** *Striatobotrys yuccae* (CBS 390.68). a–c. Conidiophores; d–e. conidiogenous cells; f. conidia. — Scale bars: a = 10 µm (apply to b–c); d–f = 10 µm.



ous collarettes and periclinal thickenings. *Conidia* aseptate, fusiform to ellipsoidal, olivaceous green to brown, longitudinally striate, with an apical hilum lacking a funnel-shaped mucoid apical appendage.

Notes — The new asexual genus *Striaticonidium* (*Str.*) is introduced here for a group of myrothecium-like fungi characterised by striate conidia, which is further supported by phylogenetic inference in this study (Fig. 1, 2). Tulloch (1972) synonymised all *Myrothecium* species with striate conidia under *Myr. cinctum* based on the similarity in conidial dimensions and marginal ornamentation of the conidiomata. Nag Raj (1993) later synonymised *Myr. cinctum* under *Hymenopsis ellipsospora*, a species in a genus that requires taxonomic revision. We select to retain the epithet '*cinctum*' (1842) for the type species of *Striaticonidium* as it predates '*ellipsospora*' (1886) (Hawksworth 2012, McNeill et al. 2012) and designate an epitype for this species. Furthermore, a new combination is provided in *Striaticonidium* for this species.

***Striaticonidium brachysporum* (Nicot) L. Lombard & Crous, comb. nov.** — MycoBank MB816043; Fig. 76

*Basionym.* *Myrothecium brachysporum* Nicot, Rev. Gén. Bot. 68: 684. 1961.

= *Myrothecium ucrainicum* Pidopl., Mykrobiol. Zh. Kiev 31: 161. 1969.

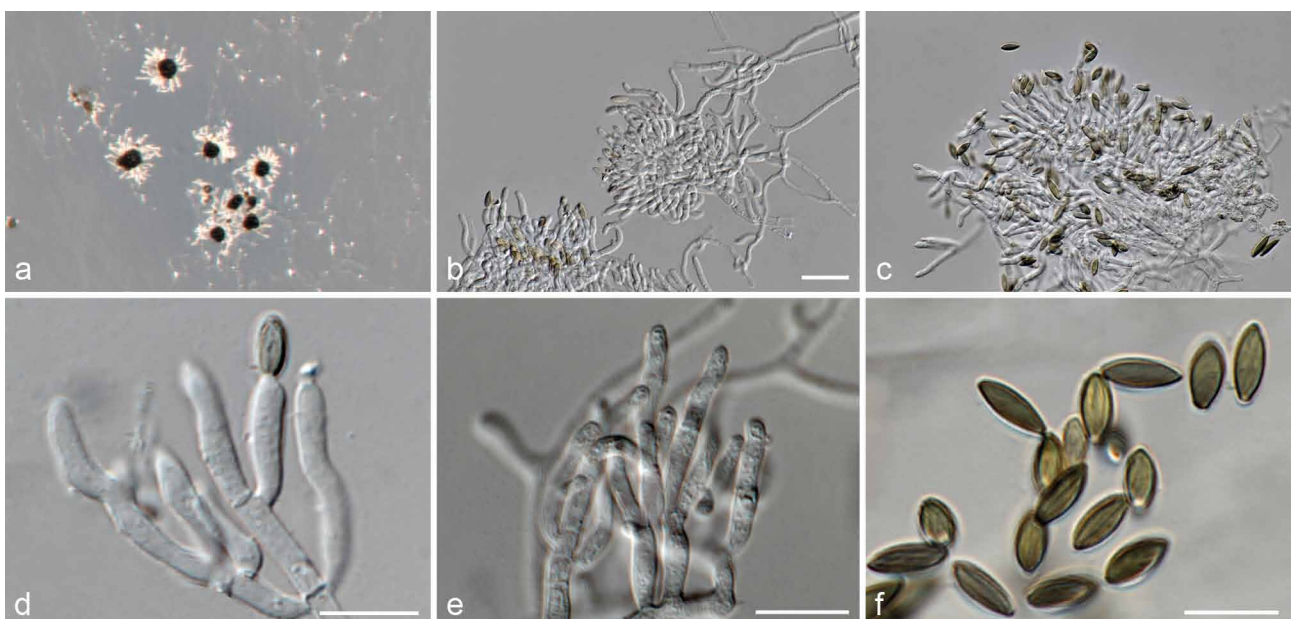
*Conidiomata* sporodochial or absent, reduced to simple conidiophores. *Sporodochia* stromatic, superficial, scattered or gregarious, oval to elongate or irregular in outline, 55–220 µm diam, 25–85 µm deep, with a white to grey setose fringe surrounding an olivaceous green to mouse grey agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Simple conidiomata* consisting of conidiogenous cells arising directly from the vegetative hypha. *Setae* sinuous, rarely branched, hyaline to subhyaline, verrucose, 10–25 µm long, 3–5 µm wide, terminating in a blunt apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched or rarely branched, hyaline, septate becoming constricted at the septum, smooth, 18–33 × 2–4 µm; conidiogenous apparatus consists of a whorl of 3–5 primary branches terminating in 3–6 conidiogenous cells; primary

branches aseptate, unbranched, smooth, 12–18 × 2–3 µm; *conidiogenous cells* phialidic, cylindrical to clavate to doliform, hyaline, smooth to lightly verrucose, straight to flexuous or bent at the upper third, 5–22 × 2–3 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, longitudinally striate, olivaceous green to brown, fusiform to ellipsoidal, (6–)6.5–7.5(–9.5) × (2–)2.5–3.5(–5) µm (av. 7 × 3 µm), with a distinct apical hilum.

Culture characteristics — Colonies on PDA, OA and CMA with abundant white aerial mycelium, olivaceous green to mouse grey in the centre becoming white towards the margins; sporodochia forming on the aerial mycelium and the surface of the medium, covered by slimy olivaceous green to mouse grey conidial masses, reverse on PDA pale luteous to white.

*Materials examined.* IRAN, bank of Caspian sea near Nochahr, from dune sand, 1961, J. Nicot (culture ex-type CBS 513.71 = IMI 115293 (ex-type of *Myr. brachysporum*)). — SOUTH AFRICA, North West Province, Potchefstroom, from leaf litter of *Acacia karroo*, 1965, M.C. Papendorf, CBS 177.65 = IMI 140053. — UKRAINE, Kiev, from soil, 1965, collector unknown, CBS 131.71 = IMI 158441 = ATCC 22270 (ex-type of *Myr. ucrainicum*). — USA, Kansas, near Manhattan, Konza Prairie Research Natural Area, long-term Ecological Research site, from soil in tallgrass prairie, 1986, M. Christensen, CBS 127287; Wisconsin, from soil in grassland prairie, 1950, P.A. Orpurt & J.T. Curtis, CBS 126552, CBS 128163.

Notes — Phylogenetic inference in this study placed the ex-type strain (CBS 513.71; Nicot & Olivry 1961) of *Str. brachysporum* in a highly supported subclade in the *Striaticonidium* clade, which also included the ex-type strain of *Myr. ucrainicum* (Fig. 2, CBS 131.71; Pidoplichko & Kirilenko 1969). As the epithet '*brachysporum*' (1961) predates '*ucrainicum*' (1969) we select to apply the former epithet to this clade, based on ICN (Hawksworth 2012, McNeill et al. 2012). Pidoplichko & Kirilenko (1969) distinguished *Myr. ucrainicum* from *Myr. brachysporum* by six phenotypic characters (see Tulloch 1972) although the conidial dimensions overlapped (Nicot & Olivry 1961, Pidoplichko & Kirilenko 1969, Tulloch 1972). Morphological comparisons of both ex-type strains under similar culturing conditions in this study revealed no phenotypic differences, indicating that the culturing conditions applied by both Nicot & Olivry (1961) and Pidoplichko & Kirilenko (1969) could have contributed to the phenotypic differences observed in the past.



**Fig. 76** *Striaticonidium brachysporum* (CBS 513.71). a. Sporodochial conidiomata on SNA; b, c. sporodochia; d–e. conidiogenous cells; f. conidia. — Scale bars: b = 20 µm (apply to c); d–f = 10 µm.

***Striaticonidium cinctum* (Corda) L. Lombard & Crous, *comb. nov.* — MycoBank MB816044; Fig. 77**

*Basionym.* *Fusarium cinctum* Corda, Icon. Fungorum 5: 80. 1842.

= *Myrothecium cinctum* (Corda) Sacc., Syll. Fung. 4: 751. 1886.

?= *Myrothecium ellipsosporum* Fuckel, Symb. Mycol.: 364. 1870.

= *Hymenopsis ellipsospora* (as *ellipsosporum*) (Fuckel) Sacc., Syll. Fung. 4: 745. 1886.

= *Myrothecium striatisporum* N.C. Preston, Trans. Brit. Mycol. Soc. 31: 275. 1948.

= *Myrothecium longistriatisporum* Matsush., Microfungi Solomon Isl. Papua-New Guinea: 39. 1971.

*Typification.* GERMANY, on *Trifolium repens*, in herb. PR ex herb. A.C.I. Corda (labelled *Fusarium cinctum* Corda), no. 155489, Mus. Hof. 1840 (holotype of *Myr. cinctum*). — THE NETHERLANDS, Eastern Flevoland, from agricultural soil, 7 Oct. 1969, J.W. Veenbaas-Rijks (epitype of *Myr. cinctum* designated here CBS H-22471, MBT204324, ex-epitype culture CBS 932.69 = IMI 145760).

*Conidiomata* sporodochial, stromatic, superficial, scattered or gregarious, oval to elongate or irregular in outline, 250–600 µm diam, 45–85 µm deep, with a white to grey setose fringe surrounding an olivaceous green to mouse grey agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* sinuous, rarely branched, hyaline to subhyaline to olivaceous green, verrucose, 45–120 µm long, 3–5 µm wide, terminating in a blunt apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched or rarely branched, hyaline, septate, smooth, 6–15 × 2–3 µm; primary branches aseptate, unbranched, smooth, 7–10 × 2–3 µm; secondary branches aseptate, unbranched, smooth, 5–10 × 2–3 µm; terminating in a whorl of 2–4 conidiogenous cells; conidiogenous cells phialidic, clavate to cylindrical to subcylindrical, hyaline, smooth to lightly verrucose, straight to slightly curved or bent at the upper third, 7–25 × 1–3 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, longitudinally striate, olivaceous green to brown, fusiform to ellipsoidal, (6–)7–9 × 2–3 µm (av. 8 × 3 µm), with a distinct apical hilum.

*Culture characteristics* — Colonies on PDA, OA and CMA with abundant white aerial mycelium with sporodochia forming on the aerial mycelium and the surface of the medium, covered by slimy olivaceous green to mouse grey conidial masses, reverse on PDA pale luteous to buff.

*Additional materials examined.* BELGIUM, West Vlaanderen, from clay soil, 1947, J. van Holder, CBS 373.50 = IMI 140052. — CANADA, Ontario, Acton, from soil under *Thuja occidentalis*, July 1964, G.C. Bhat, CBS 528.69 = IMI 140637 = ATCC 18947. — NEW ZEALAND, from clay soil, collection date unknown, J.C. Neill, CBS 277.48 = IMI 001526 (ex-type of *Myr. striatisporum*).

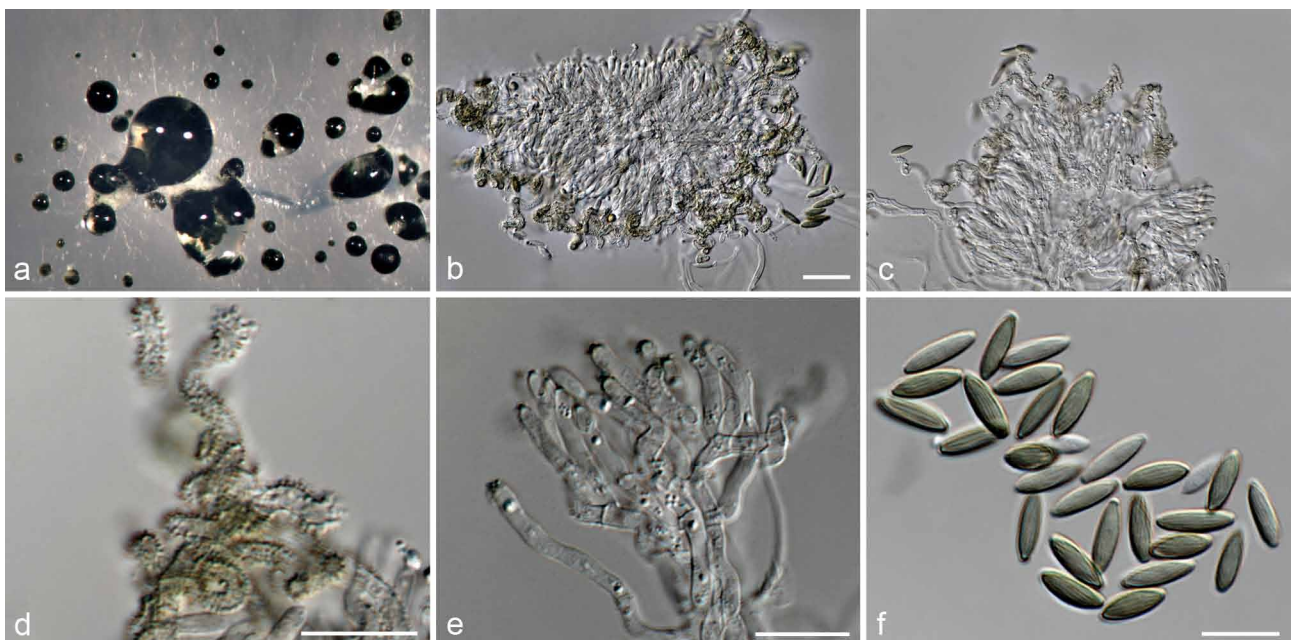
*Notes* — *Striaticonidium cinctum* is the type species of the genus and as no living type material exists for this species, we consider it important to designate an epitype. The holotype (as *F. cinctum* = *Myr. cinctum*) was studied by Tulloch (1972) and based on the similarities to the protologue and illustrations provided by Tulloch, as well as the close proximity to the holotype location, we designate CBS 932.69 as epitype. Although *Str. cinctum* is morphologically similar to *Str. brachysporum*, it can be distinguished by its longer setae (45–120 µm) compared to those of *Str. brachysporum* (10–25 µm).

***Striaticonidium humicola* L. Lombard & Crous, *sp. nov.* — MycoBank MB816046; Fig. 78**

*Etymology.* Name reflects the substrate, soil, from which this fungus was isolated.

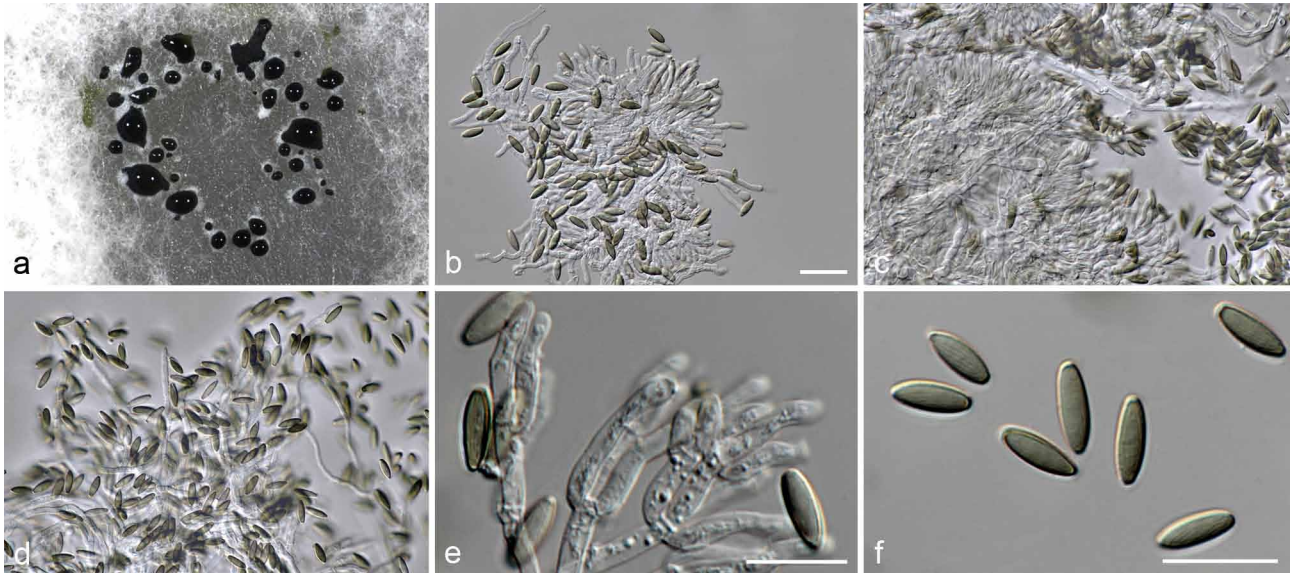
*Conidiomata* sporodochial, stromatic, superficial, scattered or gregarious, oval to elongate or irregular in outline, 120–650 µm diam, 65–125 µm deep, with a white setose-like fringe surrounding an olivaceous green agglutinated slimy mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* rare, sinuous, unbranched, hyaline to subhyaline, verrucose, 35–75 µm long, 2–3 µm wide, terminating in a blunt apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth, 7–16 × 2–5 µm; primary branches aseptate, unbranched, smooth, 8–12 × 2–3 µm; secondary branches aseptate, unbranched, smooth, 5–11 × 2–3 µm; terminating in a whorl of 2–4 conidiogenous cells; conidiogenous cells phialidic, cylindrical to subcylindrical, hyaline, smooth to lightly verrucose, straight to slightly curved, 7–17 × 2–3 µm, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, longitudinally striate, olivaceous green to brown, fusiform to ellipsoidal, (6–)6.5–7.5(–9) × 2–3 µm (av. 7 × 3 µm), with a distinct apical hilum.

*Culture characteristics* — Colonies on PDA, OA and CMA with abundant white aerial mycelium with sporodochia forming



**Fig. 77** *Striaticonidium cinctum* (CBS 932.69). a. Sporodochial conidiomata on SNA; b–c. sporodochia; d. setae; e. conidiogenous cells; f. conidia. — Scale bars: b = 20 µm (apply to c); d–f = 10 µm.





**Fig. 78** *Striaticonidium humicola* (CBS 258.76). a. Sporodochial conidiomata on SNA; b–c. sporodochia; d. setae; e. conidiogenous cells; f. conidia. — Scale bars: b = 20  $\mu\text{m}$  (apply to c–d); e–f = 10  $\mu\text{m}$ .

on the aerial mycelium and the surface of the medium, covered by slimy olivaceous green conidial masses, reverse on PDA pale luteous to olivaceous green.

*Materials examined.* PAPUA NEW GUINEA, Madang Province, Braham, from soil in tropical forest, Nov. 1995, A. Aptroot, CBS 388.97. — SPAIN, Gran Canaria, from soil, Apr. 1976, J.A. von Arx (holotype CBS H-14894, culture ex-type CBS 258.76).

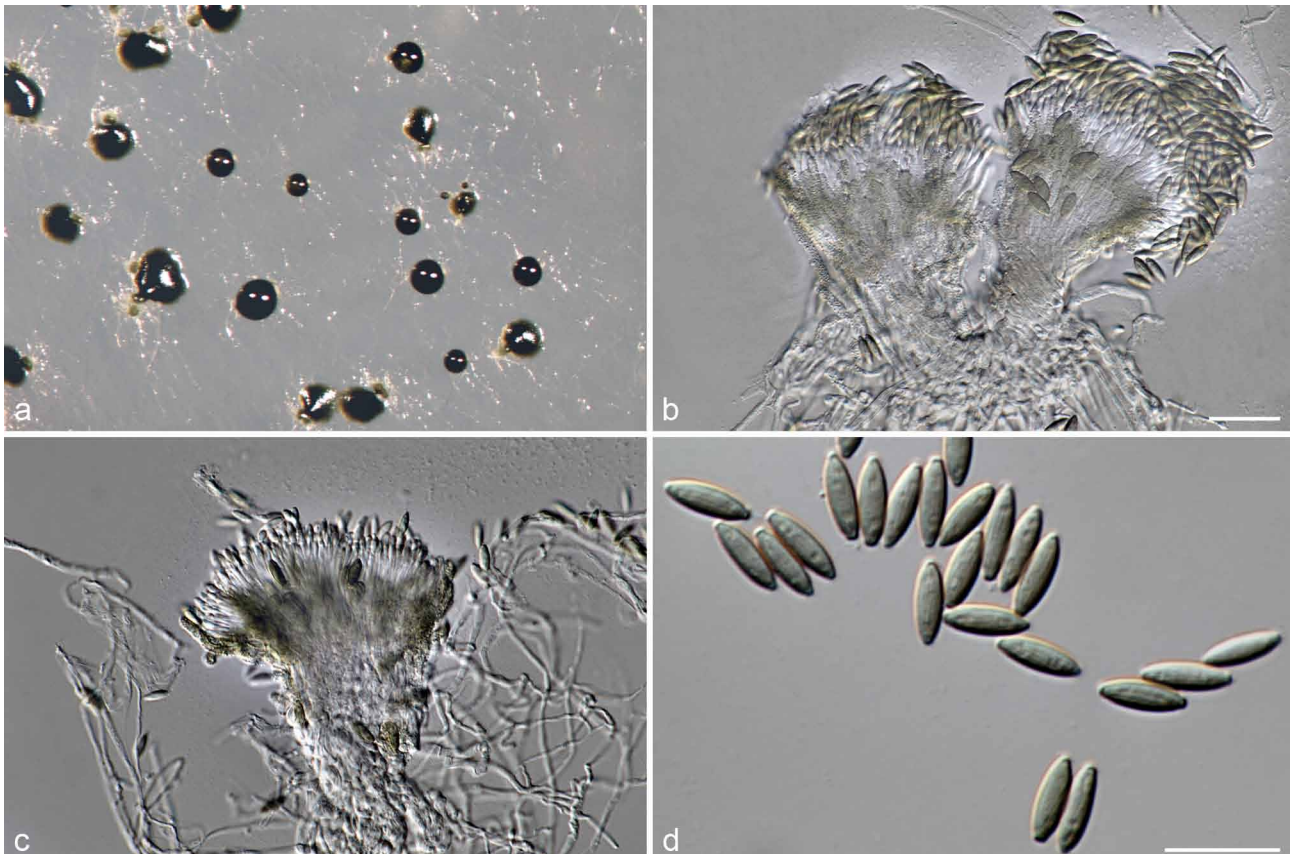
*Notes* — *Striaticonidium humicola* formed a well-supported clade closely related to *Str. cinctum* and *Str. synnematum* (Fig. 2). This species can be distinguished from the other species in this genus by the sparsely formed setae, that are not

as darkly pigmented as those observed for the other species in this genus.

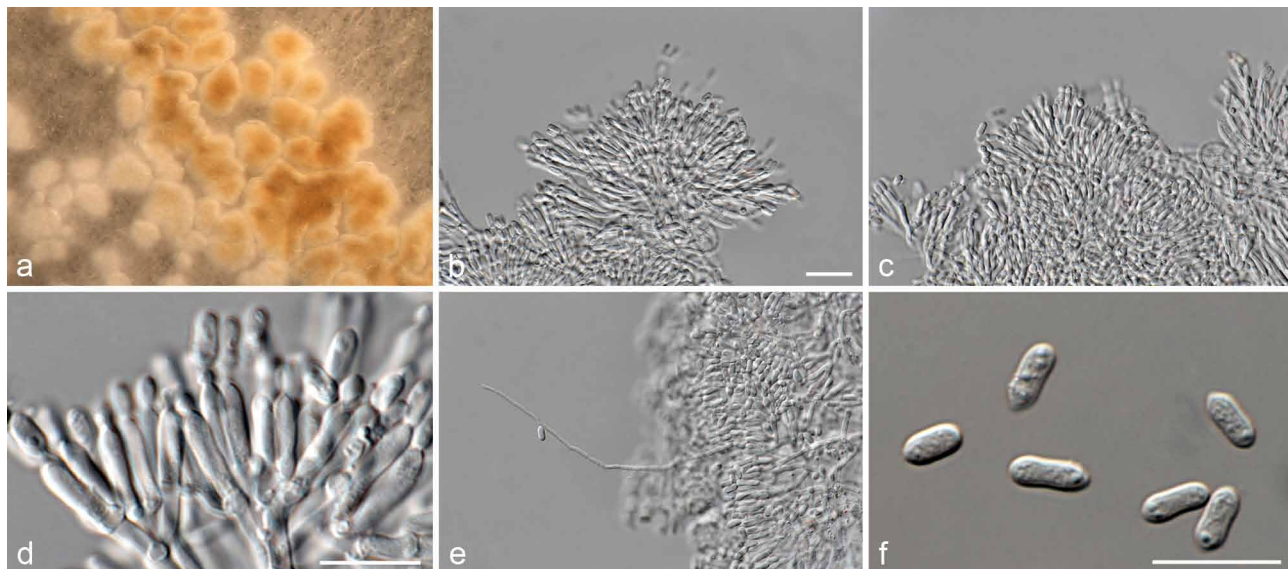
***Striaticonidium synnematum*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816047; Fig. 79

*Etymology.* Name reflects the synnematus conidiomata formed by this fungus.

*Conidiomata* synnematus, solitary, 50–85  $\mu\text{m}$  high, 35–70  $\mu\text{m}$  wide at the base, 45–85  $\mu\text{m}$  at the apex, cylindrical, unbranched, broadening towards the apex, consisting of bundles



**Fig. 79** *Striaticonidium synnematum* (CBS 479.85). a. Conidiomata on SNA; b–c. synnematus conidiomata; d. conidia. — Scale bars: b = 10  $\mu\text{m}$  (apply to c); d = 10  $\mu\text{m}$ .



**Fig. 80** *Tangerinosporium thalicticola* (CBS 317.61). a. Sporodochia with orange conidial masses on colony surface; b–c. sporodochial conidiomata; d. conidiogenous cells; e. seta; f. conidia. — Scale bars: b = 20  $\mu\text{m}$  (apply to c, e); d, f = 10  $\mu\text{m}$ .

of parallel, longitudinal, closely compacted hyphae, terminating in whorls of 2–4 conidiogenous cells, enclosed by marginal hyphae arising from the stroma and covered by an olivaceous green to mouse grey slimy mass of conidia. *Marginal hyphae* 2–3  $\mu\text{m}$  wide, sinuous, unbranched to rarely branched, hyaline to olivaceous green, verrucose, with a blunt apex. *Stroma* well developed, hyaline, of *textura globulosa* and *textura angularis*. *Conidiogenous cells* phialidic, cylindrical to subcylindrical, hyaline, smooth, 18–30  $\times$  1–2  $\mu\text{m}$  in vivo, 5–10  $\times$  1–2  $\mu\text{m}$  in vitro, with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, longitudinally striate, hyaline to olivaceous green, fusiform to ellipsoidal, 7–8  $\times$  2–3  $\mu\text{m}$  (av. 7  $\times$  3  $\mu\text{m}$ ), with a distinct apical hilum.

**Culture characteristics** — Colonies on PDA, OA and CMA with abundant white aerial mycelium with synnemata forming on the surface of the medium, covered by slimy herbage to olivaceous green conidial masses, reverse on PDA buff to olivaceous green.

**Material examined.** JAPAN, Kamakura, from leaf of unknown palm, 29 Aug. 1983, K.A. Seifert no. 312 (holotype CBS H-14895, culture ex-type CBS 479.85).

**Notes** — *Striaticonidium synnematum* formed a single lineage basal to the *Str. cinctum* clade (Fig. 2) and is the only species in this genus that only produces synnematos conidiomata in culture.

***Tangerinosporium* L. Lombard & Crous, gen. nov.** — MycoBank MB816048

**Etymology.** Name reflects the characteristic orange conidial masses covering the sporodochia produced by these fungi.

**Type species.** *Tangerinosporium thalicticola* L. Lombard & Crous.

**Sexual morph** unknown. *Conidiomata* sporodochial, stromatic, superficial, pulvinate, scattered or gregarious, oval or irregular in outline, covered by an apricot to orange slimy or dry mass of conidia, surrounded by a white fringe. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* rarely seen, thin-walled, septate, unbranched, straight to flexuous, hyaline, tapering to an acute apice. *Conidiophores* macronematous, penicillately branched, hyaline, smooth. *Conidiogenous cells* phialidic, hyaline, smooth, cylindrical to subcylindrical, straight to slightly curved, with conspicuous collarettes and periclinal

thickenings. *Conidia* aseptate, ellipsoidal to ovoid, hyaline, with a rounded basal end and apical hilum.

**Notes** — The monophyletic asexual morph genus *Tangerinosporium* is established here for a fungus that characteristically produces orange conidial masses on its sporodochia, which distinguish it from the other myrothecium-like genera. Phylogenetic inference in this study showed that *Tangerinosporium* forms a basal sister lineage to the *Myrothecium* s.str. clade (Fig. 2).

***Tangerinosporium thalicticola* L. Lombard & Crous, sp. nov.** — MycoBank MB816049; Fig. 80

**Etymology.** Name reflects the genus *Thalictrum*, from which this fungus was isolated.

*Conidiomata* sporodochial, stromatic, superficial, scattered or gregarious, oval to elongate or irregular in outline, 300–750  $\mu\text{m}$  diam, 50–250  $\mu\text{m}$  deep, with a white setose-like fringe surrounding an apricot to orange agglutinated slimy or dry mass of conidia. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Setae* rare, flexuous, unbranched, hyaline, smooth, up to 120  $\mu\text{m}$  long, 2–3  $\mu\text{m}$  wide, terminating in an acute apice. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes unbranched, hyaline, septate, smooth, 7–20  $\times$  2–3  $\mu\text{m}$ ; primary branches aseptate, unbranched, smooth, 7–14  $\times$  2–3  $\mu\text{m}$ ; secondary branches aseptate, unbranched, smooth, 4–9  $\times$  2–3  $\mu\text{m}$ ; terminating in a whorl of 3–6 conidiogenous cells; *conidiogenous cells* phialidic, cylindrical to subcylindrical, hyaline, smooth, straight to slightly curved, 6–11  $\times$  2–3  $\mu\text{m}$ , with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, ellipsoidal to ovoid, (5–)5.5–6.5(–7)  $\times$  2–3  $\mu\text{m}$  (av. 6  $\times$  2  $\mu\text{m}$ ), rounded at the base with a distinct apical hilum.

**Culture characteristics** — Colonies on PDA, OA and CMA with sparse white aerial mycelium with sporodochia forming on the surface of the medium, covered by slimy to dry apricot to orange conidial masses, reverse on PDA luteous to honey.

**Material examined.** UK, from *Thalictrum flavum*, 1949, M.B. Ellis (holotype CBS H-22472, culture ex-type CBS 317.61 = IMI 034815).

***Virgatospora* Finley, Mycologia 59: 538. 1967**

**Type species.** *Virgatospora echinofibrosa* Finley, Mycologia 59: 538. 1967.



≡ *Didymostilbe echinofibrosa* (Finley) Rossman, Stud. Mycol. 42: 56. 1999.

= *Nectria spirostriata* Rossman, Mycol. Pap. 150: 61. 1983.

≡ *Peethambara spirostriata* (Rossman) Rossman, Stud. Mycol. 42: 56. 1999.

Description and illustration — See Finley (1967), Rossman (1983) and Rossman et al. (1999).

Notes — The monotypic asexual genus, *Virgatospora*, was established by Finley (1967), based on *V. echinofibrosa*, described from a dead twig collected on the Barro Colorado Island. Rossman (1983) was able to experimentally link *V. echinofibrosa* to the sexual morph *Nectria spirostriata*. Later, Rossman et al. (1999) transferred *N. spirostriata* to the sexual genus *Peethambara* (as *P. spirostriata*) and at the same time provided a new combination for *V. echinofibrosa* as *Didymostilbe echinofibrosa*, based on morphological similarities for both generic morphs. Based on phylogenetic inference in this study, authentic strains of *P. echinofibrosa* (see Rossman 1983 and Decock et al. 2008) formed a well-supported clade, distant to the *Peethambara* and *Didymostilbe* clades (Fig. 1). Therefore, we select to apply the asexual generic name *Virgatospora* to this clade, pending recollection from the type locality and epitypification as no living ex-type strain is available for phylogenetic analyses at present.

***Xenomrothecium*** L. Lombard & Crous, *gen. nov.* — MycoBank MB816050

*Etymology.* Name reflects its morphological similarity to the genus *Myrothecium*.

*Type species.* *Xenomrothecium tongaense* (W.B. Kendr., et al.) L. Lombard & Crous

*Sexual morph* unknown. *Conidiomata* sporodochial, stromatic, superficial, scattered or gregarious, irregular in outline, covered by an olivaceous green to dark green slimy mass of conidia. Margin well developed, slightly involute, of *textura intricata*, composed of branched, septate, hyaline, verrucose, loosely coiled hyphae. *Stroma* poorly developed, hyaline, of a *textura angularis*. *Conidiophores* arising from the stroma branched, septate, hyaline, smooth. *Conidiogenous cells* phialidic, pale green, verrucose, subcylindrical, with conspicuous collarettes. *Conidia* aseptate, oblong-ellipsoidal, pale green, smooth, apex

truncate, base constricted and truncate (adapted from DiCosmo et al. 1980).

Notes — Based on phylogenetic inference in this study, the ex-type strain (CBS 598.80) of *Myr. tongaense* formed a single lineage sister to the *Myrothecium* s.str. clade and *Tangerinosporium* lineage (Fig. 1, 2). Therefore, the monotypic genus, *Xenomrothecium*, is introduced here and *Myr. tongaense* is provided with a new combination below. *Xenomrothecium* can be distinguished from *Myrothecium* s.str. and *Tangerinosporium* by its oblong-ellipsoidal conidia and lack of setae formed in the sporodochia. *Xenomrothecium* is also morphologically reminiscent of *Paramyrothecium*, but can also be distinguished by conidial morphology and lack of setae formation.

***Xenomrothecium tongaense*** (W.B. Kendr. et al.) L. Lombard & Crous, *comb. nov.* — MycoBank MB816051

*Basionym.* *Myrothecium tongaense* W.B. Kendr. et al., Mycotaxon 12: 220. 1980.

Description and illustration — See DiCosmo et al. (1980).

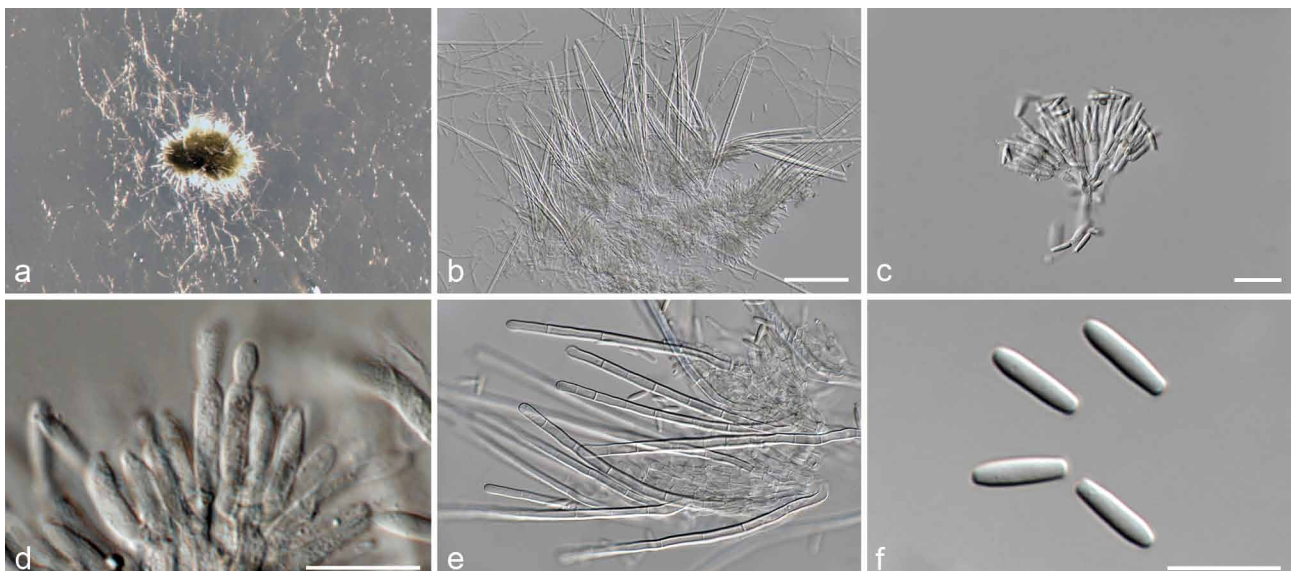
*Material examined.* TONGA, Pangai, Lifuka, Haápai Group, from calcified portions of a dead thallus of *Halimeda* sp., 1 May 1980, B. Kendrick (holotype DAOM 176764 (not seen), culture isotype CBS 598.80).

***Xepicula*** Nag Raj, Coelemycetous anamorphs with appendage-bearing conidia: 979. 1993

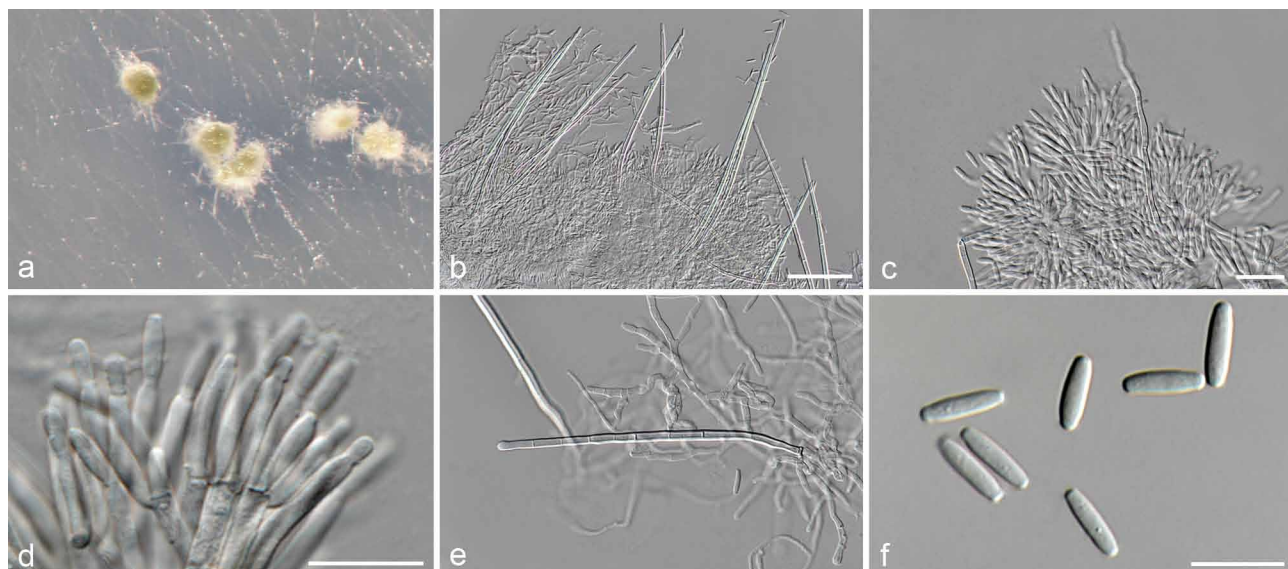
*Type species.* *Xepicula leucotricha* (Peck) Nag Raj.

Description and illustration — See Nag Raj (1993).

Notes — Nag Raj (1993) introduced the asexual genus *Xepicula*, based on *X. leucotricha* (= *Myr. leucotrichum*), to resolve the taxonomic problems associated with the broad generic concept for *Myrothecium* as proposed by Tulloch (1972). At the same time, Nag Raj (1993) synonymised *Myr. indicum* (Rama Roa 1963) and *Myr. jollymannii* (Preston 1948) under *X. leucotricha*. Based on phylogenetic inference in this study, the ex-type strain of *Myr. jollymannii* (CBS 276.48) clustered in a well-supported subclade, distinct from the well-supported subclade that includes the ex-type of *Myr. indicum* (CBS 131.64) (Fig. 2). We select to retain the name *X. leucotricha* for the latter subclade and therefore resurrect *Myr. jollymannii* and provide a new combination in the genus *Xepicula*.



**Fig. 81** *Xepicula crassiseta* (CBS 392.71). a. Sporodochial conidiomata on SNA; b–c. sporodochia; d. conidiogenous cells; e. setae; f. conidia. — Scale bars: b = 100  $\mu$ m; c = 20  $\mu$ m (apply to e); d, f = 10  $\mu$ m.



**Fig. 82** *Xepicula jollymannii* (CBS 276.48). a. Sporodochial conidiomata on SNA; b–c. sporodochia; d. conidiogenous cells; e. setae; f. conidia. — Scale bars: b = 100  $\mu\text{m}$ ; c = 20  $\mu\text{m}$  (apply to e); d, f = 10  $\mu\text{m}$ .

***Xepicula crassiseta*** L. Lombard & Crous, *sp. nov.* — MycoBank MB816052; Fig. 81

*Etymology.* Name reflects the thick-walled setae produced by this fungus.

*Conidiomata* sporodochial, stromatic, superficial, cupulate, scattered or rarely gregarious, oval to elongate or irregular in outline, 175–450  $\mu\text{m}$  diam, 55–220  $\mu\text{m}$  deep, with a white setose fringe surrounding an olivaceous green agglutinated slimy mass of conidia. *Stroma* well-developed, hyaline, of *textura globulosa* or *textura angularis*. *Setae* arising from the stroma, unbranched, straight to flexuous, thick-walled, septate, hyaline to subhyaline, 85–170  $\mu\text{m}$  long, 3–6  $\mu\text{m}$  wide, terminating in a blunt apex. *Conidiophores* arising from the basal stroma, consisting of a stipe and a penicillately branched conidiogenous apparatus; stipes branched or unbranched, hyaline, septate, smooth to slightly verrucose, 15–25  $\times$  3–4  $\mu\text{m}$ ; primary branches aseptate, unbranched, smooth to slightly verrucose, 8–14  $\times$  2–3  $\mu\text{m}$ ; secondary branches aseptate, unbranched, smooth to slightly verrucose, 6–11  $\times$  2–3  $\mu\text{m}$ ; terminating in a whorl of 2–4 conidiogenous cells; *conidiogenous cells* phialidic, cylindrical to subcylindrical, hyaline, smooth to lightly verrucose, straight to slightly curved, 7–15  $\times$  2–3  $\mu\text{m}$ , with conspicuous collarettes and periclinal thickenings. *Conidia* aseptate, hyaline, smooth, fusiform to ellipsoidal, (7–)8–10  $\times$  2  $\mu\text{m}$  (av. 9  $\times$  2  $\mu\text{m}$ ), with an obtuse apex and truncate base, lacking a funnel-shaped mucoid apical appendage.

*Culture characteristics* — Colonies on PDA, OA and CMA with abundant luteous aerial mycelium with sporodochia forming on the aerial mycelium and the surface of the medium, covered by slimy olivaceous to herbage green conidial masses, with luteous to buff exudates diffusing into the medium; reverse on PDA luteous.

*Material examined.* SPAIN, Gran Canaria, from forest soil under *Pinus canariensis*, collector and date unknown (holotype CBS H-14902, culture ex-type CBS 392.71).

*Notes* — *Xepicula crassiseta* formed a single lineage basal to the *X. jollymannii* clade (Fig. 2). The setae of *X. crassiseta* are shorter than those reported for *X. leucotrichia* (up to 200  $\mu\text{m}$ ; Nag Raj 1993), *X. leucotrichoides* (up to 300  $\mu\text{m}$ ; Nag Raj 1993) and *X. jollymannii* (up to 260  $\mu\text{m}$ ; Preston 1948). Furthermore, the conidia of *X. crassiseta*, similar to *X. jollymannii* (Preston 1948) do not bear any funnel-shaped mucoid apical appendages as recorded for the former two species, but the

conidia are slightly smaller ((7–)8–10  $\times$  2  $\mu\text{m}$  (av. 9  $\times$  2  $\mu\text{m}$ )) than those reported for *X. jollymannii* (8–12  $\times$  2.5  $\mu\text{m}$ ; Preston 1948).

***Xepicula jollymannii*** (N.C. Preston) L. Lombard & Crous, *comb. nov.* — MycoBank MB816053; Fig. 82

*Basionym.* *Myrothecium jollymannii* N.C. Preston, Trans. Brit. Mycol. Soc. 31: 272. 1948.

*Description and illustration* — See Preston (1948).

*Materials examined.* INDIA, in garden of Agricultural College Akola, from branch of *Clerodendron inerme*, Sept. 1975, R.B. Somani, CBS 511.76. — MALAWI, Nyasaland, from dried leaf of *Nicotiana tabacum*, 1936, F.W. Jollymann (holotype IMI 001495, culture ex-type CBS 276.48 = MUCL 11830 = QM 1229). — NAMIBIA, 30 km west of Maltahohe on Highway C19, from surface soil in desert, Apr. 2001, M. Christensen, CBS 126168.

***Xepicula leucotricha*** (Peck) Nag Raj, Coelemycetous anamorphs with appendage-bearing conidia: 980. 1993

= *Excipula leucotricha* Peck, Rep. St. Mus. N.Y. 29: 48. 1878.

= *Amerosporium leucotrichum* (Peck) Sacc., Syll. Fung. 3: 682. 1884.

= *Myrothecium leucotrichum* (Peck) M.C. Tulloch, Mycol. Pap. 130: 12. 1972.

= *Volutella piracicabana* Verona & S. Joly, Rc. Accad. Naz. Lincei 21 (1–2): 121. 1956.

= *Myrothecium indicum* P. Rama Rao, Antonie van Leeuwenhoek 29: 180. 1963.

*Materials examined.* BRAZIL, Piracicaba, from soil, 1956, O. Verona & P. Joly, CBS 256.57 = MUCL 9860 (ex-type culture of *Volutella piracicabana*). — COLOMBIA, Dep. del Meta, Municipio de Villavicencio, 25 km from Villavicencio to Acacias, from maize-field soil, May 1978, J. Veerkamp, CBS 278.78, CBS 483.78. — INDIA, Hyderabad, Andhra Pradesh, from uncultivated soil, 1963, P. Rama Rao, CBS 131.64 = IMI 103664 = ATCC 16686 (isotype of *Myrothecium indicum*).

## EXCLUDED GENERA AND SPECIES

***Chaetosphaeria aspergilloides*** M.E. Barr & J.L. Crane, Canad. J. Bot. 57: 835. 1979

*Description and illustration* — See Barr & Crane (1979).

*Notes* — Réblová (1998) compared *Chaetosphaeria aterrima* (now *Kastanostachys aterrima*) to *Chaetosphaeria as-*



*pergilloides* (Barr & Crane 1979) and found that both these species share morphological similarities in their sexual and asexual morphs. However, the type material of *C. aspergilloides*, lodged at NY (México, Universite Nacional Autonomia de México, Distrito Federal, on decayed woody material, tropical greenhouse, 7 Sept. 1972, *J.M. Trappe 3642*, NY), could not be located for comparative studies (Réblová 1998). The author also examined isotype (ILLS 37868), which contained several microscopic preparations; all observed morphological structures matched the description of sexual and asexual morphs of *C. aspergilloides* (Barr & Crane 1979). No living culture could be located for this species in this study. This species probably also belongs to the genus *Kastanostachys*, but formal placement in this genus requires recollection and epitypification of this species.

***Melanconis groenlandica*** (M. Bohn) L. Lombard & Crous, *comb. nov.* — MycoBank MB816054

*Basionym.* *Myrothecium groenlandicum* M. Bohn, *Mycotaxon* 46: 336. 1993.

Description and illustration — See Bohn (1993).

Notes — Analyses of the ITS (GenBank accession KU-878552), LSU (KU878553), *tef1* (KU878554) and *tub2* (KU-878555) sequence data revealed that the ex-type strain (UPSC 3407 = CBS 116540; Bohn 1993) of *Myr. groenlandicum* belongs to the sexual genus *Melanconis* (Voglmayr et al. 2012, Rossman et al. 2015; data not shown here). Therefore, this new combination is introduced here.

***Memnoniella indica*** Kesh. Prasad et al., *Mycotaxon* 85: 341. 2003

≡ *Stachybotrys indicoides* Yong Wang et al., *Fung. Diversity* 70: 54. 2015.

Description and illustration — See Keshava Prasad et al. (2003) and Wang et al. (2015).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. Based on the thick-walled, verrucose conidia formed in chains, this species probably belongs to the genus *Memnoniella*.

***Memnoniella leprosa*** R.F. Castañeda, *Fungi Cubenses*: 10. 1986

≡ *Stachybotrys leprosa* (R.F. Castañeda) R.F. Castañeda, *Fung. Diversity* 70: 57. 2015.

Description — See Castañeda (1986).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. Castañeda (1986) characterised this species with conidia borne in dry chains, placing it in the genus *Memnoniella*.

***Memnoniella levispora*** Subram., *J. Indian Bot. Soc.* 33: 40. 1954

≡ *Stachybotrys levispora* (Subram.) Yong Wang et al., *Fung. Diversity* 70: 57. 2015.

Description and illustration — See Subramanian (1954).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species produces globose, smooth-walled conidia in dry chains (Subramanian 1954) and therefore belongs to the genus *Memnoniella*.

***Memnoniella mohanramii*** Manohar. et al., *Indian Phytopathol.* 59: 489. 2006

≡ *Stachybotrys mohanramii* (Manohar. et al.) Yong Wang et al., *Fung. Diversity* 70: 58. 2015.

Description and illustration — See Manoharachary et al. (2006).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species produces ellipsoidal, smooth, thick-walled conidia in chains (Manoharachary et al. 2006) and therefore belongs to the genus *Memnoniella*.

***Memnoniella stilboidea*** (Munjal & J.N. Kapoor) M.B. Ellis, *More dematiaceous Hyphomycetes*: 464. 1976

≡ *Stachybotrys stilboidea* Munjal & J.N. Kapoor, *Mycopathol. Mycol. Appl.* 39: 121. 1969.

Description and illustration — See Munjal & Kapoor (1969) and Ellis (1979).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species forms characteristic synnematosous conidiomata (Munjal & Kapoor 1969, Ellis 1979) not known for *Memnoniella* and therefore might represent a novel genus allied to *Memnoniella*.

***Myrothecium advena*** Sacc. var. *terricola* H.Q. Pan & T.Y. Zhang, *Mycosystema* 33: 8. 2014

Description and illustration — See Jiang et al. (2014).

Notes — Although Tulloch (1972) synonymised *Myr. advena* under *Myr. roridum* (now *Paramyrothecium roridum*), Jiang et al. (2014) introduced this new variety of *Myr. advena* based on colony colour and conidial dimensions. The broad species description and illustration by Jiang et al. (2014) and lack of sequence data makes it difficult to place this variety. It probably represents *Pa. roridum*, pending re-examination of the type material and phylogenetic inference.

***Myrothecium baciliforme*** Y.L. Jiang & T.Y. Zhang, *Mycosystema* 33: 9. 2014

Description and illustration — See Jiang et al. (2014).

Notes — Jiang et al. (2014) distinguished *Myr. baciliforme* from *Pa. roridum* based on conidial morphology and dimensions. Based on the description provided by Jiang et al. (2014), *Myr. baciliforme* is morphologically similar to *Pa. parvum*. Unfortunately, the ex-type strain (HMAS 196271) or associated DNA sequence data were unavailable to us to confirm its link to *Pa. parvum*. This species probably belongs to the genus *Paramyrothecium*.

***Myrothecium biforme*** Y.L. Jiang & T.Y. Zhang, *Mycosystema* 33: 10. 2014

Description and illustration — See Jiang et al. (2014).

Notes — Jiang et al. (2014) distinguished this species from all other *Myrothecium* species based on the production of two kinds of conidia. Based on the conidial dimension indicated by Jiang et al. (2014), this species does not belong to the genus *Myrothecium*, but might represent another new allied genus. However, neither the ex-type strain (HMAS 196272) nor associated DNA sequence data were available to us to determine its relationship to the genus *Myrothecium*.

***Myrothecium macrosporum*** H.F. Wang & T.Y. Zhang, *Mycosystema* 33: 10. 2014

Description and illustration — See Jiang et al. (2014).

Notes — Jiang et al. (2014) compared this species to *Myr. verrucaria* (now *Albifimbria verrucaria*) and *Myr. flavovirens* ( $\equiv$  *Hymenopsis flavovirens*; Nag Raj 1993), distinguishing it based on conidial dimensions, pigmentation and gluttulae. However, the conidial dimensions exclude this species from the genus *Myrothecium*. Based on the illustration of the unique conidigenous cells and conidia (Jiang et al. 2014), this myrothecium-like species probably represents a new allied genus. Neither the ex-type strain (HMAS 196273) nor associated DNA sequence data were available to us to determine its relationship to the genus *Myrothecium*.

***Myrothecium miconiae*** J.L. Alves et al., *Mycologia* 102: 73. 2010

Description and illustration — See Alves et al. (2010).

Notes — This synnematos myrothecium-like species was introduced by Alves et al. (2010) based on an isolate obtained from a leaf lesion on *Miconia calvescens*. Based on its 1-septate, subconical conidia, this species does not belong to the genus *Myrothecium*, and probably represent another new allied genus. No living type material could be located for this study to determine its phylogenetic relationship to the genus *Myrothecium*.

***Myrothecium mori*** Sullia & Padma, *Curr. Sci.* 54: 757. 1985

Description — See Sullia & Padma (1985).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. Sullia & Padma (1985) distinguished *Myr. mori* from *Al. verrucaria*, *Pa. roridum* and *Myr. advena* based on conidial shape and dimensions. However, the broad species concept provided by Sullia & Padma (1985) makes it difficult to identify in which myrothecium-like genus this species belongs.

***Myrothecium mucunae*** R.F. Castañeda & W.B. Kendr., *Univ. Waterloo, Biol. Ser.* 35: 73. 1991

Description and illustration — See Castañeda-Ruiz & Kendrick (1991).

Notes — No living material could be located for this species to determine its phylogenetic placement in this study. Castañeda-Ruiz & Kendrick (1991) distinguished this species from other *Myrothecium* species based on the thick-walled, verrucose setae and conidial shape and dimensions. This species clearly does not belong to the genus *Myrothecium* based on the formation of a synnematos conidiomata and thick-walled setae, characteristics also not observed for the other myrothecium-like genera treated here.

***Myrothecium nipponicum*** Matsush., *Matsushima Mycol. Mem.* 8: 27. 1995

Description and illustration — See Matsushima (1995).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. Based on the description and illustrations provided by Matsushima (1995) this species could belong to the genus *Myxospora*.

***Myrothecium renaudii*** Escalona, *Mycotaxon* 61: 82. 1997

Description and illustration — See Escalona (1997).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This fungus is characterised by percurrent vegetative growth of the synnematos conidiomata, which was not observed for any of the synnematos myrothecium-like genera treated here. Therefore, this fungus might represent another new myrothecium-like genus.

***Myrothecium variabile*** Y.M. Wu & T.Y. Zhang, *Mycotaxon* 129: 404. 2014

Description and illustration — See Wu et al. (2014).

Notes — The ex-type strain (HMAS 196284) of this species was not available to determine its phylogenetic placement in this study. Based on the description and illustrations provided by Wu et al. (2014), this species belongs to the genus *Striaticonidium*. However, as no sequence data is presently available to confirm this, we refrain from providing a new combination for this species at this time.

***Myrothecium viride*** S.C. Agarwal, *Curr. Sci.* 49: 281. 1980

Description and illustration — See Agarwal (1980).

Notes — The ex-type strain (IMI 132173) of this species could not be located to determine its phylogenetic placement in this study. The overly broad description and poor illustration provided by Agarwal (1980) makes it difficult to determine to which myrothecium-like genus this species belongs. However, based on conidial shape and dimensions, it clearly does not belong to *Myrothecium* s.str.

***Myrothecium xigazense*** Y.M. Wu & T.Y. Zhang, *Mycotaxon* 129: 405. 2014

Description and illustration — See Wu et al. (2014).

Notes — The ex-type strain (HMAS 196285) of this species was not available to determine its phylogenetic placement in this study. Based on the description and illustrations provided by Wu et al. (2014), this species belongs to the genus *Xepicula*. However, as no sequence data are presently available to confirm this, we refrain from providing a new combination for this species at this time.

***Stachybotrys bambusicola*** Rifai, *Trans. Brit. Mycol. Soc.* 47: 270. 1964

Description and illustration — See Rifai (1964).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This fungus is characterised by percurrent vegetative growth of the conidiophore, which produces pink conidia in mass (Rifai 1964). These characteristics were not observed for any of the studied stachybotrys-like genera introduced here.

***Stachybotrys breviuscula*** McKenzie, *Mycotaxon* 41: 180. 1991

Description and illustration — See McKenzie (1991).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species is morphologically very similar to *St. chartarum* (McKenzie 1991, Wang et al. 2015) and its placement in the ge-



nus *Stachybotrys* is probably correct but needs to be confirmed experimentally.

***Stachybotrys cordylines*** McKenzie, Fung. Diversity 17: 146. 2004

Description and illustration — See Pinruan et al. (2004).

Notes — The ex-type strain (ICMP 15219; Pinruan et al. 2004) of this species was not available to determine its phylogenetic placement in this study.

***Stachybotrys crassa*** Marchal, Bull. Acad. Roy. Sci. Belgique, Cl. Sci., sér. 5, 34: 140. 1895

Description — See Wang et al. (2015).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species appears to produce conidia borne in chains, which could place it in the genus *Memmoniella*.

***Stachybotrys elegans*** (Pidopl.) W. Gams, Compendium of Soil Fungi: 746. 1980

≡ *Hyalobotrys elegans* Pidopl., Fungus flora of coarse fodder: 186. 1948.  
= *Stachybotrys pallida* Orpurt, Studies on the soil microfungi of Wisconsin prairies, Diss. Univ. Wisconsin: 95. 1954 [nom. invalid., Art. 30.5, 36.1].  
= *Hyalostachybotrys bisby* Sriniv., J. Indian Bot. Soc. 37: 340. 1964.  
For additional synonyms see Wang et al. 2015.

Description and illustration — See Domsch et al. (1980).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species is characterised by hyaline, smooth, limoniform to fusiform conidia, which would place it in the stachybotrys-like genus *Achroiostachys*.

***Stachybotrys freycinetiae*** McKenzie, Mycotaxon 41: 183. 1991

Description and illustration — See McKenzie (1991).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species is morphologically very similar to *St. chartarum* (McKenzie 1991, Wang et al. 2015), and its placement in the genus *Stachybotrys* is probably correct but needs to be confirmed experimentally.

***Stachybotrys frondicola*** (K.D. Hyde et al.) Yong Wang et al., Fung. Diversity 70: 52. 2015

≡ *Ornatipora frondicola* K.D. Hyde et al., Mycol. Res. 103: 1438. 1999.

Description and illustration — See Hyde et al. (1999).

Notes — No ex-type strain of this species is available to determine its phylogenetic placement. Hyde et al. (1999) did not include a description of the asexual morph of *O. frondicola* in their treatment of this fungus.

***Stachybotrys globose*** P.C. Misra & S.K. Srivast., Trans. Brit. Mycol. Soc. 78: 556. 1982

Description and illustration — See Misra & Srivastava (1982).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species is morphologically very similar to *St. microspora*

(Wang et al. 2015) and its placement in the genus *Stachybotrys* is probably correct but needs to be confirmed experimentally.

***Stachybotrys guttulispora*** Muhsin & Al-Helfi, Sydowia 34: 133. 1981

Description and illustration — See Muhsin & Al-Helfi (1981).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. Muhsin & Al-Helfi (1981) and Wang et al. (2015) considered it morphologically similar to *St. albipes* (= *Melanopsamma pomiformis*) but distinguished it based on the biguttulate, ellipsoidal, smooth conidia formed on thin-walled, verrucose, hyaline conidiophores. These are distinct characters not observed for any of the stachybotrys-like fungi studied here, which exclude this species from *Stachybotrys* s.str., pending availability of sequence data to confirm this.

***Stachybotrys havanensis*** Mercado & J. Mena, Acta Bot. Cub. 55: 2. 1988

Description — See Mercado Sierra et al. (1997).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys jiangziensis*** Y.M. Wu & T.Y. Zhang, Mycotaxon 114: 459. 2010

Description and illustration — See Wu & Zhang (2010).

Notes — The ex-type strain (HMAS 196256; Wu & Zhang 2010) of this species was not available to determine its phylogenetic placement in this study.

***Stachybotrys kampalensis*** Hansf., Proc. Linn. Soc. London 155: 45. 1943

Description and illustration — See Hansford (1943).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys kapiti*** Whitton et al., New Zealand J. Bot. 39: 493. 2001

Description and illustration — See Whitton et al. (2001).

Notes — No ex-type strain of this species is available to determine its phylogenetic placement.

***Stachybotrys mangiferae*** P.C. Misra & S.K. Srivast., Trans. Brit. Mycol. Soc. 78: 556. 1982

Description and illustration — See Misra & Srivastava (1982).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys mexicanus*** J. Mena & Heredia, Boln Soc. Micol. Madrid 33: 12. 2009

Description — See Wang et al. (2015).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. Based on the hyaline, smooth, ellipsoidal to limoniform conidia (Wang et al. 2015) produced by this fungus, it probably belongs to the genus *Achroiostachys*.

***Stachybotrys nepalensis*** (Whitton et al.) Whitton et al., Fung. Diversity 70: 59. 2015

≡ *Ornatisspora nepalensis* Whitton et al., Fungi associated with Pandanaceae. Fung. Divers. Res. Ser. 21: 86. 2012.

Description and illustration — See Whitton et al. (2012) and Wang et al. (2015).

Notes — No ex-type strain of this species is available to determine its phylogenetic placement.

***Stachybotrys nephrodes*** McKenzie, Mycotaxon 41: 185. 1991

Description and illustration — See McKenzie (1991).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species is morphologically very distinct, having tightly curled or tightly reniform conidia (McKenzie 1991, Wang et al. 2015) and its placement in the genus *Stachybotrys* is probably incorrect but needs to be confirmed experimentally.

***Stachybotrys nephrospora*** Hansf., Proc. Linn. Soc. London 155: 45. 1943

Description and illustration — See Hansford (1943).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. See notes under *St. reniformis* for more comments.

***Stachybotrys nielamuensis*** Y.M. Wu & T.Y. Zhang, Mycotaxon 109: 461. 2009

Description and illustration — See Wu & Zhang (2009).

Notes — The ex-type strain (HMAS 196254; Wu & Zhang 2009) of this species was not available to determine its phylogenetic placement in this study. The smooth, thick-walled conidiophores with a slightly bulbous apex as illustrated by Wu & Zhang (2009) indicates that this species might belong to the genus *Melanopsamma*.

***Stachybotrys nilagirica*** Subram., Proc. Indian Acad. Sci., Pl. Sci. 46: 331. 1957

Description and illustration — See Subramanian (1957) and Wang et al. (2015).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. See notes under *Mem. pseudonilagiria* for more comments.

***Stachybotrys palmae*** Pinruan, Fung. Diversity 17: 146. 2004

Description and illustration — See Pinruan et al. (2004).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species is distinct in producing hyaline, verrucose conidia on conidiophores that are darkly pigmented for the bottom two-thirds of its length (Pinruan et al. 2004) making its placement in *Stachybotrys* s.str. highly unlikely. This species probably represents a new stachybotrys-like genus, but requires sequence data to confirm this.

***Stachybotrys palmicola*** (K.D. Hyde et al.) Yong Wang et al., Fung. Diversity 70: 61. 2015

≡ *Ornatisspora palmicola* K.D. Hyde et al., Mycol. Res. 103: 1438. 1999.

Description and illustration — See Hyde et al. (1999).

Notes — No ex-type strain of this species is available to determine its phylogenetic placement. Hyde et al. (1999) was unable to include a description of the asexual morph of *O. palmicola* in their treatment of this fungus, as only scattered remnants of conidiophore-like structures on the ascumata were found and illustrated.

***Stachybotrys palmijunci*** Rifai, Reinwardtia 8: 537. 1974

Description and illustration — See Rifai (1974).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This fungus is characterised by percurrent vegetative growth of the conidiophore, which produces pink conidia in mass (Rifai 1974), similar to *St. bambusicola* (Rifai 1964). These characteristics were not observed for any of the studied stachybotrys-like genera introduced here.

***Stachybotrys parvispora*** S. Hughes, Mycol. Pap. 48: 74. 1952

Description and illustration — See Hughes (1952).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species is morphologically similar to *St. chartarum*, but is distinguished by smaller, smooth-walled conidia (Wang et al. 2015).

***Stachybotrys proliferata*** K.G. Karand., S.M. Kulk. & Patw., Biovigyanam 18: 79. 1992

Description — See Wang et al. (2015).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species is characterised by reniform conidia and indeterminate conidiophores, which proliferate through the apex in place of the phialides (Wang et al. 2015). These characteristics excludes this species from *Stachybotrys* s.str. and its phylogenetic relationship needs to be determined.

***Stachybotrys punctata*** (Dulym. et al.) Yong Wang et al., Fung. Diversity 70: 61. 2015

≡ *Ornatisspora punctata* Dulym. et al., Fung. Diversity 8: 95. 2001.

Description and illustration — See Dulymamode et al. (2001).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. Dulymamode et al. (2001) did not include a description of the asexual morph in their treatment of this fungus.

***Stachybotrys queenslandica*** Matsush., Matsushima Mycol. Mem. 6: 40. 1989

Description and illustration — See Matsushima (1989).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. Based on the description and illustrations provided by Matsushima (1989), this species might belong to the new genus *Melanopsamma*.

***Stachybotrys ramosa*** Dorai & Vittal, Trans. Brit. Mycol. Soc. 87: 642. 1987

Description and illustration — See Dorai & Vittal (1987).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.



This species is characterised by sympodially branched conidiophores that are loosely intertwined, which excludes this species from *Stachybotrys* s.str. and its phylogenetic relationship needs to be determined.

***Stachybotrys renispora*** P.C. Misra, Mycotaxon 4: 161. 1976

Description and illustration — See Misra (1976).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species is morphologically similar to *St. reniformis* and *St. renisporoides*, which Wang et al. (2015) considers the latter as a possible synonym of *St. renispora*, pending further study.

***Stachybotrys renisporoides*** K.G. Karand., S.M. Kulk. & Patw., Biovignanam 19: 79

Description — See Wang et al. (2015).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species is probably a synonym of *St. renispora*, which requires further investigation.

***Stachybotrys reniverrucosa*** Whitton et al., New Zealand J. Bot. 39: 496. 2001

Description and illustration — See Whitton et al. (2001).

Notes — No ex-type strain of this species is available to determine its phylogenetic placement.

***Stachybotrys ruwenzoriensis*** Matsush., Matsushima Mycol. Mem. 4: 17. 1985

Description and illustration — See Matsushima (1985).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys sansevieriae*** G.P. Agarwal & N.D. Sharma, J. Indian Bot. Soc. 53: 78. 1974

= *Stachybotrys indica* P.C. Misra, Mycotaxon 2: 107. 1975.

Description and illustration — See Sharma & Agarwal (1974).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys sinuatophora*** Matsush., Bull. Natl. Sci. Mus., Tokyo 14: 476. 1971

Description and illustration — See Kobayashi (1971).

Notes — The ex-type strain (ATCC 22706; Jong & Davis 1976) of this species was not available to determine its phylogenetic placement in this study. This species was synonymised under *St. nephrospora* by Jong & Davis (1976) based on conidial morphology. However, Wang et al. (2015) considered it distinct from *St. nephrospora* after examination of type material. *Stachybotrys sinuatophora* is characterised by repeatedly, alternately branched, undulating to coiling conidiophores (Kobayashi 1971) not known for *St. nephrospora* (Hansford 1943) or other species of *Stachybotrys* s.str.

***Stachybotrys sphaerospora*** Morgan-Jones & R.C. Sinclair, Mycotaxon 10: 372. 1980

Description and illustration — See Morgan-Jones & Sinclair (1980).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys suthepensis*** Photita et al., Cryptog. Mycol. 24: 149. 2003

Description and illustration — See Photita et al. (2003).

Notes — The ex-type strain (BCC 9776; Photita et al. 2003) of this species was not available to determine its phylogenetic placement in this study.

***Stachybotrys taiwanensis*** (Sivan. & W.H. Hsieh) Yong Wang et al., Fung. Diversity 70: 70. 2015

= *Niesslia taiwanensis* Sivan. & W.H. Hsieh, Mycol. Res. 93: 342. 1989.

Description and illustration — See Sivanesan & Hsieh (1989).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. Wang et al. (2015) provided a new combination for *Niesslia taiwanensis* in *Stachybotrys* without explanation. Sivanesan & Hsieh (1989) considered the conidiophores formed in culture could represent *Monocillium* but could not confirm this due to a lack of conidia. Placement of this species in *Stachybotrys* is doubtful pending further investigation.

***Stachybotrys terrestris*** J.H. Kong & T.Y. Zhang, Mycosystema 26: 200. 2007

Description and illustration — See Kong et al. (2007).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys thaxteri*** D.W. Li, Mycotaxon 115: 240. 2011

Description and illustration — See Li (2011).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. The smooth-walled, striate conidia produced by this fungus (Li 2011) indicate that this species probably belongs to the new genus *Striatibotrys*.

***Stachybotrys theobromae*** Hansf., Proc. Linn. Soc. London 155: 45. 1943

Description and illustration — See Hansford (1943).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. See notes under *Grandibotrys*.

***Stachybotrys thermotolerans*** McKenzie, Fung. Diversity 17: 149. 2004

Description — See Pinruan et al. (2004).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys variabilis*** H.F. Wang & T.Y. Zhang, Mycosystema 28: 23. 2009

Description and illustration — See Wang & Zhang (2009).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys verrucispora*** Matsush., Matsushima Mycol. Mem. 4: 18. 1985

Description and illustration — See Matsushima (1985).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys virgata*** Krzemien. & Badura, Acta Soc. Bot. Poloniae 23: 759. 1954

Description and illustration — See Wang et al. (2015).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys waitakere*** Whitton, McKenzie & K.D. Hyde, New Zealand J. Bot. 39: 497. 2001

Description and illustration — See Whitton et al. (2001).

Notes — No ex-type strain of this species is available to determine its phylogenetic placement.

***Stachybotrys xanthosomatis*** Mercado & J. Mena, Acta Bot. Cub. 55: 4. 1988

Description and illustration — See Mercado Sierra et al. (1997).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys xigazenensis*** Y.M. Wu & T.Y. Zhang, Mycotaxon 114: 461. 2010

Description and illustration — See Wu & Zhang (2010).

Notes — The ex-type strain (HMAS 196257; Wu & Zhang 2010) of this species was not available to determine its phylogenetic placement in this study.

***Stachybotrys yunnanensis*** H.Z. Kong, Mycotaxon 62: 427. 1997

Description and illustration — See Kong (1997).

Notes — The ex-type strain (HMAS 71158; Kong 1997) of this species was not available to determine its phylogenetic placement in this study.

***Stachybotrys zeae*** Morgan-Jones & Karr, Mycotaxon 4: 510. 1976

Description and illustration — See Morgan-Jones & Karr (1976).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Stachybotrys zhangmuensis*** Y.M. Wu & T.Y. Zhang, Mycotaxon 109: 463. 2009

Description and illustration — See Wu & Zhang (2009).

Notes — The ex-type strain (HMAS 196255; Wu & Zhang 2009) of this species was not available to determine its phylogenetic placement in this study.

***Stachybotrys zingiberis*** (V. Rao) Yong Wang et al., Fung. Diversity 70: 70. 2015

≡ *Memnoniella zingiberis* V. Rao, Sydowia 16: 43. 1962.

Description and illustration — See Rao (1962).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. See notes under *Brevistachys*.

***Stachybotrys zuckii*** K. Matsush. & Matsush., Matsushima Mycol. Mem. 8: 53. 1995

Description and illustration — See Matsushima & Matsushima (1995).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. This species produces conidia in both slimy masses and in dry chains (Matsushima & Matsushima 1995), which indicates that this species might belong to the genus *Memnoniella*.

***Xepicula leucotrichoides*** Nag Raj, Coelomycetous anamorphs with appendage-bearing conidia: 980. 1993

Description and illustration — See Nag Raj (1993).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study. Nag Raj (1993) distinguished *X. leucotrichoides* from *X. leucotricha* based on the longer setae of *X. leucotrichoides* (up to 300 µm) compared to those of *X. leucotricha* (up to 200 µm). See notes under *Xepicula*.

***Xepiculopsis*** Nag Raj, Coelomycetous anamorphs with appendage-bearing conidia: 983. 1993

*Type species. Xepiculopsis graminea* (Lib.) Nag Raj.

Description and illustration — See Nag Raj (1993).

Notes — Nag Raj (1993) introduced the asexual genus *Xepiculopsis* (*Xe.*), based on *X. graminea* (≡ *Myr. gramineum*), distinguishing it from *Xepicula* by the aseptate, thick-walled setae and two kinds of sterile excipular elements. Unfortunately, no living cultures could be located representing this genus.

***Xepiculopsis graminea*** (Lib.) Nag Raj, Coelomycetous anamorphs with appendage-bearing conidia: 983. 1993

≡ *Myrothecium gramineum* Lib., Pl. Crypt. Arduenna: 380. 1837.

Description and illustration — See Nag Raj (1993).

Notes — No living type material could be located for this species to determine its phylogenetic placement in this study.

***Xepiculopsis perpulchra*** Nag Raj, Coelomycetous anamorphs with appendage-bearing conidia: 983. 1993

Description and illustration — See Nag Raj (1993).

Notes — Nag Raj (1993) distinguished *Xe. graminea* from *Xe. perpulchra* based on conidial dimensions. No living type material could be located for this species to determine its phylogenetic placement in this study.

## KEY TO GENERA IN STACHYBOTRIACEAE

1. Genera with sporodochial, myrothecium-like conidiomata 2
1. Genera with stachybotrys-like conidiophores . . . . . 18
1. Genera with synnematosous conidiomata or not as above 28
2. Sporodochia surrounded by white to grey fringe . . . . . 3
2. Sporodochia lacking a fringe . . . . . 13
3. One type of setae present . . . . . 4
3. Two types of setae present . . . . . 12



3. Sterile hyphoid extensions protruding through the olivaceous green to black conidial masses, hyaline, septate, smooth, simple or apically dichotomously branched; conidia 0–1-septate, cylindrical, straight to curved . . . . . *Septomyrothecium*
4. Setae thick-walled . . . . . 5
4. Setae thin-walled . . . . . 8
5. Setae septate . . . . . 6
5. Setae aseptate, smooth-walled; marginal hyphae of sporodochia of two kinds; conidiophores branched or unbranched, smooth, hyaline; conidiogenous cells phialidic, subcylindrical to lageniform to ampulliform, smooth, hyaline; conidia aseptate, fusiform to ellipsoidal, smooth, with apical, funnel-shaped mucoid appendage . . . . *Xepiculopsis*
6. Conidia bearing an apical funnel-shaped mucoid appendage . . . . . 7
6. Conidia lacking an apical funnel-shaped mucoid appendage, fusiform, initially hyaline becoming darker with age; conidiophores hyaline, smooth to lightly verrucose . . . . . *Myxospora*
7. Conidia hyaline, smooth-walled, fusiform to ellipsoidal to asymmetrically ellipsoidal; setae hyaline, smooth to lightly verrucose . . . . . *Inaequalispora*
7. Conidia pale green, smooth-walled, fusiform to ellipsoidal; setae hyaline, smooth-walled . . . . . *Xepicula*
8. Conidial mass olivaceous green to black . . . . . 9
8. Conidial mass orange; conidia smooth-walled, ellipsoidal to ovoid . . . . . *Tangerinosporium*
9. Conidia lacking ornamentations . . . . . 10
9. Conidia with longitudinal striations, olivaceous green to brown, fusiform to ellipsoidal . . . . . *Striaticonidium*
10. Conidia > 5 µm in length . . . . . 11
10. Conidia < 5 µm in length, hyaline, smooth, ellipsoidal to ovoid; conidiogenous cells sometimes arising directly from vegetative hyphae directly or borne on a short stipe . . . . . *Myrothecium*
11. Conidia aseptate, ellipsoidal to fusiform to limoniform to subglobose, hyaline, sometimes bearing an apical funnel-shaped mucoid appendage; setae hyaline, verrucose, straight to circinate . . . . . *Albifimbria*
11. Conidia 0–1-septate, cylindrical to ellipsoidal to obovoid, straight to slightly bent, hyaline to pale green; setae hyaline, smooth-walled, becoming sinuous above the apical septum . . . . . *Paramyrothecium*
12. Type I setae thin-walled, flexuous to circinate, verrucose, hyaline; Type II setae hyaline, septate, thick-walled, smooth; conidia fusiform, bearing an apical funnel-shaped mucoid appendage . . . . . *Dimorphiseta*
12. Type I setae compacted, thick-walled, verrucose, emerald green; Type II setae hyaline, septate, thick-walled, smooth to lightly verrucose; conidia obclavate to narrowly ellipsoidal . . . . . *Smaragdiniseta*
13. Setae present . . . . . 14
13. Setae absent . . . . . 17
14. Setae hyaline . . . . . 15
14. Setae darkening towards the base; conidia cylindrical to ellipsoidal to ovoid, hyaline to subhyaline . . . . *Alfaria*
15. Setae with acute apices . . . . . 16
15. Setae with obtuse apices, conidia ellipsoidal, smooth-walled, hyaline . . . . . *Parvothecium*
16. Conidiophore stipes hyaline to subhyaline, septate, becoming constricted at the septa, smooth; conidiogenous cells hyaline, cylindrical to subcylindrical, straight to slightly curved; conidia cylindrical to subcylindrical . . . . . *Gregatothecium*
16. Conidiophore stipes hyaline, septate without constrictions; conidiogenous cells hyaline cylindrical to subcylindrical, straight to slightly curved, covered by olivaceous green mucoid layer; conidia cylindrical . . . . . *Neomyrothecium*
17. Marginal hyphae terminating in a capitate to clavate thick-walled cell, coarsely rugose or tuberculate; conidiophores subhyaline to pale olivaceous brown; conidiogenous cells hyaline, smooth; conidia cylindrical, smooth, olivaceous brown . . . . . *Capitofimbria*
17. Marginal hyphae well-developed, slightly involute, verrucose, loosely coiled; conidiophores hyaline; conidiogenous cells olivaceous green, verrucose; conidia oblong-ellipsoidal, smooth pale olivaceous green . . . . . *Xenomyrothecium*
18. Conidiophores thin-walled . . . . . 19
18. Conidiophores thick-walled . . . . . 25
19. Conidiophores hyaline . . . . . 20
19. Conidiophores hyaline to subhyaline to pale green . . . . 22
20. Conidia initially hyaline becoming pigmented with age . . . 21
20. Conidia remaining hyaline, smooth, ellipsoidal to limoniform to globose to subglobose, containing 1–2 large guttules; conidiophores smooth with verrucose base, 1–3-septate; phialides elongate ampulliform to ventricose to subcylindrical, smooth to verrucose . . . . . *Achroiostachys*
21. Conidia globose to broadly ellipsoidal, thick-walled, containing 1–2 guttules, with truncate hilum . . . . . *Globobotrys*
21. Conidia limoniform to ellipsoidal, thick-walled, with mammiform apices and rounded base . . . . . *Grandibotrys*
22. Conidiophores unbranched or branched once . . . . . 23
22. Conidiophores irregularly cymosely branched, smooth to slightly verrucose; conidia olivaceous to dark brown, smooth to verrucose, fabiform to globose . . . . . *Cymostachys*
23. Conidiophores carried on vegetative hyphae . . . . . 24
23. Conidiophores carried on synnematus hyphae, smooth with verrucose apex; conidia hyaline to olivaceous brown to dark brown, smooth to verrucose, ellipsoidal to obovoid to cylindrical . . . . . *Sirastachys*
24. Conidiophores 1–3-septate, smooth to verrucose; conidia olivaceous brown to dark brown, smooth to verrucose, ellipsoidal to globose to fusiform to limoniform . . . . *Stachybotrys*
24. Conidiophores 1–5-septate, smooth with verrucose apex, conidia pale olivaceous brown to dark brown, smooth with longitudinal striations, ellipsoidal to fusiform to subcylindrical . . . . . *Striatibotrys*
25. Conidiophores hyaline to subhyaline to pale brown . . . . 26
25. Conidiophores dark brown, with 1–3 percurrent proliferations at the apex; conidia smooth, hyaline, ellipsoidal . . . . . *Kastanostachys*
26. Conidiophores with bulbous apex . . . . . 27
26. Conidiophores without bulbous apex, unbranched, smooth to lightly verrucose; conidia initially hyaline becoming olivaceous brown to dark brown, smooth to verrucose, thick-walled, ellipsoidal to globose to reniform, sometimes borne in chains . . . . . *Memnoniella*
27. Conidiophores 1-septate, terminating in 3–8 conidiogenous cells; conidiogenous cells carried on the apices of the conidiophores or on the stipe; conidia hyaline to dark brown, smooth to verrucose, obovoid to globose to ovoid to ellipsoidal . . . . . *Brevistachys*
27. Conidiophores 1–5-septate, terminating in 4–10 conidiogenous cells; conidia hyaline to dark brown, smooth to verrucose, limoniform to obovoid to globose to ellipsoidal, containing 1–2 guttules . . . . . *Melanopsamma*

28. Conidiomata synnematosus . . . . . 29
28. Conidiomata not synnematosus, straight to flexuous, verrucose becoming warty with age, hyaline to subhyaline, branched in the upper regions with spiralling to twisted ends, conidiogenous cells carried in the middle or on branches in rows or whorls; conidia cylindrical, straight to curved with mucoid appendages at both ends *Parasarcopodium*
29. Synnemata white to yellow . . . . . 30
29. Synnemata white to dark brown or black to olivaceous grey . . . . . 31
30. Conidia ellipsoidal to oblong, thick-walled, dark brown to black, 3-septate . . . . . *Albosynnema*
30. Conidia ellipsoidal to limoniform, thick-walled, hyaline to subhyaline, 1-septate, with mammiform basal and/or apical protrudance . . . . . *Peethambara*
31. Conidia 0–1-septate, ellipsoidal to fusiform, thick-walled, with mammiform basal and/or apical protrudance . . . . . *Didymostilbe*
31. Conidia 3-septate, fusiform with papillate and truncate ends, olivaceous grey, coarsely striate . . . . . *Virgatospora*

## DISCUSSION

This study represents the first multi-locus sequence analysis of the family *Stachybotriaceae*, and provides a broad phylogenetic backbone and framework for future studies of this fungal family. In this study, we were able to resolve 33 genera in the *Stachybotriaceae*, of which 21 are newly introduced here. The remaining 12 genera include established genera (i.e., *Myrothecium*, *Peethambara* and *Stachybotrys*), of which some (i.e., *Albosynnema*, *Alfaria*, *Didymostilbe*, *Parasarcopodium*, *Septomyrothecium* and *Xepicula*) were previously treated as either *incertae sedis* or members of the *Bionectriaceae* (Nag Raj 1993, Rossmann et al. 1999, Seifert et al. 2003, Mel'nik et al. 2004, Decock et al. 2008, Crous et al. 2014). Several older generic names were also resurrected here (i.e., *Melanopsamma*, *Memnoniella* and *Virgatospora*) based on phylogenetic inference.

This study supports the view of Nag Raj (1993, 1995) that the overly broad generic concept for the genus *Myrothecium* (Tulloch 1972) has resulted in the misplacement of several fungal species in this genus based solely on the formation of green, slimy, aseptate conidia (Matsushima 1995, Escalona 1997, Seifert et al. 2003, Watanabe et al. 2003, Castañeda-Ruiz et al. 2008, Decock et al. 2008, Alves et al. 2010, Jiang et al. 2014, Wu et al. 2014). Multi-locus phylogenetic inference, supported by phenotypic characters in this study revealed that *Myrothecium* fide Tulloch is generically diverse with the introduction of 13 new genera (*Albifimbria*, *Capitofimbria*, *Dimorphiseta*, *Gregatothecium*, *Inaequalispora*, *Myxospora*, *Neomyrothecium*, *Paramyrothecium*, *Parvothecium*, *Smaragdini-seta*, *Striaticonidium*, *Tangerinosporium* and *Xenomyrothecium*). *Septomyrothecium* (Matsushima 1971a) and *Xepicula* (Nag Raj 1993) are also recognised as distinct genera in this study. Additionally, several strains deposited in the CBS collection as *Myrothecium* species surprisingly belonged to the presumed monotypic genus *Alfaria* (Crous et al. 2014) based on phylogenetic inference.

Of the 13 new myrothecium-like genera introduced here, nine are monotypic, i.e., *Capitofimbria compacta* (= *Myr. compactum*; Castañeda-Ruiz et al. 2008), *Inaequalispora prestonii* (= *Myr. prestonii*; Tulloch 1972, Nag Raj 1995), *Smaragdini-seta bisetosa* (= *Myr. bisetosum*; Rao & De Hoog 1983) and *Xenomyrothecium tongaense* (= *Myr. tongaense*; DiCosmo et al. 1980) were initially treated as members of *Myrothecium*. The remaining five monotypic genera include *Dimorphiseta terrestris*, *Gregatothecium humicola*, *Neomyrothecium humi-*

*cola*, *Parvothecium terrestre* and *Tangerinosporium thalicicola*. *Albifimbria*, based on *Al. verrucaria* (= *Myr. verrucaria*; Tulloch 1972), *Myxospora*, based on *Myx. masonii* (Tulloch 1972), *Paramyrothecium*, based on *Pa. roridum* (= *Myr. roridum*; Tulloch 1972) and *Striaticonidium*, based on *Stri. cinctum* (= *Myr. cinctum*; Tulloch 1972) also include well-known species, previously treated as members of *Myrothecium*.

The present morphological emendment of *Myrothecium* to include only species producing conidia that are less than 5 µm in length, borne in olivaceous to dark green slimy masses surrounded by a setose fringe, reduces this genus to only two species. Although the remaining myrothecium-like genera share several phenotypic characters, suitable morphological features could be identified to distinguish these fungal genera. For example, the genera *Albifimbria*, *Alfaria*, *Dimorphiseta*, *Inaequalispora*, *Myxospora*, *Paramyrothecium*, *Smaragdini-seta*, *Xepicula* and *Xepiculopsis* each produce setae that have distinct morphologies (Tulloch 1972, Rao & De Hoog 1983, Nag Raj 1993); *Capitofimbria* is characterised by marginal hyphae terminating in thick-walled cells (Castañeda-Ruiz et al. 2008); *Gregatothecium* is characterised by sporodochial and penicillately branched conidiomata; *Neomyrothecium* is characterised by the absence of a setose fringe, but producing thin-walled setae; *Parvothecium* is also characterised by the absence of a setose fringe but producing verrucose conidiogenous cells; *Septomyrothecium* is characterised by long hyphoid extensions (Decock et al. 2008); *Striaticonidium* is characterised by striate conidia not seen for other genera in this group; *Tangerinosporium* is the only genus in this group to produce orange conidial masses; *Xenomyrothecium* is characterised by the lack of setae formation.

Comparisons of the ecological characters of the myrothecium-like genera included in this study revealed that the majority of the genera are soil-borne fungi displaying a saprobic lifestyle. Only a small number of species were originally obtained from symptomatic plant material, but their relevance as plant pathogens require further investigation. Based on the narrowed generic concept for *Myrothecium* applied in this study, this genus appears to be fungicolous as the majority of the strains included were originally isolated from dry or decaying agarics.

This study represents the largest collection of *Myrothecium* s.l. species subjected to DNA sequence analyses thus far. DNA sequence data for the *cmdA*, ITS, LSU, *rpb2*, *tef1* and *tub2* gene regions have been extensively used to explore the phylogenetic relationships within and between genera in the *Hypocreales* (Chaverri et al. 2011, Gräfenhan et al. 2011, Lombard et al. 2015b). In this regard, analyses of the individual gene regions (results not shown) showed that partial sequences of the *rpb2* gene region followed by *cmdA* and *tub2* gene regions provided the best statistical support to resolve genera and underlying species for this group of fungi. The LSU sequence data also provided significant support at the generic level, but failed to resolve most of the species within the myrothecium-like genera. The ITS gene region, the standard fungal barcode region (Schoch et al. 2012), provided the least resolution at the generic and species level, although most were resolved with low to moderate statistical support. Sequences of the *tef1* gene region for the *Myrothecium* s.l. species included numerous ambiguous regions, complicating alignment of the sequences within and between the myrothecium-like genera. Phylogenetic inference of this gene region produced conflicting results compared to the other five gene regions used in this study. Therefore, this gene region was excluded in the multi-locus analyses.

Wang et al. (2015) questioned whether *Stachybotrys* represents a monophyletic or polyphyletic genus. Phylogenetic inference in this study clearly illustrated that this genus harbours several



phylogenetic genera of which seven were provided with names in this study. At the same time, the genera *Melanopsamma* and *Memnoniella* are resurrected to genus level based on the well-supported monophyletic clades resolved in this study. Wang et al. (2015) synonymised both *Melanopsamma* and *Memnoniella* under *Stachybotrys* based on ITS sequence data and following the arguments of Haugland et al. (2001) and Castlebury et al. (2004). The greatest problem facing taxonomic studies of the genus *Stachybotrys*, is the availability of living type material for molecular study. Of the 74 *Stachybotrys* species recognised by Wang et al. (2015), sequence data of type material were available for only 15 species (Haugland et al. 2001, Andersen et al. 2003, Li 2007, Jie et al. 2013, Wang et al. 2015).

Of the eight new stachybotrys-like genera introduced in this study, only *Globobotrys sansevieriicola* (= *St. sansevieriicola*; Crous et al. 2015) and *Kastanostachys aterrima* (= *Chaetosphaeria aterrima*; Réblová 1998) formed single lineages distant to the *Stachybotrys* s.str. clade. The remaining six genera introduced here (*Achroioestachys*, *Brevistachys*, *Cymostachys*, *Grandibotrys*, *Sirastachys* and *Striatibotrys*) each formed well to highly supported monophyletic clades, distant or closely related to the *Melanopsamma*, *Memnoniella* and *Stachybotrys* s.str. clades, which was further supported by subtle but suitable phenotypic characters (see notes in Taxonomy section). Of these genera with stachybotrys-like morphology, only *Brevistachys* did not group in the complex of genera centred on *Stachybotrys*, but formed together with *Parasarcopodium* a statistically unsupported sister lineage to the clade containing myrothecium-like genera.

Sequence comparisons of the individual loci defined in this study (results not shown) for *Stachybotrys* s.l., showed that the *cmdA* and *rpb2* gene regions provided similar and the highest statistical support to resolve genera and underlying species for this group of fungi. Both the *tef1* and *tub2* gene regions were also able to provide resolution, although with lower statistical support, at the generic and species level, with LSU sequence data only providing significant support at the generic level. The ITS sequence data did not resolve the same clades as was observed for the *Stachybotrys* s.l. dataset based on five loci. Where similar clades were resolved, the support values were lower or equal, with less phylogenetic species resolved. This lack of consistency between the results of the ITS phylogenetic inference and that of the combined five-locus phylogenetic inference highlights the limitations of using ITS sequences to identify *Stachybotrys* species and species in allied genera (Stielow et al. 2015).

The ecological niche of *Stachybotrys* s.str. has been well documented in the past (Ellis 1971, 1979, Jong & Davis 1976, McKenzie 1991, Redlick et al. 1997, Whitton et al. 2001, Andersen et al. 2003, Tang et al. 2007, Pinruan et al. 2004, Li 2007, Crook & Burton 2010, Jie et al. 2013, Wang et al. 2015) and comparison with the remaining 10 genera showed some overlap. Species in the genera *Achroioestachys*, *Grandibotrys*, *Kastanostachys*, *Memnoniella*, *Sirastachys* and *Striatibotrys* were mostly isolated from soil and decaying plant material, indicating a possible saprobic lifestyle. Species of *Brevistachys*, *Cymostachys*, *Globobotrys* and *Melanopsamma* were mostly isolated from living plant material, although it is not clear whether these fungi were isolated from symptomatic plant material. Therefore, the relevance of these fungi as plant pathogens requires further investigation.

The inclusion of *Parasarcopodium ceratocaryi* within the *Stachybotriaceae* was surprising, as this fungus was initially classified as a member of the *Bionectriaceae* based on LSU sequence data (Mel'nik et al. 2004). This fungus displays a distinct morphology unlike any observed for the other genera studied

here. Additionally, the phylogenetic placement of *Alfaria*, with its myrothecium-like asexual morph morphology, and *Didymostilbe*, with its synnematos conidiomata (Seifert 1985), in close relationship with the stachybotrys-like genera *Achroioestachys*, *Globobotrys*, *Grandibotrys*, *Melanopsamma* and *Sirastachys* was unexpected. This poses interesting questions pertaining to the morphological evolution of these fungi, which requires further investigation.

In conclusion, this study should serve as a backbone for future taxonomic studies of the *Stachybotriaceae*. A large number of species, especially those with a stachybotrys-like morphology, still need to be included in a phylogenetic study to clarify the taxonomy of this apparently heterogeneous group of fungi. This also highlights the importance of maintaining living type cultures in public culture collections, as molecular analysis techniques are becoming commonplace in modern taxonomic studies of fungi. At present only one genome sequence is available for *Myr. inundatum* (<http://genome.jgi.doe.gov>) and for *Stachybotrys* only genome sequences of *St. chartarum* (Semeiks et al. 2014, Betancourt et al. 2015) and *St. chlorohalonata* (Semeiks et al. 2014) are presently available. This under-representation of these fungi in genomic studies is unexpected, especially since they play such an important role in human health. Further genomic studies are therefore urgently required to address this issue.

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