

Inside *Plectosphaerellaceae*

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Abstract: The family *Plectosphaerellaceae* (*Glomerellales*, *Sordariomycetes*) includes numerous plant pathogenic genera and soil-borne fungal species. Ten genera are currently accepted, including several taxa that occupy an unresolved position within the family. To address this issue, a multilocus sequence analysis was carried out using partial gene sequences from the 28S large subunit nrRNA gene (LSU), the internal transcribed spacer (ITS) regions of the nrDNA region, including the 5.8S nrRNA gene, the translation elongation factor 1-alpha (*TEF1-α*), tryptophan synthase (*TS*), actin (*ACT*) and the RNA polymerase II second largest subunit (*RPB2*), based on a large set of isolates mainly from the CBS collection. Results of the molecular data combined with a detailed morphological study resolved 22 genera in the family, of which 12 are newly described. Additionally, 15 new species and 10 new combinations are proposed. An epitype and neotype are also introduced for *Stachylidium bicolor* and *Plectosphaerella cucumerina*, respectively.

Key words: *Acremonium*, New taxa, Phylogeny, Plant pathogens, *Plectosphaerella*, Soil fungi, Taxonomy.

Taxonomic novelties: new genera: *Brunneochlamydosporium* Giraldo López & Crous, *Chlamydosporiella* Giraldo López & Crous, *Furcaterigmium* Giraldo López & Crous, *Fuscohypha* Giraldo López & Crous, *Musidium* Giraldo López & Crous, *Nigrocephalum* Giraldo López & Crous, *Paragibellulopsis* Giraldo López & Crous, *Paramusicillium* Giraldo López & Crous, *Phialoparvum* Giraldo López & Crous, *Summerbellia* Giraldo López & Crous, *Sayamraella* Giraldo López & Crous, *Theobromium* Giraldo López & Crous; **New species:** *Brunneochlamydosporium macroclavatum* Giraldo López & Crous, *B. terrestre* Giraldo López & Crous, *Fuscohypha expansa* Giraldo López & Crous, *Gibellulopsis aquatica* Giraldo López & Crous, *G. catenata* Giraldo López & Crous, *Lectera humicola* Giraldo López & Crous, *L. phaseoli* Giraldo López & Crous, *Musicillium tropicale* Giraldo López & Crous, *M. eletariae* Giraldo López & Crous, *Paramusicillium asperulatum* Giraldo López & Crous, *Phialoparvum bifurcatum* Giraldo López & Crous, *Plectosphaerella humicola* Giraldo López & Crous, *Summerbellia oligotrophica* Giraldo López & Crous, *Sayamraella subulata* Giraldo López & Crous, *Theobromium fuscum* Giraldo López & Crous, *Sodiomyces alkalinus* Grum-Grzhim., Debets & Bilanenko; **New combinations:** *Brunneochlamydosporium cibotii* (J.F.H. Beyma) Giraldo López & Crous, *B. nepalense* (W. Gams) Giraldo López & Crous, *Chlamydosporiella restricta* (J.F.H. Beyma) Giraldo López & Crous, *Furcaterigmium furcatum* (W. Gams) Giraldo López & Crous, *Gibellulopsis fusca* (Thurum & Sukapure) Giraldo López & Crous, *G. serrae* (Maffei) Giraldo López & Crous, *Musidium stromaticum* (W. Gams & R.H. Stover) Giraldo López & Crous, *Nigrocephalum collariferum* (Weissenb. & R. Kirschner) Giraldo López & Crous, *Paragibellulopsis chrysanthemi* (Hirooka *et al.*) Giraldo López & Crous, *Sodiomyces alcalophilus* (Okada) Giraldo López & Crous; **Typification: lectotypification:** *Stachylidium bicolor* Link; **Epitypification:** *Stachylidium bicolor* Link; **Neotypification:** *Valentaria cucumerina* Lindf.

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INTRODUCTION

The family *Plectosphaerellaceae* was proposed by Zare *et al.* (2007) based on the plant pathogen *Plectosphaerella cucumerina* as the type species. The saprotrophic species *Verticillium nigrescens* and the causal agent of the cigar-end rot of bananas, *Verticillium theobromae*, which were demonstrated to not be congeneric with the type species of *Verticillium*, *V. dahliae*, were included in the family as members of *Gibellulopsis* and the new genus *Musicillium*, respectively (Zare *et al.* 2007). Additionally, *Verticillium* s. str., the type species of *Acrostalagmus*, *A. luteoalbus*, and other taxa were also placed in the new family. Based on DNA phylogenetic analyses published in the last decade, the genus *Stachylidium*, and recently described genera such as *Brunneomyces*, *Chordomyces*, *Lectera* and *Sodiomyces* have been added to the family (Réblová *et al.* 2011, Cannon *et al.* 2012, Grum-Grzhimaylo *et al.* 2013, 2016, Giraldo *et al.* 2017).

Dedicated to Prof. dr Walter Gams (9 Aug. 1934, 9 Apr. 2017), who spent many years collecting and studying these fungi, and also initially suggested it to us as potential research topic. We thank him for his invaluable comments, taxonomical discussions and detailed morphological observations.

Based on molecular data, Pitt *et al.* (2004) and Zhang *et al.* (2006) demonstrated the affinity between *Plectosphaerella* and *Verticillium dahliae* with *Glomerella*, respectively, which was placed in *Glomerellaceae* although with an uncertain position at the order level in *Hypocreomycetidae* (Zhang *et al.* 2006). Following these studies, Réblová *et al.* (2011) proposed the order *Glomerellales* to accommodate *Glomerellaceae*, and *Plectosphaerellaceae* was considered as sister clade of the new order. Finally, in a recent systematic revision of the families in *Sordariomycetes*, Maharachchikumbura *et al.* (2016) established the taxonomic position of *Plectosphaerellaceae* in the order *Glomerellales*.

Few sexual morphs have been reported in this family. *Plectosphaerella cucumerina* produces perithecial ascomata with clavate asci and hyaline, two-celled ascospores (Uecker 1993, Carlucci *et al.* 2012). This is in stark contrast with the cleistothecial ascomata, saccate asci and pale brown ascospores of *Sodiomyces* spp. (Grum-Grzhimaylo *et al.* 2013, 2016). However, the asexual morphs are more homogeneous, and they have simple or verticillate conidiophores with phialidic conidiogenous cells and mostly cylindrical or ellipsoidal conidia arranged in slimy heads (Zare *et al.* 2007).

Species of this family are mainly soil-borne saprobes or weak to virulent, facultative or obligate plant pathogens. Some are

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causal agents of important diseases in different host plants worldwide (Cannon *et al.* 2012, Carlucci *et al.* 2012, Hyde *et al.* 2014, Giraldo *et al.* 2017). A few species have also been reported as fungicolous or insecticolous, or as opportunistic pathogens of animals (Batista & Maia 1959, Domsch *et al.* 2007, Duc *et al.* 2009, Gräfenhan *et al.* 2011) and some members are known for their alkalitolerant properties (Okada *et al.* 1993, Grum-Grzhimaylo *et al.* 2013, 2016).

Currently, 10 genera are accepted in the family, i.e. *Acrostalagmus*, *Brunneomyces*, *Chordomyces*, *Gibellulopsis*, *Lectera*, *Musciillum*, *Plectosphaerella*, *Sodiomyces*, *Stachylidium* and *Verticillium* s. str. However, *Cephalosporium serrae*, *Gliocladium cibotii* and several *Acremonium* species are included in the family, but their placement remains unresolved. In order to revise this family, we thus conducted a multilocus sequence analysis combined with phenotypic data from all genera and species known in pure culture and traditionally classified as *Plectosphaerellaceae*.

MATERIALS AND METHODS

Isolates

Fungal strains were obtained from the CBS Culture Collection at the Westerdijk Fungal Biodiversity Institute (WI) in Utrecht, The Netherlands, the working collection of Pedro W. Crous housed at the WI (CPC), the CABI Genetic Resource Collection in the UK (IMI), the Canadian Collection of Fungal Cultures (DAOMC) and the BIOTEC Culture Collection in Thailand (BCC).

DNA extraction, amplification and sequencing

Total genomic DNA was extracted from fresh colonies using the Wizard® Genomic DNA Purification Kit (Promega Corporation, Madison, WI, USA), following the manufacturer's protocol. The internal transcribed spacer (ITS) regions and the 5' end of the 28S nrRNA gene (LSU) were amplified and sequenced with the primer pairs ITS5/ITS4 (White *et al.* 1990) and LR0R/LR5 (Vilgalys & Hester 1990, Vilgalys & Sun 1994), respectively. Fragments of the translation elongation factor 1-alpha (*TEF1-α*) and RNA polymerase II second largest subunit (*RPB2*) genes were amplified with the primer sets EF1-983F/EF1-2218R (Rehner & Buckley 2005) and RPB2-5F2/RPB2-7cR (Liu *et al.* 1999), correspondingly. In addition, fragments of actin (*ACT*), elongation factor (*EF*) and tryptophan synthase (*TS*) were amplified for *Verticillium* species with the following primer sets: VActf/VActR for *ACT*, VEFf/VEFr for *EF* and VTs3f/ VTs3r for *TS* (Inderbitzin *et al.* 2011b). Polymerase chain reaction (PCR) protocols followed Zuccaro *et al.* (2004), Inderbitzin *et al.* (2011b) and Grum-Grzhimaylo *et al.* (2013). The program SeqMan v. 12.1.0 (DNASTAR, Madison, WI, USA) was used to obtain consensus sequences of each isolate.

Phylogenetic analysis

Sequences of each locus were aligned through MAFFT v. 7 (Kato *et al.* 2017), using the default parameters, and were manually corrected in MEGA v. 6.06 (Tamura *et al.* 2013). Phylogenetic reconstructions were based on Maximum Composite Likelihood (ML) and were performed on the CIPRES

Science Gateway portal (Miller *et al.* 2012) using RAxML v. 8.2.9. The selection of the best-fit nucleotide substitution model for each locus was calculated with MrModelTest v. 2.3 (Nylander 2004). For ML analyses, the default parameters were used, and bootstrap support (BS) was carried out using the rapid bootstrapping algorithm with the automatic halt option. A BS value ≥ 70 % was considered as statistically significant. Each partition was assessed for incongruence before being concatenated by checking individual phylogenies for conflicts between clades with significant ML support (Mason-Gamer & Kellogg 1996, Wiens 1998). All novel DNA sequences generated in this study were deposited in GenBank and the European Nucleotide Archive (ENA) (Table 1), while the alignments and the resulting trees were accessioned in TreeBASE (<http://www.treebase.org>) and the taxonomic novelties in MycoBank (<http://www.MycoBank.org>, Crous *et al.* 2004).

Morphology

Morphological features were determined on oatmeal agar (OA), potato carrot agar (PCA), 2 % potato dextrose agar (PDA) and 2 % malt extract agar (MEA) (recipes in Crous *et al.* 2009). In the case of alkalophilic species MEA with 5 mL KOH 2N was used as a standard medium. Cultures were incubated at 25 °C in the dark for 4 wk. Macroscopic characters and diameters were measured after 14 d of incubation, and the colony colour (surface and reverse) rated after Rayner (1970). Microscopic features were examined from slide cultures and preparations mounted in clear lactic acid or Shear's mounting fluid from colonies sporulating on the media previously mentioned. Observations were performed with a Zeiss V20 Discovery (Zeiss, Oberkochen, Germany) and Nikon AZ100 (Nikon, Tokyo, Japan) stereo-microscopes and with a Zeiss Axio Imager 2 light microscope using differential interference contrast (DIC) optics. Photomicrographs and measurements were taken with a Nikon DS-Ri2 digital camera using the NIS-elements D software v. 4.50. The length and width of at least 30 randomly selected structures were measured, and the extreme values calculated.

RESULTS

The combined alignment of the LSU, ITS, *TEF1-α* and *RPB2* loci from 330 strains, including the outgroup *Monilochaetes infuscans* (CBS 379.77 and CBS 869.96), encompassed 2 966 characters including 981 phylogenetically informative positions (197 LSU, 203 ITS, 241 *TEF1-α* and 340 *RPB2*). The best-fit evolutionary model for each dataset was GTR+I+G. The phylogenetic tree (Fig. 1) showed 12 well-supported clades and one lineage, which include the genera currently accepted in *Plectosphaerellaceae*, and 12 that represent putative new genera.

Clade I (80 % BS) was formed by the genus *Gibellulopsis*, which encompassed three main subclades and two single branches. The first subclade (94 % BS) included the ex-type strains of *Cephalosporium serrae* CBS 290.30, *Gibellulopsis piscis* CBS 892.70 and *Verticillium amaranthi* CBS 387.35, in addition to 22 isolates from different origins (soil, plants, fungi and animals). The second (100 % BS) and third (82 % BS) subclades included the neotype of *G. nigrescens* CBS 120949 and the ex-type strain of *Cephalosporium serrae* var. *fuscum* CBS 560.65, respectively. The two single branches were formed

Table 1. Details of strains used in this study.

Species	Isolate nr. ¹	Source	Locality	GenBank/ENA Accession No. ²						
				LSU	ITS	TEF1- α	RPB2	ACT	EF	TS
<i>Acrostalagmus luteoalbus</i>	CBS 112.16	Unknown	UK	LR025797	LR026668	LR026369	LR026101	-	-	-
	CBS 194.87	Straw-meal-amended field soil	Germany	LR025799	LR026670	LR026371	-	-	-	-
	CBS 222.60	Wall, treated with fungicides	Germany, Geisenheim	LR025794	LR026665	LR026366	LR026099	-	-	-
	CBS 236.55	Unknown	Unknown	LR025798	LR026669	LR026370	LR026102	-	-	-
	CBS 325.61	Decayed wood	Canada, Quebec, Gatineau Park	LR025796	LR026667	LR026368	-	-	-	-
	CBS 331.52	Bark of <i>Fagus sylvatica</i>	UK	LR025793	LR026664	LR026365	-	-	-	-
	CBS 388.65	Decaying timber of boat	Netherlands	LR025800	LR026671	LR026372	-	-	-	-
	CBS 565.80	Decaying leaf	Canada, Ontario, York Co., Toronto, High Park	LR025795	LR026666	LR026367	LR026100	-	-	-
	CBS 577.78B	On <i>Colletotrichum lagenarium</i>	Russia, Astrakhan	LR025801	LR026672	LR026373	LR026103	-	-	-
	CBS 121213	<i>Musa sapientum</i>	Brazil, Minas Gerais, Viçosa	LR025806	LR026677	LR026378	LR026108	-	-	-
	CBS 121214	<i>Musa sapientum</i>	Brazil, Minas Gerais, Viçosa	LR025791	LR026662	-	-	-	-	-
	CBS 121215	<i>Musa sapientum</i>	Brazil, Minas Gerais, Viçosa	LR025792	LR026663	LR026364	-	-	-	-
	CBS 137628	Soda soil	Russia, Kulunda Steppe, Altai	KJ443144	KJ443274	KJ443231	KJ443187	-	-	-
	CBS 137629	Soda soil	Russia, Kulunda Steppe, Altai	KJ443145	KJ443275	KJ443232	KJ443188	-	-	-
	<i>A. annulatus</i>	CBS 121.84	Leaf of <i>Ananas comosus</i>	Sierra Leone, Njala	LR025802	LR026673	LR026374	LR026104	-	-
CBS 185.70		<i>Glycine soja</i>	Mexico	LR025803	LR026674	LR026375	LR026105	-	-	-
CBS 450.85		Wood	Venezuela, Amazonas, Cerro de la Neblina	LR025804	LR026675	LR026376	LR026106	-	-	-
CBS 545.84		Dead stem	Japan, Okinawa Pref., Ishigaki Island, Mt. Omoto	LR025805	LR026676	LR026377	LR026107	-	-	-
DAOMC 212126		Soil and roots	Brazil, Pará, near Belém	GU180646	GU180632	LR026379	GU180662	-	-	-
<i>Brunneochlamydosporium cibotii</i>	CBS 109240 ^T	<i>Cibotium schiedei</i>	Netherlands, Delft	LR025807	LR026678	LR026380	-	-	-	-
<i>B. macroclavatum</i>	CBS 372.93	<i>Aphelandra</i> sp.	Switzerland	LR025808	LR026679	LR026381	-	-	-	-
	CBS 373.93	<i>Aphelandra</i> sp.	Switzerland	LR025809	LR026680	LR026382	LR026109	-	-	-
	CBS 823.73	<i>Salvinia auriculata</i>	India, Bangalore	LR025810	LR026681	LR026383	LR026110	-	-	-
	CBS 101249 ^T	Pteridophyte	Mauritius	LR025811	LR026682	LR026384	-	-	-	-
<i>B. nepalense</i>	CBS 277.89	Soil	Unknown	LR025812	LR026683	LR026385	LR026111	-	-	-
	CBS 971.72 ^T	Soil under <i>Pinus</i> sp.	Nepal, Northern Himalaya	LR025813	LR026684	LR026386	LR026112	-	-	-
	CBS 112045	Scrub sandy soil	Netherlands, Kwade Hoek	LR025814	LR026685	LR026387	LR026113	-	-	-
	CBS 113254	Scrub sandy soil	Netherlands, Kwade Hoek	LR025815	LR026686	LR026388	LR026114	-	-	-
	CBS 116720	Scrub sandy soil	Netherlands, Kwade Hoek	LR025816	LR026687	LR026389	LR026115	-	-	-
	CBS 116721	Scrub sandy soil	Netherlands, Kwade Hoek	LR025817	LR026688	LR026390	LR026116	-	-	-
	CBS 116722	Scrub sandy soil	Netherlands, Kwade Hoek	LR025818	LR026689	LR026391	LR026117	-	-	-
	<i>B. terrestre</i>	CBS 112777 ^T	Soil under <i>Manihot</i>	French Polynesia, Moorea, Vallée de Toto	LR025819	LR026690	LR026392	LR026118	-	-
<i>Brunneomyces brunnescens</i>	CBS 559.73 ^T	On dead stem of <i>Dendrocalamus giganteus</i>	Sri Lanka	HQ231966	LN810520	LN810534	LR026119	-	-	-

(continued on next page)

Table 1. (Continued).

Species	Isolate nr. ¹	Source	Locality	GenBank/ENA Accession No. ²							
				LSU	ITS	TEF1- α	RPB2	ACT	EF	TS	
<i>B. europaeus</i>	CBS 560.86	Leaf of <i>Bambusa</i> sp.	France	LN810511	LN810518	LN810537	LN810527	–	–	–	
	CBS 652.96 ^T	River sediment	Spain	LN810512	LN810519	LN810538	LN810528	–	–	–	
<i>B. hominis</i>	FMR 10429 ^T	Sputum	USA	LN810509	KP131517	LN810535	–	–	–	–	
	FMR 10437	Sputum	USA	LN810510	KP131518	LN810536	–	–	–	–	
<i>Chlamydosporiella restricta</i>	CBS 119.97	Unknown	Brazil	LR025820	LR026691	LR026393	LR026120	–	–	–	
	CBS 177.40	Packing material	Netherlands, Rotterdam, Unileve	LR025821	LR026692	LR026394	LR026121	–	–	–	
	CBS 178.40 ^T	Packing material	Netherlands, Rotterdam, Unileve	LR025822	LR026693	LR026395	LR026122	–	–	–	
	CBS 434.83	Unknown	Sweden	LR025823	LR026694	LR026396	LR026123	–	–	–	
	CBS 443.66	Moist wall	Germany, Kiel-Kitzeberg	LR025824	LR026695	LR026397	LR026124	–	–	–	
	CBS 716.88	Human skin	France	LR025825	LR026696	LR026398	LR026125	–	–	–	
	CBS 988.69	Mineral wool packing	UK, England, Newcastle on Tyne	LR025826	LR026697	LR026399	–	–	–	–	
	<i>Chordomyces albus</i>	CBS 204.70	Dead stem of <i>Angelica archangelica</i>	Germany, Kiel-Kitzeberg	LR025827	LR026698	LR026400	LR026126	–	–	–
CBS 205.70		Rhizosphere soil of <i>Ammophila arenaria</i>	Germany, Kiel, Bottsand	LR025828	LR026699	LR026401	LR026127	–	–	–	
CBS 206.70		Moist wall	Germany, Kiel, Botanical Garden	LR025829	LR026700	LR026402	LR026128	–	–	–	
CBS 299.70E		Agricultural soil	France, Grignon	LR025830	LR026701	LR026403	LR026129	–	–	–	
CBS 409.70		Dead leaf of <i>Canna indica</i>	Netherlands, Baarn	LR025831	LR026702	–	–	–	–	–	
CBS 508.65		Forest humus soil	Netherlands, Baarn	LR025832	LR026703	–	–	–	–	–	
CBS 580.97		On leaf litter of <i>Viscum album</i>	UK, England, Egham	LR025833	LR026704	LR026404	–	–	–	–	
CBS 741.69		Garden soil	Belgium, Heverlee	LR025834	LR026705	–	–	–	–	–	
CBS 742.69		Peat	Ireland	LR025835	LR026706	LR026405	LR026130	–	–	–	
CBS 743.69		Soil	Netherlands	LR025836	LR026707	LR026406	LR026131	–	–	–	
CBS 987.87 ^T		On <i>Hypogymnia physodes</i>	Luxembourg	JX158444	DQ825970	JX158400	JX158466	–	–	–	
<i>C. antarcticus</i>		CBS 120042	Soda soil	Mongolia, North Gobi	KJ443108	KJ443240	KJ443196	KJ443156	–	–	–
		CBS 120045 ^T	Soda soil	Russia, Kulunda Steppe, Altai	KJ443109	KJ443241	KJ443197	KJ443157	–	–	–
	CBS 120046	Soda soil	Russia, Kulunda Steppe, Altai	KJ443110	KJ443242	KJ443198	KJ443158	–	–	–	
	CBS 120047	Soda soil	Russia, Kulunda Steppe, Altai	KJ443111	KJ443243	KJ443199	KJ443159	–	–	–	
	CBS 137606	Soda soil	Russia, Kulunda Steppe, Altai	KJ443102	KJ443234	KJ443190	KJ443150	–	–	–	
	CBS 137610	<i>Suaeda salsa</i>	Kazakhstan, Aral Lake	KJ443106	KJ443238	KJ443194	KJ443154	–	–	–	
	CBS 137630	Soda soil	Russia, Kulunda Steppe, Altai	KJ443146	KJ443276	KJ443233	KJ443189	–	–	–	
	CBS 610.69	Cork	Portugal, Lisboa	LR025837	LR026708	LR026407	LR026132	–	–	–	
	<i>Furcasterigmium furcatum</i>	CBS 122.42 ^T	Dune sand under <i>Calystegia soldanella</i>	France, Normandie, Pointe du Siège	LR025838	LR026709	LR026408	LR026133	–	–	–
		CBS 299.70A	Agricultural soil	Italy, Turin	LR025839	LR026710	–	–	–	–	–
CBS 299.70C		Loamy löss soil	Germany	LR025840	LR026711	–	–	–	–	–	
CBS 299.70F		<i>Gymnopilus</i> sp.	Germany, Kr. Plön, Schüttbrehm	LR025841	–	–	–	–	–	–	
CBS 116548		Endophyte in stem of <i>Vitis vinifera</i>	Iran	LR025842	LR026712	LR026409	LR026134	–	–	–	
CBS 116550		Moist house	Germany, Lübeck	LR025843	LR026713	LR026410	LR026135	–	–	–	

Table 1. (Continued).

Species	Isolate nr. ¹	Source	Locality	GenBank/ENA Accession No. ²							
				LSU	ITS	TEF1- α	RPB2	ACT	EF	TS	
<i>Fuscohypha expansa</i>	CBS 103.95	Soil	Brazil	LR025844	LR026714	LR026411	–	–	–	–	
	CBS 418.89 ^T	Tuber of <i>Dioscorea</i> sp.	Martinique	LR025845	LR026715	LR026412	LR026136	–	–	–	
<i>Gibellulopsis aquatica</i>	CBS 117131 ^T	Cloud water	France	LR025850	LR026720	LR026414	–	–	–	–	
<i>G. catenata</i>	CBS 113951 ^T	Cervical swab of mare	Germany	LR025851	LR026721	LR026415	LR026137	–	–	–	
<i>G. fusca</i>	CBS 308.38	<i>Apium graveolens</i>	Germany, Giessen	LR025852	LR026722	LR026416	LR026138	–	–	–	
	CBS 402.80	On <i>Aegopodium podagraria</i>	Netherlands, Baarn	LR025853	LR026723	LR026417	LR026139	–	–	–	
	CBS 560.65 ^T	Soil	India, Banaras	LR025854	LR026724	LR026418	LR026140	–	–	–	
	CBS 747.83	<i>Apium graveolens</i>	Netherlands	LR025855	LR026725	LR026419	–	–	–	–	
<i>G. nigrescens</i>	CBS 120818	Root of <i>Beta vulgaris</i>	Iran, Mashad	LR025856	LR026726	LR026420	LR026141	–	–	–	
	CBS 179.40	Wrapping material	Netherlands, Rotterdam	LR025857	LR026727	–	–	–	–	–	
	CBS 455.51	<i>Solanum tuberosum</i>	UK	LR025858	LR026728	–	–	–	–	–	
	CBS 469.64	Seedling of <i>Linum usitatissimum</i>	Denmark, Klippinge	LR025859	LR026729	LR026421	LR026142	–	–	–	
	CBS 470.64	<i>Medicago sativa</i>	France	LR025860	LR026730	LR026422	LR026143	–	–	–	
	CBS 577.50	Soil under <i>Humulus lupulus</i>	UK	LR025861	LR026731	–	–	–	–	–	
	CBS 100829	<i>Solanum tuberosum</i>	Israel, Kerem-Shalom	LR025862	LR026732	LR026423	LR026144	–	–	–	
	CBS 100832	Soil	Israel, Lahav	LR025863	LR026733	LR026424	LR026145	–	–	–	
	CBS 100833	Soil	Israel, Lahav	LR025864	LR026734	LR026425	LR026146	–	–	–	
	CBS 100844	<i>Solanum tuberosum</i>	Israel, Kerem-Shalom	LR025865	LR026735	LR026426	LR026147	–	–	–	
	CBS 110719	Sandy soil	Netherlands, Kwade Hoek	LR025866	LR026736	LR026427	LR026148	–	–	–	
	CBS 119666	Nail	Netherlands	LR025867	LR026737	LR026428	–	–	–	–	
	CBS 120949 ^{NT}	Soil under lawn	Netherlands, Baarn	LR025868	LR026738	LR026429	LR026149	–	–	–	
	CBS 123176	Moisture damaged building insulator wool	Finland	LR025869	LR026739	LR026430	LR026150	–	–	–	
	<i>G. serrae</i>	CBS 125.79	Soil	New Zealand, Havelock North	LR025870	LR026740	LR026431	LR026151	–	–	–
		CBS 175.75	<i>Solanum tuberosum</i>	Germany	LR025871	LR026741	LR026432	LR026152	–	–	–
CBS 290.30 ^T		Human eye	Italy	LR025872	LR026742	LR026433	–	–	–	–	
CBS 345.39		Wood pulp	Sweden	LR025873	LR026743	LR026434	LR026153	–	–	–	
CBS 383.66		<i>Beta vulgaris</i> var. <i>altissima</i>	Canada, Quebec	LR025874	LR026744	LR026435	–	–	–	–	
CBS 387.35		<i>Amaranthus tricolor</i>	Italy	LR025875	LR026745	–	–	–	–	–	
CBS 392.89		Seed of <i>Abelmoschus esculentus</i>	Cuba, Santiago de las Vegas	LR025876	LR026746	LR026436	–	–	–	–	
CBS 416.76		Unknown	India	LR025877	LR026747	LR026437	LR026154	–	–	–	
CBS 493.82A		Soil of <i>Glycine max</i>	Argentina, Misiones, Cerro Azul	LR025878	LR026748	LR026438	LR026155	–	–	–	
CBS 493.82B		Seed	Argentina, Buenos Aires, Castelar	LR025879	LR026749	LR026439	–	–	–	–	
CBS 493.82C		Seed	Argentina, Chaco, Las Brenas	LR025880	LR026750	LR026440	–	–	–	–	
CBS 493.82D		Seed	Argentina, Buenos Aires, Castelar	LR025881	LR026751	LR026441	LR026156	–	–	–	
CBS 565.78A		On <i>Oidium</i> sp.	Russia, Odessa	LR025882	LR026752	LR026442	LR026157	–	–	–	
CBS 565.78B		On <i>Cercospora beticola</i>	Moldavia	LR025883	LR026753	LR026443	–	–	–	–	
CBS 565.78C		On <i>Erysiphe</i> sp.	Russia, Astrakhan	LR025884	LR026754	LR026444	LR026158	–	–	–	
CBS 892.70 ^T		Gold-fish (<i>Carassius auratus</i>)	Brazil, Recife	LR025885	LR026755	LR026445	LR026159	–	–	–	
CBS 100826		<i>Solanum tuberosum</i>	Israel, Gilat	LR025886	LR026756	LR026446	LR026160	–	–	–	
CBS 100827		Soil in cotton field	Israel, Ramat-David	LR025887	LR026757	LR026447	LR026161	–	–	–	

(continued on next page)

Table 1. (Continued).

Species	Isolate nr. ¹	Source	Locality	GenBank/ENA Accession No. ²							
				LSU	ITS	<i>TEF1-α</i>	<i>RPB2</i>	<i>ACT</i>	<i>EF</i>	<i>TS</i>	
	CBS 100830	Soil	Israel, Ein-Shemer	LR025888	LR026758	LR026448	LR026162	–	–	–	
	CBS 100831	Soil	Israel, Ein-Shemer	LR025889	LR026759	LR026449	–	–	–	–	
	CBS 101221	Soil in cotton field	Israel, Ein-Shemer	LR025890	LR026760	LR026450	LR026163	–	–	–	
	CBS 109724	Human blood	Greece, Thessaloniki	LR025891	LR026761	LR026451	LR026164	–	–	–	
	CBS 120008	Leaf of <i>Musa</i> sp.	India, Bangoan, W.-Bengal	LR025892	LR026762	LR026452	LR026165	–	–	–	
	CBS 120177	<i>Solanum tuberosum</i>	Japan	LR025893	LR026763	LR026453	–	–	–	–	
	DAOMC 226890	Soil	Canada, Ontario	GU180648	GU180631	–	GU180664	–	–	–	
<i>Lectera capsici</i>	CBS 142534 ^T	<i>Capsicum annuum</i>	Malaysia	KY979825	KY979770	LR026454	LR026166	–	–	–	
<i>L. colletotrichoides</i>	IMI 303685	<i>Capsicum annuum</i>	Morocco	LR025894	JQ647450	LR026455	LR026167	–	–	–	
	IMI 332702	<i>Cicer arietinum</i>	Egypt	LR025895	JQ647428	LR026456	LR026168	–	–	–	
<i>L. humicola</i>	IMI 265740 ^T	Soil	Brazil	LR025896	JQ647449	LR026457	LR026169	–	–	–	
<i>L. longa</i>	IMI 181698 ^T	<i>Triticum</i> sp.	Australia	LR025897	JQ647448	LR026458	LR026170	–	–	–	
<i>L. phaseoli</i>	IMI 366179 ^T	<i>Phaseolus vulgaris</i>	Ethiopia	LR025898	JQ693168	LR026459	LR026171	–	–	–	
<i>Lectera</i> sp.	CBS 144921	Garden soil	Netherlands, Friesland, Leeuwarden	MK047511	MK047461	MK047549	MK047570	–	–	–	
	CBS 144922	Garden soil	Netherlands, Güeldres, Arnhem	MK047513	MK047463	MK047551	MK047572	–	–	–	
	JW 231013	Garden soil	Netherlands, Friesland, Leeuwarden	MK047512	MK047462	MK047550	MK047571	–	–	–	
<i>Monilochaetes infuscans</i>	CBS 379.77	<i>Ipomoea batatas</i>	New Zealand, South Auckland, Mangere	GU180645	LR026764	LR026460	GU180658	–	–	–	
	CBS 869.66	<i>Ipomoea batatas</i>	South Africa, Eastern Cape, Gamtoos	GU180639	GU180626	LR026461	GU180657	–	–	–	
<i>Musicillium elettariae</i>	CBS 252.80 ^T	<i>Elettaria cardomomum</i>	Rwanda	LR025899	LR026765	LR026462	LR026172	–	–	–	
	CBS 110322	Leaf of <i>Musa acuminata</i>	Thailand, Chiang Mai, Doi Suthep Pui National Park	LR025900	LR026766	LR026463	–	–	–	–	
<i>M. theobromae</i>	CBS 140681	Dead leaf of <i>Carex pendula</i>	Iran, Golestan, Forest park of Tuskestan	LR025901	LR026767	LR026464	LR026173	–	–	–	
	CBS 122.97	Unknown	Brazil	LR025902	LR026768	–	–	–	–	–	
	CBS 243.74	Decaying stalk of <i>Musa</i> sp.	Netherlands, Baarn	LR025903	LR026769	–	LR026174	–	–	–	
	CBS 360.76	Unknown	Finland, Rovaniemi	LR025904	LR026770	LR026465	LR026175	–	–	–	
	CBS 385.32	Unknown	Unknown	LR025905	LR026771	LR026466	LR026176	–	–	–	
	CBS 397.58	<i>Musa</i> sp.	Jamaica	LR025906	LR026772	LR026467	LR026177	–	–	–	
	CBS 968.72 ^{NT}	<i>Musa</i> sp.	Egypt, Cairo	LR025907	LR026773	LR026468	LR026178	–	–	–	
	CBS 120527	<i>Musa sapientum</i>	Iran, Chabahar	LR025908	LR026774	LR026469	LR026179	–	–	–	
	CBS 120528	<i>Musa sapientum</i>	Iran, Chabahar	LR025909	LR026775	LR026470	LR026180	–	–	–	
	CBS 120827	<i>Musa nana</i>	Iran, Mazandaran	LR025910	LR026776	LR026471	–	–	–	–	
	CBS 121211	Rotten banana	Brazil, Minas Gerais	LR025911	LR026777	LR026472	LR026181	–	–	–	
	CPC 29810	Leaf of <i>Musa</i> sp.	Morocco, Kenitra	LR025912	LR026778	LR026473	–	–	–	–	
	<i>M. tropicale</i>	CBS 395.58	<i>Lactarius</i> sp.	Czech Republic, Bohemia	LR025913	LR026779	LR026474	LR026182	–	–	–
		CBS 398.58	<i>Musa</i> sp.	Zambia	LR025914	LR026780	–	LR026183	–	–	–
CBS 458.51		Unknown	Japan	LR025915	LR026781	LR026475	LR026184	–	–	–	
CBS 100951		Leaf litter	Cuba, Estado de Agua, Parque Nacional Henry Pittie	LR025916	LR026782	LR026476	LR026185	–	–	–	
CBS 120009 ^T		Leaf of <i>Musa</i> sp.	Bangladesh, Bangoan	LR025917	LR026783	LR026477	LR026186	–	–	–	
CBS 121212		Rotten banana	Brazil, Minas Gerais	LR025918	LR026784	LR026478	–	–	–	–	

Table 1. (Continued).

Species	Isolate nr. ¹	Source	Locality	GenBank/ENA Accession No. ²						
				LSU	ITS	TEF1- α	RPB2	ACT	EF	TS
<i>Musidium stromaticum</i>	CBS 132.74	<i>Musa</i> sp.	Costa Rica, Coto valley	LR025919	LR026785	LR026479	LR026187	-	-	-
	CBS 133.74	<i>Musa</i> sp.	Costa Rica, Coto valley	LR025920	LR026786	LR026480	LR026188	-	-	-
	CBS 134.74	<i>Musa</i> sp.	Honduras, Lula Valley	LR025921	-	LR026481	-	-	-	-
	CBS 135.74A	<i>Musa</i> sp.	Panama, Changumola	LR025922	LR026787	LR026482	LR026189	-	-	-
	CBS 135.74C	<i>Musa</i> sp.	Honduras, Lula Valley	LR025923	LR026788	LR026483	LR026190	-	-	-
	CBS 135.74D	<i>Musa</i> sp.	Colombia, Turbo	LR025924	LR026789	-	-	-	-	-
	CBS 135.74F	Rhizosphere of <i>Musa</i> sp.	Philippines	LR025925	LR026790	LR026484	LR026191	-	-	-
	CBS 135.74G	<i>Musa</i> sp.	United Kingdom, England, Kew, Royal Botanical Gardens	LR025926	LR026791	-	-	-	-	-
	CBS 135.74H	<i>Musa</i> sp.	Tanzania	LR025927	-	-	-	-	-	-
	CBS 863.73 ^T	Root and rhizome of <i>Musa sapientum</i>	Honduras	HQ232143	DQ825969	LN810533	-	-	-	-
<i>Nigrocephalum collariferum</i>	CBS 124585	Toenail	Panama, Chiriquí, Los Algarrobos	LR025928	FJ765365	LR026485	LR026192	-	-	-
	CBS 124586 ^T	Toenail	Panama, Chiriquí, Los Algarrobos	LR025929	FJ765367	LR026486	LR026193	-	-	-
<i>Paramusicillium asperulatum</i>	CBS 120158 ^T	Soil	Democratic Republic of São Tomé and Príncipe	LR025930	LR026792	LR026487	LR026194	-	-	-
<i>Paragibbellulopsis chrysanthemi</i>	MAFF 242621 ^T	On rotten leaves of <i>Garland chrysanthemum</i>	Japan, Osaka, Kishiwada	KC287230	KC287235	KC287232	-	-	-	-
	MAFF 243429	On rotten leaves of <i>Garland chrysanthemum</i>	Japan, Osaka, Kishiwada	KC287229	KC287234	KC287231	-	-	-	-
	MAFF 243430	On rotten leaves of <i>Garland chrysanthemum</i>	Japan, Osaka, Kishiwada	KC287228	KC287233	-	-	-	-	-
<i>Phialoparvum bifurcatum</i>	CBS 299.70B ^T	Soil	Belgium, Heverlee	LR025931	LR026793	LR026488	LR026195	-	-	-
<i>Plectosphaerella alismatis</i>	CBS 113362 ^T	<i>Alisma plantago-aquatica</i>	Netherlands, Pijnenburg near Soest	LR025932	LR026794	LR026489	LR026196	-	-	-
<i>P. citrullae</i>	CBS 131740	Root of <i>Cucumis melo</i>	Italy, Foggia, Torre Bianca	LR025933	LR026795	LR026490	-	-	-	-
	CBS 131741 ^T	Root of <i>Citrullus lanatus</i>	Italy, Foggia	LR025934	LR026796	LR026491	LR026197	-	-	-
<i>P. cucumerina</i>	CBS 137.33 ^{NT}	<i>Nicotiana tabacum</i>	England, Bristol	LR025935	LR026797	LR026492	LR026198	-	-	-
	CBS 137.37 ^T	Paper	Italy	LR025936	LR026798	LR026493	LR026199	-	-	-
	CBS 139.60	Unknown	USA	LR025937	LR026799	LR026494	LR026200	-	-	-
	CBS 286.64	<i>Nicotiana tabacum</i>	Belgium, Heverlee	LR025938	LR026800	LR026495	LR026201	-	-	-
	CBS 355.36	Root of <i>Viola tricolor</i>	Netherlands	LR025939	LR026801	LR026496	-	-	-	-
	CBS 367.73	<i>Viola odorata</i>	Egypt	LR025940	LR026802	LR026497	LR026202	-	-	-
	CBS 400.58	<i>Solanum esculentum</i>	Canada	LR025941	LR026803	LR026498	LR026203	-	-	-
	CBS 567.78	Unknown fungus	USSR	LR025942	LR026804	LR026499	LR026204	-	-	-
	CBS 619.74	Leaf of <i>Pyrus malus</i>	Switzerland, Basel	LR025943	LR026805	LR026500	LR026205	-	-	-
	CBS 632.94	<i>Arabidopsis</i> sp.	Switzerland	LR025944	LR026806	LR026501	LR026206	-	-	-

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Table 1. (Continued).

Species	Isolate nr. ¹	Source	Locality	GenBank/ENA Accession No. ²						
				LSU	ITS	TEF1- α	RPB2	ACT	EF	TS
	CBS 101014	<i>Arabidopsis thaliana</i>	Switzerland	LR025945	LR026807	LR026502	LR026207	-	-	-
	CBS 101958	Endophyte in leaf and stem of <i>Galium spurium</i>	Canada, Alberta	LR025946	LR026808	LR026503	LR026208	-	-	-
	CBS 131739 ^{NT}	Collar of <i>Cucumis melo</i>	Italy, Foggia, Borgo Cervaro	LR025947	LR026809	LR026504	-	-	-	-
<i>P. delsorboi</i>	CBS 116708 ^T	<i>Curcuma alismatifolia</i>	Italy, Portici	LR025948	LR026810	LR026505	LR026209	-	-	-
<i>P. humicola</i>	CBS 423.66 ^T	Soil	Zaire, Katanga	LR025949	LR026811	LR026506	LR026210	-	-	-
<i>P. melonis</i>	CBS 489.96 ^T	Root of <i>Cucurbita melo</i>	Japan, Shizuoka, Asaba-chou	LR025950	LR026812	LR026507	-	-	-	-
	CBS 525.93	<i>Cucumis melo</i>	Spain	LR025951	LR026813	LR026508	-	-	-	-
<i>P. oligotrophica</i>	CBS 440.90	Soil	Brazil, Pará	LR025952	LR026814	LR026509	LR026211	-	-	-
<i>P. oratosquillae</i>	NJM 0662 ^T	Mantis shrimp (<i>Oratosquilla oratoria</i>)	Japan, Yamaguchi	-	AB425974	-	-	-	-	-
	NJM 0665	Mantis shrimp (<i>Oratosquilla oratoria</i>)	Japan, Yamaguchi	-	AB425975	-	-	-	-	-
<i>P. pauciseptata</i>	CBS 131744	Collar of <i>Cucumis melo</i>	Italy, Foggia	LR025953	LR026815	LR026510	-	-	-	-
	CBS 131745 ^T	Root of <i>Solanum esculentum</i>	Italy, Apulia, Rignano Garganico	LR025954	LR026816	LR026511	LR026212	-	-	-
<i>P. plurivora</i>	CBS 101.87	<i>Lolium perenne</i>	Australia, New South Wales	LR025955	LR026817	LR026512	-	-	-	-
	CBS 215.84	Soil	Netherlands, Oostelijk Flevoland, De Schreef	LR025956	LR026818	LR026513	-	-	-	-
	CBS 260.89	Soil	Germany	LR025957	LR026819	LR026514	LR026213	-	-	-
	CBS 261.89	Soil	Germany	LR025958	LR026820	LR026515	-	-	-	-
	CBS 291.38	<i>Solanum tuberosum</i>	USA, Tennessee	LR025959	LR026821	LR026516	-	-	-	-
	CBS 292.66	Soil	Netherlands	LR025960	LR026822	LR026517	LR026214	-	-	-
	CBS 386.68	Wheat field soil	Netherlands, Oostelijk Flevoland	LR025961	LR026823	LR026518	LR026215	-	-	-
	CBS 406.85	<i>Solanum tuberosum</i>	Netherlands, Haren	LR025962	LR026824	LR026519	-	-	-	-
	CBS 417.81	<i>Solanum tuberosum</i>	Scotland, Lona	LR025963	LR026825	LR026520	-	-	-	-
	CBS 642.63	Soil	Belgium	LR025964	LR026826	LR026521	LR026216	-	-	-
	CBS 757.68	Garden soil	Netherlands	LR025965	LR026827	LR026522	LR026217	-	-	-
	CBS 101607	<i>Nicotiana tabacum</i>	New Zealand, Auckland	LR025966	LR026828	LR026523	LR026218	-	-	-
	CBS 131742 ^T	Apex turion of <i>Asparagus officinalis</i>	Italy, Apulia, Borgo Cervaro	LR025967	LR026829	LR026524	LR026219	-	-	-
	CBS 131860	Collar of <i>Solanum esculentum</i>	Italy, Apulia, Rignano Garganico	LR025968	LR026830	LR026525	LR026220	-	-	-
	CBS 143233 ^T	Soil	Netherlands, Nieuwegein	MG386133	MG386080	LR026526	LR026221	-	-	-
<i>P. populi</i>	CBS 139623 ^T	Branch of <i>Populus nigra</i>	Germany, Kuestrin-Kietz, Brandenburg	KR476783	KR476750	LR026527	LR026222	-	-	-
	CBS 139624	<i>Populus nigra</i>	Germany, Kuestrin-Kietz, Brandenburg	MH878144	KR476751	LR026528	LR026223	-	-	-
<i>P. ramiseptata</i>	CBS 131743	Collar of <i>Citrullus lanatus</i>	Italy, Foggia	LR025969	LR026831	LR026529	LR026224	-	-	-
	CBS 131861 ^T	Root of <i>Solanum esculentum</i>	Italy, Apulia, Rignano Garganico	LR025970	LR026832	LR026530	LR026225	-	-	-
<i>P. sinensis</i>	ACCC 39144	Stem of <i>Citrullus lanatus</i>	China, Hebei	KX527892	KX527889	-	-	-	-	-
	ACCC 39145 ^T	Stem of <i>Cucumis melo</i>	China, Hebei	KX527891	KX527888	-	-	-	-	-
<i>Sayamraella subulata</i>	BCC 78964 ^T	Soil around <i>Hopea odorata</i>	Thailand, Lopburi province, Wang Kan Lueang Waterfall	LR025971	LR026833	LR026531	LR026226	-	-	-

Table 1. (Continued).

Species	Isolate nr. ¹	Source	Locality	GenBank/ENA Accession No. ²						
				LSU	ITS	TEF1- α	RPB2	ACT	EF	TS
<i>Sodiomyces alcalophilus</i>	CBS 114.92 ^T	Sludge of pig faeces compost	Japan, Kanagawa Pref., Tsukui-gun	JX158443	JX158421	JX158399	JX158465	-	-	-
<i>S. alkalinus</i>	CBS 110278 ^T	Soda soils	Mongolia, Choibalsan area	JX158427	NR_145378	JX158383	JX158449	-	-	-
	CBS 132729	Soda soils	Russia, Chitinskaya area, Kunkur Steppe	JX158423	JX158401	JX158379	JX158445	-	-	-
	CBS 133680	Soda soils	Russia, Chitinskaya area, Kunkur Steppe	JX158424	JX158402	JX158380	JX158446	-	-	-
<i>S. magadii</i>	CBS 137619 ^T	Soda soils	Kenya, Magadi Lake	KJ443148	KJ443278	-	-	-	-	-
<i>S. tronii</i>	CBS 137618 ^T	Soda soils	Kenya, Magadi Lake	KJ443147	KJ443277	-	-	-	-	-
	CBS 137620	Soda soils	Kenya, Magadi Lake	KJ443149	KJ443279	-	-	-	-	-
<i>Stachylidium bicolor</i>	CBS 121802 ^{ET}	Plant debris	Spain, Asturias, Picos de Europa, Sotres	LR025972	LR026834	LR026532	-	-	-	-
<i>S. pallidum</i>	BCC 79031	Soil	Thailand	LR025973	LR026835	LR026533	LR026227	-	-	-
	CBS 292.72	Soil, under <i>Abies</i> sp. and <i>Rhododendron</i> sp.	Nepal	LR025974	LR026836	-	-	-	-	-
	CBS 449.88	Soil	Turkey	LR025975	LR026837	-	-	-	-	-
	DAOMC 226658	<i>Oryza sativa</i>	India	GU180651	LR026838	LR026534	LR026228	-	-	-
<i>Summerbellia oligotrophica</i>	CBS 299.70G	Grapefruit juice can	USA, Florida	LR025846	LR026716	LR026413	-	-	-	-
	CBS 299.70H	Bath towel	USA, Florida	LR025847	LR026717	-	-	-	-	-
	CBS 620.76	Unknown	Australia, New South Wales	LR025848	LR026718	-	-	-	-	-
	CBS 657.94 ^T	Alkaline soil	Indonesia	LR025849	LR026719	-	-	-	-	-
<i>Theobromium fuscum</i>	CBS 112271 ^T	<i>Theobroma</i> sp.	Ecuador, Pichincha Province, Vicente Maldonado	LR025976	LR026839	LR026535	LR026229	-	-	-
<i>Verticillium albo-atrum</i>	CBS 387.82	<i>Morchella esculenta</i>	Netherlands, Vogelenzang	LR025977	LR026840	LR026536	LR026230	-	-	-
	CBS 388.82	Dung of carnivore	Germany, Holzdorf	LR025978	LR026841	LR026537	LR026231	LR026286	LR026322	-
	CBS 682.88	<i>Solanum tuberosum</i>	Netherlands	LR025979	LR026842	LR026538	-	-	-	-
	CBS 745.83	Dead stem of <i>Urtica dioica</i>	UK, Scotland, Kindrogan Field Centre	LR025980	LR026843	LR026539	-	-	-	-
	CBS 101242	<i>Solanum tuberosum</i>	United Kingdom	LR025981	LR026844	LR026540	-	LR026287	LR026323	-
	CBS 102464	<i>Cynara scolymus</i>	Italy	LR025982	LR026845	LR026541	-	-	-	-
	CBS 120947	Leaf of <i>Humulus lupulus</i>	Denmark	LR025983	LR026846	LR026542	LR026232	LR026288	LR026324	-
	CBS 130340 ^{ET}	Soil from potato field	Canada, Prince Edward Island	LR025984	LR026847	LR026543	LR026233	JN188144	JN188272	JN188080
	<i>V. alfalfae</i>	CBS 241.82	<i>Catalpa bignonioides</i>	Italy	LR025985	LR026848	LR026544	LR026234	-	-
CBS 453.51		<i>Catalpa bignonioides</i>	United Kingdom	LR025986	LR026849	LR026545	-	-	-	-
CBS 127169		<i>Medicago sativa</i>	USA, Pennsylvania	LR025987	LR026850	LR026546	LR026235	-	-	-
CBS 130603 ^T		<i>Medicago sativa</i>	USA	LR025988	LR026851	LR026547	LR026236	JN188097	JN188225	JN188033
<i>V. dahliae</i>	CBS 127.79B	<i>Nicotiana tabacum</i>	New Zealand, Motueka	LR025989	LR026852	LR026548	LR026237	-	-	-
	CBS 177.66	<i>Solanum lycopersicon</i>	Netherlands, Wageningen	LR025990	LR026853	-	-	-	-	-
	CBS 178.66	<i>Solanum lycopersicon</i>	Netherlands, Wageningen	LR025991	-	-	-	LR026289	LR026325	LR026611
	CBS 179.66	<i>Solanum lycopersicon</i>	Netherlands, Wageningen	LR025992	LR026854	LR026549	LR026238	-	-	-

(continued on next page)

Table 1. (Continued).

Species	Isolate nr. ¹	Source	Locality	GenBank/ENA Accession No. ²						
				LSU	ITS	TEF1- α	RPB2	ACT	EF	TS
	CBS 204.26	<i>Rubus idaeus</i>	Unknown	LR025993	–	–	–	LR026290	LR026326	–
	CBS 205.26	Stem of <i>Rubus idaeus</i>	Unknown	LR025994	LR026855	–	–	–	–	–
	CBS 222.72A	Unknown	Russia	LR025995	LR026856	LR026550	–	–	–	–
	CBS 222.72C	Unknown	Russia	LR025996	LR026857	LR026551	LR026239	–	–	–
	CBS 380.49	<i>Humulus lupulus</i>	United Kingdom	LR025997	LR026858	LR026552	–	–	LR026327	LR026612
	CBS 381.66	<i>Solanum lycopersicon</i>	Canada, Quebec	LR025998	LR026859	LR026553	LR026240	LR026291	LR026328	LR026613
	CBS 383.49	<i>Xanthium italicum</i>	Italy	LR025999	LR026860	–	–	–	–	–
	CBS 384.49	<i>Solanum tuberosum</i>	Netherlands	LR026000	LR026861	LR026554	LR026241	–	–	–
	CBS 385.49	<i>Rosa rugosa</i>	Netherlands	LR026001	LR026862	–	–	LR026292	LR026329	LR026614
	CBS 386.49	<i>Solanum melongena</i>	Netherlands	LR026002	LR026863	–	–	LR026293	LR026330	LR026615
	CBS 388.49	<i>Antirrhinum majus</i>	Netherlands	LR026003	LR026864	–	–	–	–	–
	CBS 389.49	<i>Humulus lupulus</i>	Unknown	LR026004	LR026865	LR026555	LR026242	–	–	–
	CBS 390.49	<i>Fragaria</i> sp.	Unknown	LR026005	LR026866	LR026556	LR026243	–	–	–
	CBS 391.49	<i>Solanum tuberosum</i>	Unknown	LR026006	LR026867	–	–	–	–	–
	CBS 392.49	<i>Rubus idaeus</i>	Unknown	LR026007	LR026868	LR026557	LR026244	–	–	–
	CBS 425.52	<i>Solanum lycopersicon</i>	Netherlands, Naaldwijk	LR026008	LR026869	–	–	–	–	–
	CBS 717.96	Root of <i>Solanum tuberosum</i>	Netherlands, Drente	LR026009	LR026870	–	–	–	–	–
	CBS 718.96	Root of <i>Vicia faba</i>	Netherlands, Oost-Flevoland	LR026010	LR026871	LR026558	LR026245	–	–	–
	CBS 800.97	Soil	Netherlands, Wageningen	LR026011	LR026872	LR026559	LR026246	–	–	–
	CBS 801.97	Soil	Netherlands, Wageningen	LR026012	LR026873	LR026560	LR026247	–	–	–
	CBS 802.97	Vessel in stem of <i>Phlox</i> sp.	Netherlands	LR026013	LR026874	LR026561	LR026248	–	–	–
	CBS 806.97	Vessel in stem of <i>Ribes rubrum</i>	Netherlands	LR026014	LR026875	–	–	–	LR026331	LR026616
	CBS 807.97	Vessel in stem of <i>Fragaria</i> sp.	Netherlands	LR026015	LR026876	–	–	–	LR026332	–
	CBS 809.97	Vessel in stem of <i>Rosa</i> sp.	Netherlands	LR026016	LR026877	–	–	–	–	–
	CBS 810.97	Stem of <i>Rubus fruticosus</i>	Unknown	LR026017	LR026878	LR026562	LR026249	–	–	–
	CBS 811.97	Stem of <i>Acer</i> sp.	Unknown	LR026018	LR026879	LR026563	–	–	–	–
	CBS 812.97	Soil	Netherlands, Lelystad	LR026019	LR026880	LR026564	LR026250	–	–	–
	CBS 814.97	<i>Forsythia</i> sp.	Netherlands	LR026020	LR026881	LR026565	LR026251	–	–	–
	CBS 110223	<i>Helianthus annuus</i>	Argentina	LR026021	LR026882	–	LR026252	LR026294	LR026333	LR026617
	CBS 110224	<i>Helianthus annuus</i>	Argentina	LR026022	LR026883	LR026566	LR026253	–	–	–
	CBS 110225	<i>Helianthus annuus</i>	Argentina	LR026023	LR026884	LR026567	LR026254	–	–	–
	CBS 110274	<i>Trifolium pratense</i>	Germany	LR026024	LR026885	LR026568	LR026255	–	–	–
	CBS 111590	<i>Caerola frutescens</i> var. <i>sericea</i>	USA, Hawaii	LR026025	LR026886	LR026569	–	–	–	–
	CBS 127170	<i>Lactuca sativa</i>	USA, California, Watsonville	LR026026	LR026887	LR026570	–	–	LR026334	LR026618
	CBS 128315	<i>Capsicum annuum</i>	USA, California, Salinas	LR026027	LR026888	LR026571	LR026256	–	–	–
	CBS 130341 ^{ET}	<i>Lactuca sativa</i>	USA, California, Watsonville	LR026028	LR026889	–	–	HQ206921	HQ414624	HQ414909
<i>V. isaacii</i>	CBS 237.75	<i>Lactuca sativa</i>	Netherlands, Wageningen	LR026029	LR026890	LR026572	–	LR026295	LR026335	LR026619
	CBS 238.75	<i>Lactuca sativa</i>	Netherlands, Groningen	LR026030	LR026891	LR026573	–	LR026296	LR026336	LR026620
	CBS 804.97	Stem of <i>Limonium</i> sp.	Netherlands	LR026031	LR026892	–	–	–	LR026337	LR026621
	CBS 805.97	<i>Chrysanthemum</i> sp.	Netherlands	LR026032	LR026893	–	–	–	–	LR026622
	CBS 813.97	Leaf of <i>Limonium</i> sp.	Netherlands	LR026033	LR026894	LR026574	LR026257	–	–	–
	CBS 100839	Soil from potato field	Israel, Re'im	LR026034	LR026895	LR026575	LR026258	LR026297	LR026338	LR026623

Table 1. (Continued).

Species	Isolate nr. ¹	Source	Locality	GenBank/ENA Accession No. ²						
				LSU	ITS	TEF1- α	RPB2	ACT	EF	TS
	CBS 100840	Soil from potato field	Israel, Re'im	LR026035	LR026896	–	–	–	–	–
	CBS 100843	<i>Solanum</i> sp.	Israel, Kerem-Shalom	LR026036	LR026897	–	–	LR026298	LR026339	–
	CBS 101220	<i>Brassica</i> sp.	Israel, Nir-Itzhak	LR026037	LR026898	LR026576	–	LR026299	LR026340	LR026624
	CBS 130343 ^T	<i>Lactuca sativa</i>	USA, California	LR026038	LR026899	LR026577	–	HQ206985	HQ414688	HQ414973
<i>V. klebahnii</i>	CBS 130344 ^T	<i>Lactuca sativa</i>	USA, Watsonville	LR026039	LR026900	LR026578	–	JN188093	JN188221	JN188029
<i>V. longisporum</i>	CBS 124.64 ^T	Root of <i>Armoracia rusticana</i>	Germany, Niedersachsen, Altes Land	LR026040	LR026901	–	–	HQ206993	HQ414697	HQ414981
	CBS 649.85	Stem of <i>Brassica rapa</i>	Sweden	LR026041	LR026902	–	–	–	–	–
	CBS 110218	<i>Brassica napus</i>	Sweden	LR026042	LR026903	–	–	–	–	–
	CBS 110219	<i>Brassica napus</i>	Sweden	LR026043	LR026904	–	LR026259	–	–	–
	CBS 110220	<i>Brassica napus</i>	Sweden	LR026044	LR026905	–	LR026260	–	–	–
	CBS 110221	<i>Brassica napus</i>	Sweden	LR026045	LR026906	–	LR026261	–	–	–
	CBS 110226	<i>Brassica napus</i>	Sweden	LR026046	LR026907	–	LR026262	–	–	–
	CBS 110227	<i>Brassica napus</i>	Sweden	LR026047	LR026908	–	LR026263	–	–	–
	CBS 110228	<i>Brassica napus</i>	Sweden	LR026048	LR026909	–	LR026264	–	–	–
	CBS 110229	<i>Brassica napus</i>	Sweden	LR026049	LR026910	–	LR026265	–	–	–
	CBS 110230	<i>Brassica napus</i>	Sweden	LR026050	LR026911	–	LR026266	–	–	–
	CBS 110231	<i>Brassica napus</i>	Sweden	LR026051	LR026912	–	LR026267	–	–	–
	CBS 110232	<i>Brassica napus</i>	Germany	LR026052	LR026913	–	LR026268	–	–	–
	CBS 110233	<i>Brassica napus</i>	Germany	LR026053	LR026914	–	LR026269	–	–	–
	CBS 110272	<i>Brassica napus</i>	Sweden	LR026054	LR026915	–	–	–	–	–
	CBS 110273	<i>Brassica napus</i>	Unknown	LR026055	LR026916	–	LR026270	–	–	–
	CBS 110275	<i>Brassica napus</i>	Unknown	LR026056	LR026917	–	LR026271	–	–	–
	CBS 110276	<i>Brassica napus</i>	Sweden	LR026057	LR026918	–	LR026272	–	–	–
	CBS 110277	<i>Brassica napus</i>	Sweden	LR026058	LR026919	–	LR026273	–	–	–
	CBS 128316	<i>Armoracia rusticana</i>	USA, Illinois	LR026059	LR026920	–	–	–	–	–
	CBS 128317	<i>Brassica oleracea</i> var. <i>botrytis</i>	USA, California, Salinas	LR026060	LR026921	–	–	–	–	–
<i>V. nonalfalfae</i>	CBS 321.91	<i>Solanum lycopersicon</i>	Netherlands, Naaldwijk	LR026061	LR026922	LR026579	LR026274	LR026300	LR026341	LR026625
	CBS 322.91	<i>Solanum lycopersicon</i>	Netherlands, Naaldwijk	LR026062	LR026923	LR026580	LR026275	–	–	–
	CBS 381.49	<i>Humulus lupulus</i>	UK	LR026063	LR026924	LR026581	–	LR026301	LR026342	–
	CBS 382.49	<i>Fragaria</i> sp.	UK	LR026064	LR026925	LR026582	LR026276	LR026302	LR026343	LR026626
	CBS 382.66	On <i>Verticillium albo-atrum</i>	Canada	LR026065	LR026926	–	–	LR026303	LR026344	LR026627
	CBS 385.91	<i>Solanum esculentum</i>	Netherlands, Loenen	LR026066	LR026927	–	LR026277	LR026304	LR026345	LR026628
	CBS 395.91	<i>Humulus lupulus</i>	Belgium, Poperinge	LR026067	LR026928	LR026583	LR026278	–	–	–
	CBS 451.88	Unknown	Belgium	LR026068	LR026929	LR026584	–	LR026305	LR026346	LR026629
	CBS 452.51	<i>Antirrhinum</i> sp.	UK	LR026069	LR026930	LR026585	–	LR026306	LR026347	LR026630
	CBS 454.51	<i>Solanum tuberosum</i>	UK	LR026070	LR026931	LR026586	LR026279	LR026307	LR026348	LR026631
	CBS 113707	<i>Citrus sinensis</i>	Portugal	LR026071	LR026932	LR026587	LR026280	–	–	–
	CBS 121305	<i>Humulus lupulus</i>	Slovenia, Savinja valley	LR026072	LR026933	LR026588	LR026281	–	–	–
	CBS 121306	<i>Humulus lupulus</i>	Slovenia, Savinja valley	LR026073	LR026934	LR026589	–	–	–	–
	CBS 130339 ^T	<i>Solanum tuberosum</i>	Japan, Hokkaido	LR026074	LR026935	LR026590	–	JN188099	JN188227	JN188035

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Table 1. (Continued).

Species	Isolate nr. ¹	Source	Locality	GenBank/ENA Accession No. ²							
				LSU	ITS	<i>TEF1-α</i>	<i>RPB2</i>	<i>ACT</i>	<i>EF</i>	<i>TS</i>	
<i>V. nubilum</i>	CBS 578.50	Soil	UK, England, East Malling Res. Sta.	LR026075	LR026936	–	–	–	–	–	
	CBS 457.51 ^T	Soil	UK	LR026076	LR026937	LR026591	LR026282	JN188139	JN188267	JN188075	
	CBS 456.51	<i>Solanum tuberosum</i>	UK	LR026077	LR026938	–	–	–	–	–	
<i>V. tricorpus</i>	CBS 126.79	Soil	New Zealand, Havelock North	LR026078	LR026939	LR026592	–	–	–	–	
	CBS 127.79A	<i>Solanum lycopersicon</i>	New Zealand, Roxborough	LR026079	LR026940	LR026593	LR026283	LR026308	LR026349	LR026632	
	CBS 227.84	<i>Solanum tuberosum</i>	Netherlands, Oostelijk Flevoland, De Schreef	LR026080	LR026941	LR026594	–	LR026309	LR026350	LR026633	
	CBS 255.57	<i>Solanum lycopersicon</i>	UK, England, Cambridgeshire	LR026081	LR026942	LR026595	–	LR026310	LR026351	LR026634	
	CBS 280.75	<i>Lactuca sativa</i>	Netherlands, Vleuten	LR026082	LR026943	LR026596	–	LR026311	LR026352	LR026635	
	CBS 447.54 ^T	<i>Solanum lycopersicon</i>	UK, England, Fareham, Hants	LR026083	LR026944	–	–	JN188121	JN188249	JN188057	
	CBS 545.79	<i>Solanum lycopersicon</i>	New Zealand	LR026084	LR026945	LR026597	LR026284	LR026312	–	LR026636	
	CBS 803.97	Root of <i>Alstroemeria</i> sp.	Netherlands	LR026085	LR026946	LR026598	LR026285	–	LR026353	LR026637	
	CBS 808.97	Stem of <i>Solanum lycopersicon</i>	Netherlands	LR026086	LR026947	LR026599	–	–	LR026354	LR026638	
	CBS 100834	<i>Solanum</i> sp.	Israel, Gilat	LR026087	LR026948	LR026600	–	LR026313	–	LR026639	
	CBS 100835	Soil from potato field	Israel, Gilat	LR026088	LR026949	LR026601	–	LR026314	LR026355	LR026640	
	CBS 100836	<i>Solanum</i> sp.	Israel, Gilat	LR026089	LR026950	LR026602	–	LR026315	LR026356	LR026641	
	CBS 100867	<i>Solanum</i> sp.	Israel, Gilat	LR026090	LR026951	LR026603	–	LR026316	LR026357	LR026642	
	CBS 100868	<i>Senecio</i> sp.	Israel, Ein-Hashlosha	LR026091	LR026952	–	–	LR026317	LR026358	LR026643	
	CBS 101218	Soil from potato field	Israel, Re'im	LR026092	LR026953	LR026604	–	LR026318	LR026359	LR026644	
	CBS 102465	<i>Cynara scolymus</i>	Italy	LR026093	LR026954	LR026605	–	LR026319	LR026360	LR026645	
	<i>V. zaregamsianum</i>	CBS 100837	<i>Solanum</i> sp.	Israel, Sde-Boker	LR026094	LR026955	LR026606	–	–	LR026361	LR026646
		CBS 100838	<i>Solanum</i> sp.	Israel, Kerem-Shalom	LR026095	LR026956	LR026607	–	LR026320	LR026362	LR026647
		CBS 100841	<i>Solanum</i> sp.	Israel, Kerem-Shalom	LR026096	LR026957	LR026608	–	LR026321	LR026363	LR026648
		CBS 100842	<i>Solanum</i> sp.	Israel, Kerem-Shalom	LR026097	LR026958	LR026609	–	–	–	–
CBS 130342 ^T		<i>Lactuca sativa</i>	Japan, Chiba	LR026098	LR026959	LR026610	–	JN188133	JN188261	JN188069	

^T Ex-type, ^{ET} Ex-epitype, ^{IT} Ex-isotype, ^{NT} Ex-neotype

¹ ACCC: Agricultural Culture Collection of China, Beijing, China; BCC: BIOTEC Culture Collection, Pathumthani, Thailand; CBS: Culture Collection of the Westerdijk Fungal Biodiversity Institute, Utrecht, The Netherlands; CPC: Collection of Pedro W. Crous, Utrecht, The Netherlands; DAOMC Canadian Collection of Fungal Cultures; FMR: Faculty of Medicine of Reus, Reus, Spain; IMI: International Mycological Institute, CABI-Bioscience, Egham, Boreham Lane, UK; JW: Johanna Westerdijk Collection, Utrecht, The Netherlands; MAFF: Ministry of Agriculture, Forestry and Fisheries, Ibaraki, Japan; NJM: Nippon Veterinary and Life Science University, Tokyo, Japan.

² ENA, European Nucleotide Archive; LSU, large subunit of the nrDNA; ITS, internal transcribed spacer regions of the nrDNA and intervening 5.8S nrRNA gene; *TEF1-α*, translation elongation factor 1- α ; *RPB2*, RNA polymerase II second largest subunit; *ACT*, actin; *EF*, elongation factor 1- α fragment amplified in [Inderbitzin et al. \(2011b\)](#); *TS*, tryptophan synthase. Accession numbers of sequences generated in this study are in bold.

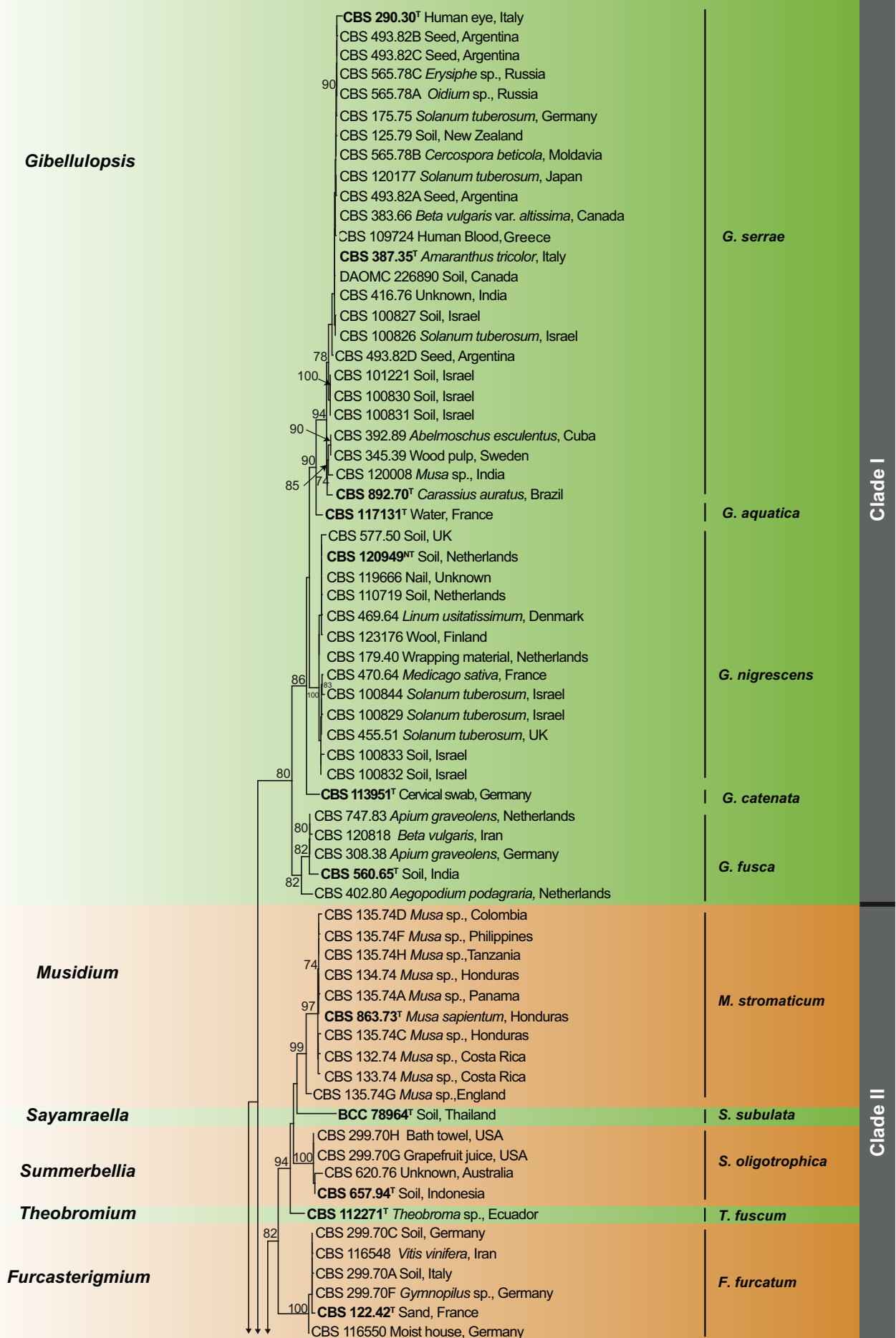


Fig. 1. Maximum composite likelihood tree constructed with partial sequences from the LSU, ITS, *TEF1- α* and *RPB2* regions from genera of Plectosphaerellaceae. Bootstrap support values above 70 % are shown at the nodes. ^T Ex-type, ^{ET} Ex-epitype, ^{IT} Ex-isotype, ^{NT} Ex-neotype.

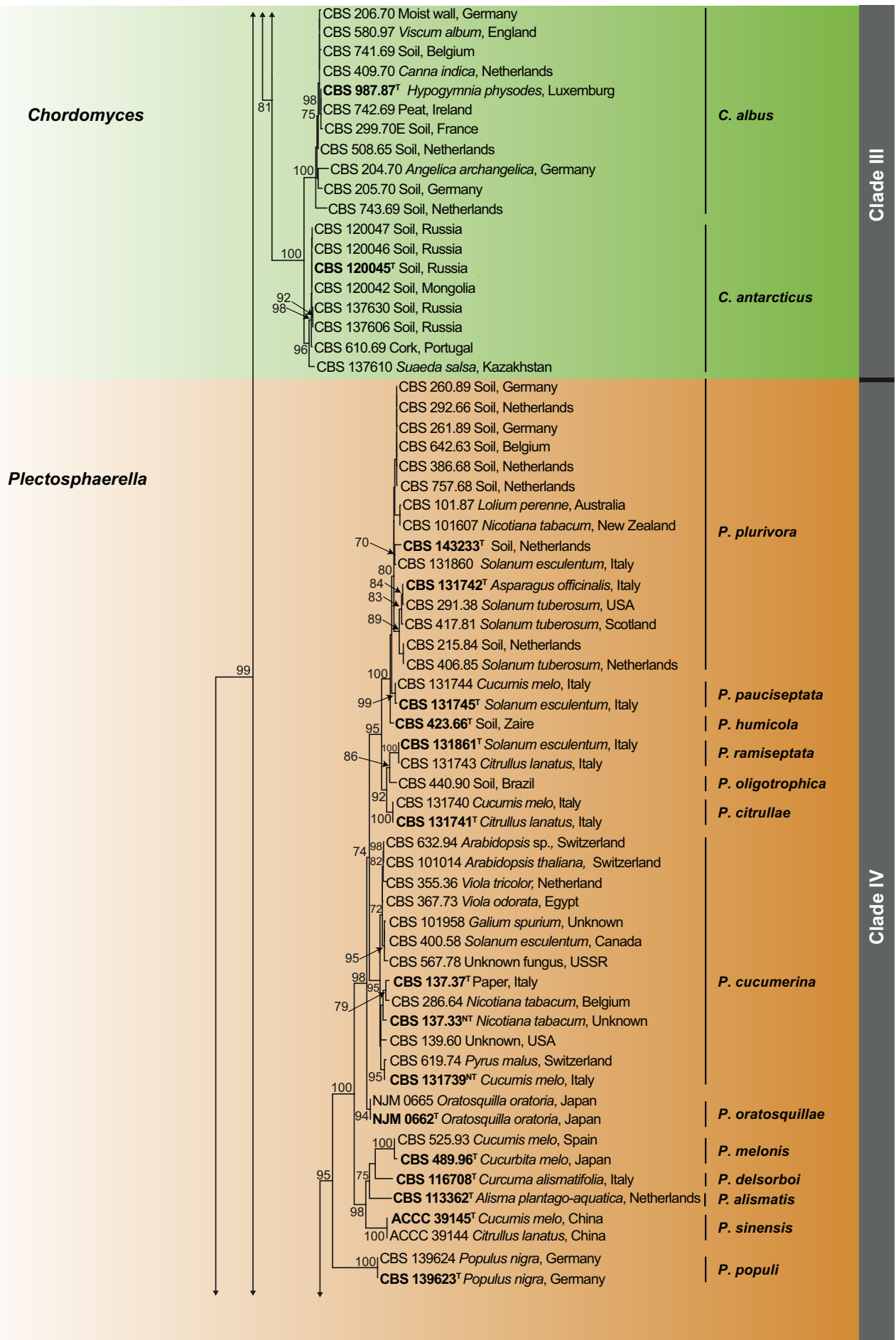


Fig. 1. (Continued).

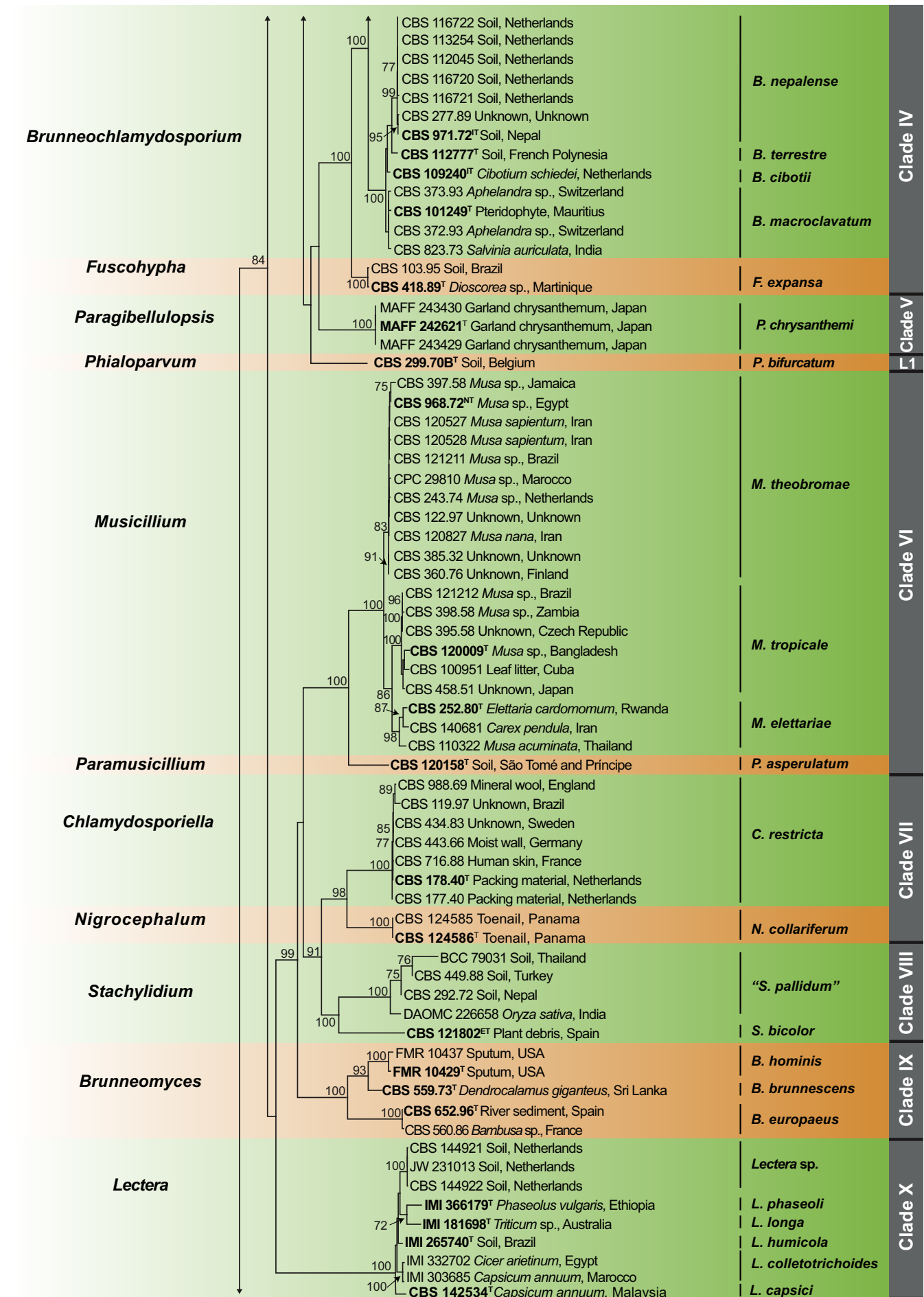


Fig. 1. (Continued).

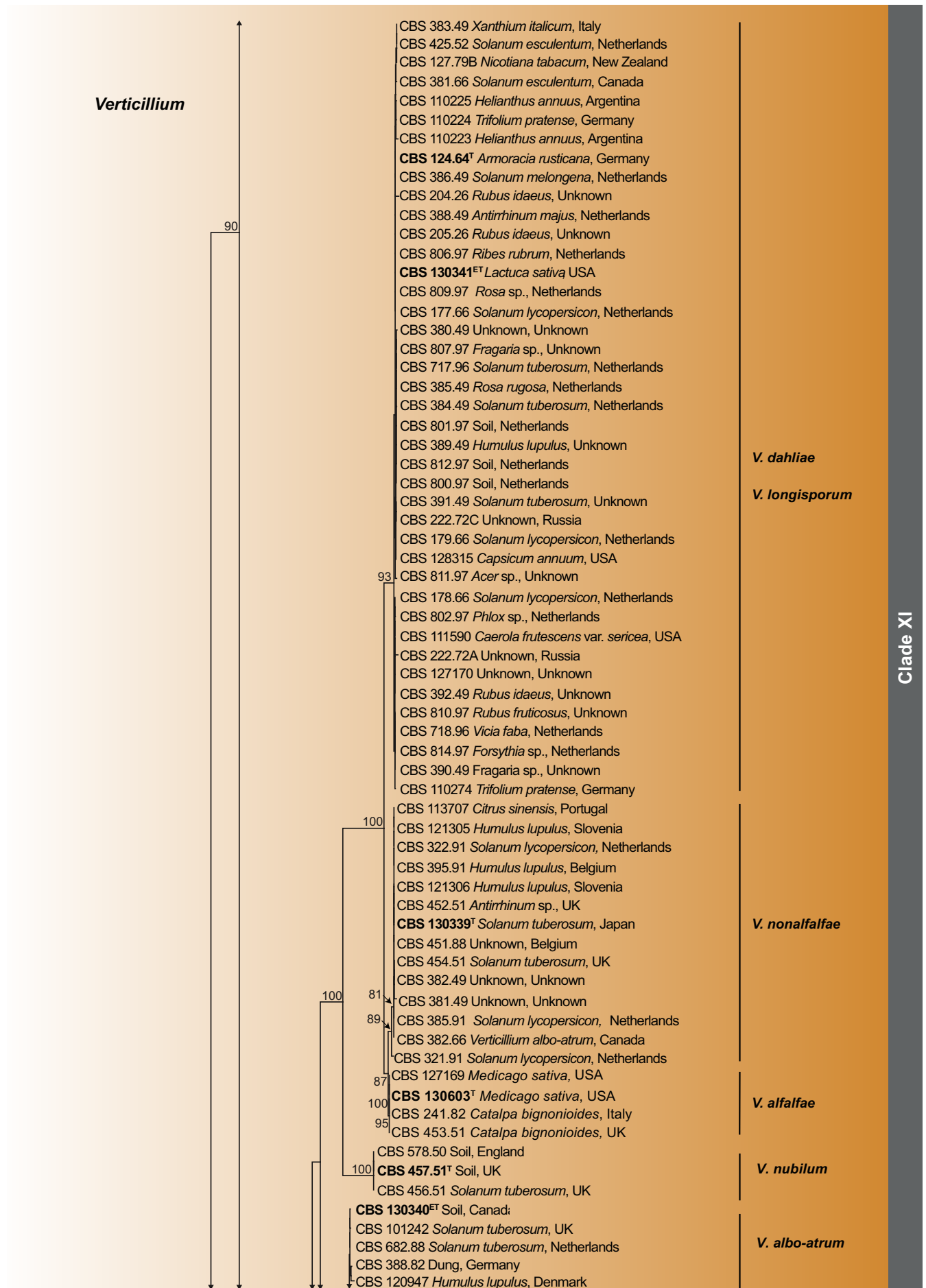


Fig. 1. (Continued).

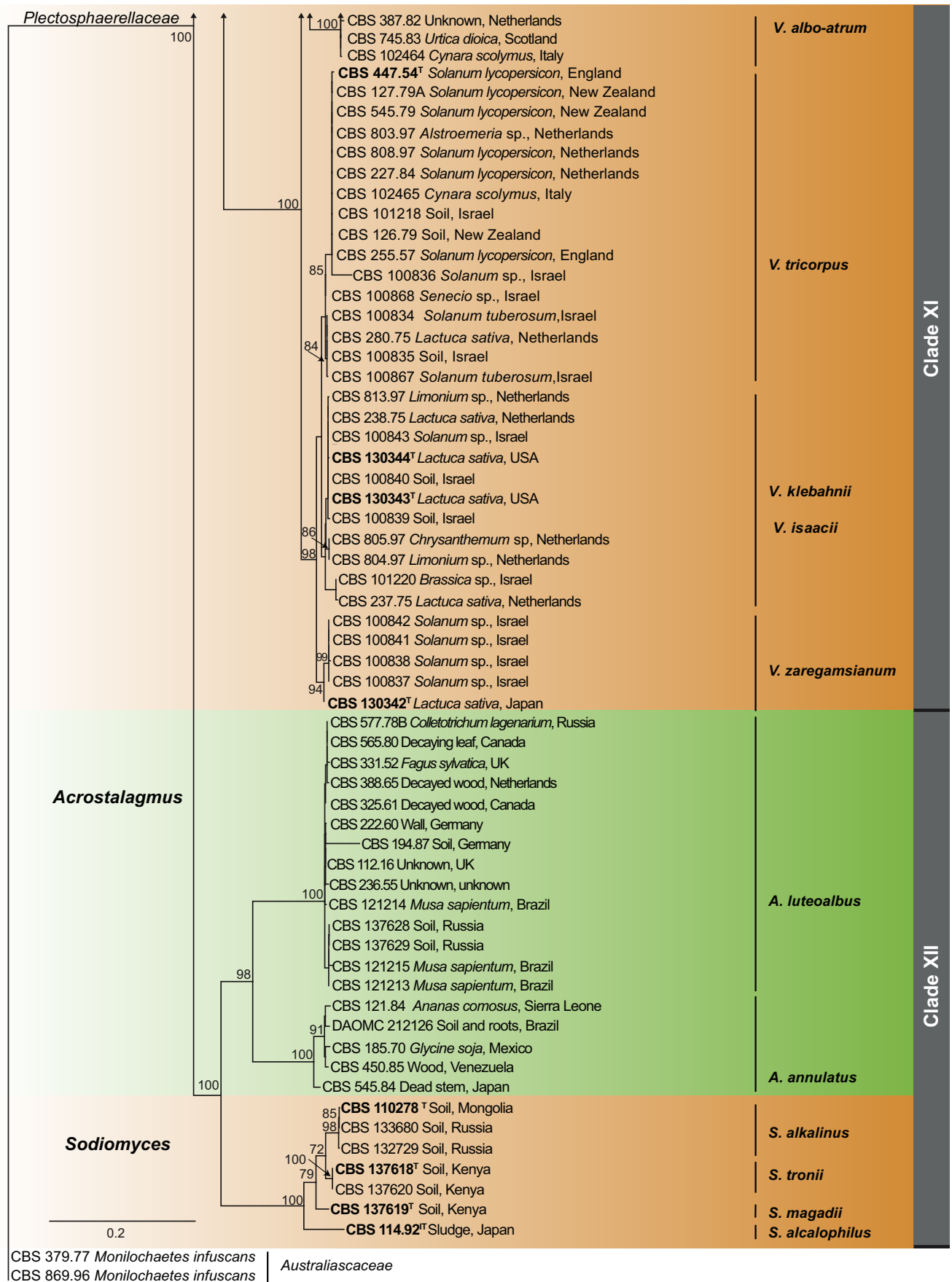


Fig. 1. (Continued).

by the isolates CBS 117131 and CBS 113951. **Clade II** (82 % BS) encompassed one subclade representing *Acremonium stromaticum* (99 % BS), a second subclade (100 % BS) formed by four unnamed isolates CBS 299.70G, CBS 299.70H, CBS 620.76 and CBS 657.94, and a third subclade (100 % BS) representing *Acremonium furcatum*. The isolates BCC 78964 and CBS 112271 from soil and *Theobroma* sp., respectively were distributed in two single lineages within the clade II. The genus *Chordomyces* was placed in **clade III** (100 % BS), which was divided in two terminal subclades. The first one (100 % BS) included the ex-type strain of *C. albus* CBS 987.87 and 10 European isolates from different sources, and the second one (96 % BS) harboured the ex-type strain of *C. antarcticus* CBS 120045 and seven Asian isolates mainly from soil. **Clade IV** (100 % BS) encompassed three well-supported subclades. The first one (95 % BS) was represented by 13 accepted species of *Plectosphaerella*, which were distributed in well-separated lineages. An unnamed isolate CBS 423.66 was placed in a single branch, phylogenetically related (100 % BS) with the clade containing *P. plurivora* and *P. pauciseptata*. The second subclade (100 % BS) included the ex-isotype strain of *Acremonium nepalense* CBS 971.72, the isotype of *Gliocladium cibotii* CBS 109240, and five isolates mainly from ferns belonging to two unnamed species. The third terminal subclade (100 % BS) was represented by two unidentified isolates, CBS 103.95 and CBS 418.89 from soil and *Dioscorea* sp., respectively. **Clade V** (100 % BS) encompassed three Japanese isolates of *Gibellulopsis chrysanthemi*, including the ex-type MAFF 242621. Basal but unrelated with this clade, the isolate CBS 299.70B was placed in a single lineage (L1). **Clade VI** (100 % BS) comprised the genus *Musicillium*, with the ex-neotype strain of *Musicillium theobromae* CBS 968.72 located in a terminal subclade (83 % BS) together with 10 isolates mainly from *Musa*, and nine isolates distributed in two subclades representing two putative new species. The soil isolate CBS 120158 was located in a single branch, basal to *Musicillium* clade. **Clade VII** (98 % BS) clustered two separate monophyletic lineages, one of them included the ex-type strain of *Acremonium restrictum* CBS 178.40 and six isolates from different origins, and the other one contained two isolates of *A. collariferum* including the ex-type CBS 124586. **Clade VIII, IX and X** represented the genera *Stachylidium*, *Brunneomyces* and *Lectera*, respectively, each one fully supported (100 % BS). **Clade XI** was the biggest clade, representing the genus *Verticillium* with 10 accepted species. Most of the species were placed in independent and well-supported clades. However, the ex-type strains of *V. dahliae* CBS 130341 and *V. longisporum* CBS 124.64 grouped together in a highly supported (93 % BS) terminal clade, phylogenetically related (100 % BS) with *V. nonalfalfae* and *V. alfalfae*. Similarly, the ex-type strains of *V. klebahnii* CBS 130344 and *V. isaacii* CBS 130343 clustered together, but in a poorly supported clade, which was phylogenetically related (98 % BS) with *V. zaregamsianum* and *V. tricorpus*. The ex-type strain of *V. tricorpus* CBS 447.54 clustered with a pool of isolates mainly from *Solanum lycopersicum* and *S. tuberosum*, in a poorly supported clade. **Clade XII** (100 % BS) encompassed the genera *Acrostalagmus* and *Sodiomyces*. The former was represented by 14 isolates of *A. luteoalbus* and five isolates of *A. annulatus*, distributed in two main subclades. The subclade containing *Sodiomyces* (100 % BS) clustered the three accepted species, *S. alkalinus*, *S. tronii* and *S. magadii*, and the ex-isotype strain of *Acremonium alcaophilum* CBS 114.92.

In order to resolve the species delimitation in *Verticillium*, a second phylogenetic analysis was carried out with a subset of isolates and the ex-type strain of each species from this genus. The combined dataset of ITS, ACT, EF and TS loci included 54 ingroup taxa, with *Gibellulopsis nigrescens* PD709 as the out-group. The final alignment encompassed 2 960 characters including 805 phylogenetically informative positions (135 ITS, 151 EF, 158 TS and 361 ACT). The best-fit nucleotide substitution model for ML analysis was GTR+I+G. The phylogenetic tree (Fig. 2) resolved the 10 accepted species in *Verticillium*, placing the ex-epitype strain of *V. dahliae* CBS 130341 in a well-supported clade (92 % BS) with nine more isolates, and separated from the two alleles of *V. longisporum* A1 and D3 (Inderbitzin *et al.* 2011a). Those species together with *V. alfalfae* and *V. nonalfalfae* were accommodated in a main clade (95 % BS) called Flavnonexudans according to Inderbitzin (2011a). In the case of *V. klebahnii*, it was placed on a single branch phylogenetically related (100 % BS) but separate from the clade containing the *V. isaacii* isolates. The ex-type strain of *V. tricorpus* was distant, located in a fully supported clade (100 % BS) with 14 isolates mainly obtained from tomato and potato. The last three species, plus *V. albo-atrum* and *V. zaregamsianum* were nested in a main clade (89 % BS) named Flavexudans, following the nomenclature of Inderbitzin *et al.* (2011a).

According to the phylogenetic results and the morphological features, 12 new genera and 15 new species are proposed in this study, in addition to 10 new combinations. Generic and species descriptions and illustrations are provided here for the new taxa and for some species previously described by other authors, but included in this revision. Genera and species are alphabetically arranged following the clade number shown in Fig. 1.

TAXONOMY

Plectosphaerellaceae W. Gams *et al.*, Nova Hedwigia 85: 476. 2007. **Emended.**

Type genus: Plectosphaerella Kleb.

Ascomata perithecial or cleistothecial, solitary or gregarious, superficial, subglobose, globose or pyriform, brown to dark brown, with paler and elongate neck, with or without setae around the base of the neck. *Peridium* multi-layered, with *textura angularis*. *Paraphyses* conspicuous in young stages or absent. *Asci* unitunicate, cylindrical, clavate or saccate, thin-walled, lacking an apical differentiation, 8-spored. *Ascospores* ellipsoidal or ovoid, 1- or 2-celled, hyaline or pale brown, smooth to slightly warted. *Conidiomata* when present, synnematos, sporodochial or acervular. *Conidiophores* simple or branched. *Conidiogenous cells* enteroblastic, mono- or polyphialidic. *Conidia* variable in shape, 1- or 2-celled, hyaline or pigmented, arranged in slimy heads or chains. *Chlamydospores* and pigmented microsclerotia usually formed by some species (modified from Zare *et al.* 2007, Maharachchikumbura *et al.* 2016).

Notes: The family concept was based in the holomorphic species *Plectosphaerella cucumerina*, which produces perithecia with elongate necks. The asexual morphs were described as phialidic with mononematous conidiophores (Zare *et al.* 2007). However, since the introduction of *Sodiomyces*, which forms cleistothecial

ascomata (Grum-Grzhimaylo *et al.* 2013), and *Lectera* and *Acrostalagmus annulatus* which produce conidiomata (Réblová *et al.* 2011, Cannon *et al.* 2012), the diagnosis of the family had to be broadened.

Clade I

Gibellulopsis Bat. & H. Maia, Anais Soc. Biol. Pernambuco 16: 153. 1959.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae. *Conidiophores* arising from submerged or superficial hyphae, more or less erect, mostly terminal, usually 1–2 times branched, bearing one or two verticillate branches at a node. *Conidiogenous cells* enteroblastic, monophialidic, terminal, lateral, subulate or cylindrical, hyaline, with inconspicuous collarette and distinct periclinal thickening at the conidiogenous locus. *Conidia* elongate ellipsoidal to cylindrical, 1- or 2-celled, hyaline, smooth-walled, produced in slimy heads. *Chlamydo-spores* lateral, terminal or intercalary, singly or in chains, pale to dark brown, smooth- and thick-walled. *Sexual morph* unknown (modified from Zare *et al.* 2007).

Type species: Gibellulopsis serrae (Maffei) Giraldo & Crous (= *Gibellulopsis piscis* Bat. & H. Maia).

Gibellulopsis aquatica Giraldo López & Crous, **sp. nov.** MycoBank MB828033. Fig. 3.

Etymology: From the Latin *aquaticus*, in reference to the freshwater habitat of the fungus.

Mycelium consisting of branched, septate, smooth, hyaline and thin-walled hyphae, up to 2 µm wide. *Conidiophores* arising from submerged or superficial hyphae, erect, up to 4 septa at the base, simple or poorly branched, bearing 1–6 levels with 1–2 phialides per node, ca. up to 104 µm long, 1.5–2.5 µm wide at the base, hyaline, smooth-walled, with cell walls usually thicker than those of the vegetative hyphae. *Phialides* terminal, lateral, cylindrical, hyaline, thick- and smooth-walled, often borne on short cylindrical subtending cells; 19–48.5 µm long, 1.5–2 µm wide at the base, with inconspicuous collarette and periclinal thickening at the conidiogenous locus. *Conidia* cylindrical with rounded ends or ellipsoidal, sometimes with a slightly truncate base, 1-celled, hyaline, thin- and smooth-walled, 3.9–6.1 × 1.6–2.5 µm, arranged in slimy heads. *Chlamydo-spores* intercalary, in single or branched chains, subglobose to elongated, olivaceous brown, smooth- and thick-walled, 3.2–9.1 × 3.9–6.9 µm. *Sexual morph* not observed.

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 68–70 mm diam, flat, floccose at centre, glabrous at periphery, entire margin, dirty white, reverse uncoloured. On OA reaching 57–59 mm diam, flat, dusty, entire margin, white, reverse uncoloured.

Specimen examined: France, from cloud water, unknown date, M. Sancelme (**holotype** CBS H-23649, culture ex-type CBS 117131).

Notes: The type culture of *Gibellulopsis aquatica* is placed in a single branch which is sister to the clade (90 % BS) harbouring *G. serrae*, *G. catenata* and *G. nigrescens*. Although *G. aquatica* produces branched chains of chlamydo-spores as does *G. catenata*, the production of these structures remained scarce after

14 d, becoming profuse after 21 d. Only 1-celled conidia were observed in all media tested.

Gibellulopsis catenata Giraldo López & Crous, **sp. nov.** MycoBank MB828035. Fig. 4.

Etymology: Named after the production of chlamydo-spores in chains.

Mycelium consisting of branched, septate, smooth, hyaline and thin-walled hyphae, up to 2 µm wide. *Conidiophores* arising from submerged or superficial hyphae, (sub-)erect, simple or poorly branched, bearing 1–2 levels with 2–3 phialides per node, ca. up to 96 µm long, 1.5–2.5 µm wide at the base, hyaline, smooth-walled, with cell walls usually thicker than those of the vegetative hyphae. *Phialides* terminal, lateral, cylindrical or acicular, hyaline, thick- and smooth-walled, 29–61 µm long, 1.5–2 µm wide at the base, with inconspicuous collarette and periclinal thickening at the conidiogenous locus, occasionally with a percurrent proliferation. *Conidia* cylindrical with rounded ends, 1- or 2-celled, hyaline, thin- and smooth-walled, 4.1–12.9 × 1.5–2.8 µm, arranged in slimy heads. *Chlamydo-spores* terminal, lateral or intercalary, mostly in single or branched chains, subglobose or ellipsoidal, pale brown, smooth- and thick-walled, 5.3–9 × 3.9–6.9 µm. *Sexual morph* not observed.

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 48 mm diam, flat, woolly, entire margin, fuscous black at centre and white at periphery, reverse fuscous black. On OA reaching 44–45 mm diam, flat, dusty, entire margin, white, reverse uncoloured.

Specimen examined: Germany, from cervical swab of mare, unknown date and collector (**holotype** CBS H-23650, culture ex-type CBS 113951).

Notes: *Gibellulopsis catenata* is represented by a single isolate, which is placed in a single branch basal to the main clade (86 % BS) containing *G. serrae*, *G. aquatica* and *G. nigrescens*. *Gibellulopsis catenata* can be morphologically distinguished from the other species of the genus by the production of long branched chains of chlamydo-spores and by formation of 2-celled conidia.

Gibellulopsis fusca (Thurum. & Sukapure) Giraldo López & Crous, **comb. et stat. nov.** MycoBank MB828038. Fig. 5.

Basionym: *Cephalosporium serrae* var. *fuscum* Thurum. & Sukapure, Mycologia 58: 360. 1966.

Synonyms: ? *Cephalosporium apii* M.A. Smith & Ramsey, Bot. Gaz. 112: 399. 1951.

? *Acremonium apii* (M.A. Smith & Ramsey) W. Gams, Cephalosporium-artige Schimmelpilze 136. 1971.

Mycelium consisting of branched, septate, smooth, hyaline and thin-walled hyphae, 1.5–2.5 µm wide. *Conidiophores* arising from submerged or superficial hyphae, erect or slightly curved, simple or poorly branched, up to 65 µm long, 1.5–2 µm wide at the base, hyaline, smooth-walled, with cell walls usually thicker than those of the vegetative hyphae. *Phialides* lateral, cylindrical or subulate, hyaline, thick- and smooth-walled, occasionally borne on short cylindrical subtending cells; 32–65 µm long, 1.5–2 µm wide at the base, with inconspicuous collarette and periclinal thickening at the conidiogenous locus, occasionally with a percurrent proliferation. *Conidia* cylindrical with rounded ends, 1- or 2-celled, hyaline, thin- and smooth-walled,

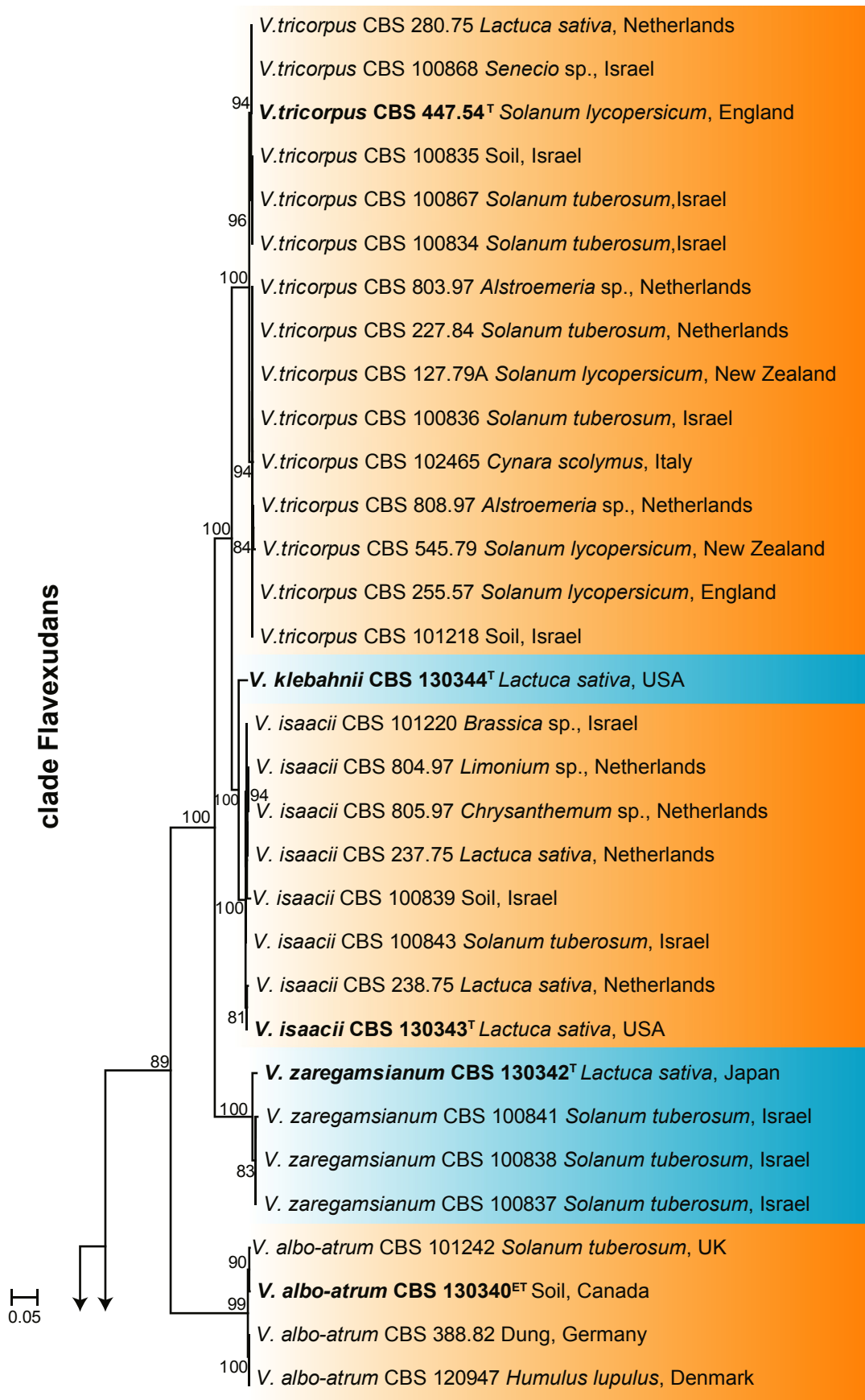


Fig. 2. Maximum composite likelihood tree based on partial sequences from ITS, ACT, *TEF1- α* and TS regions from *Verticillium* species. Bootstrap support values above 70 % are shown at the nodes. ^T Ex-type, ^{ET} Ex-epitype.

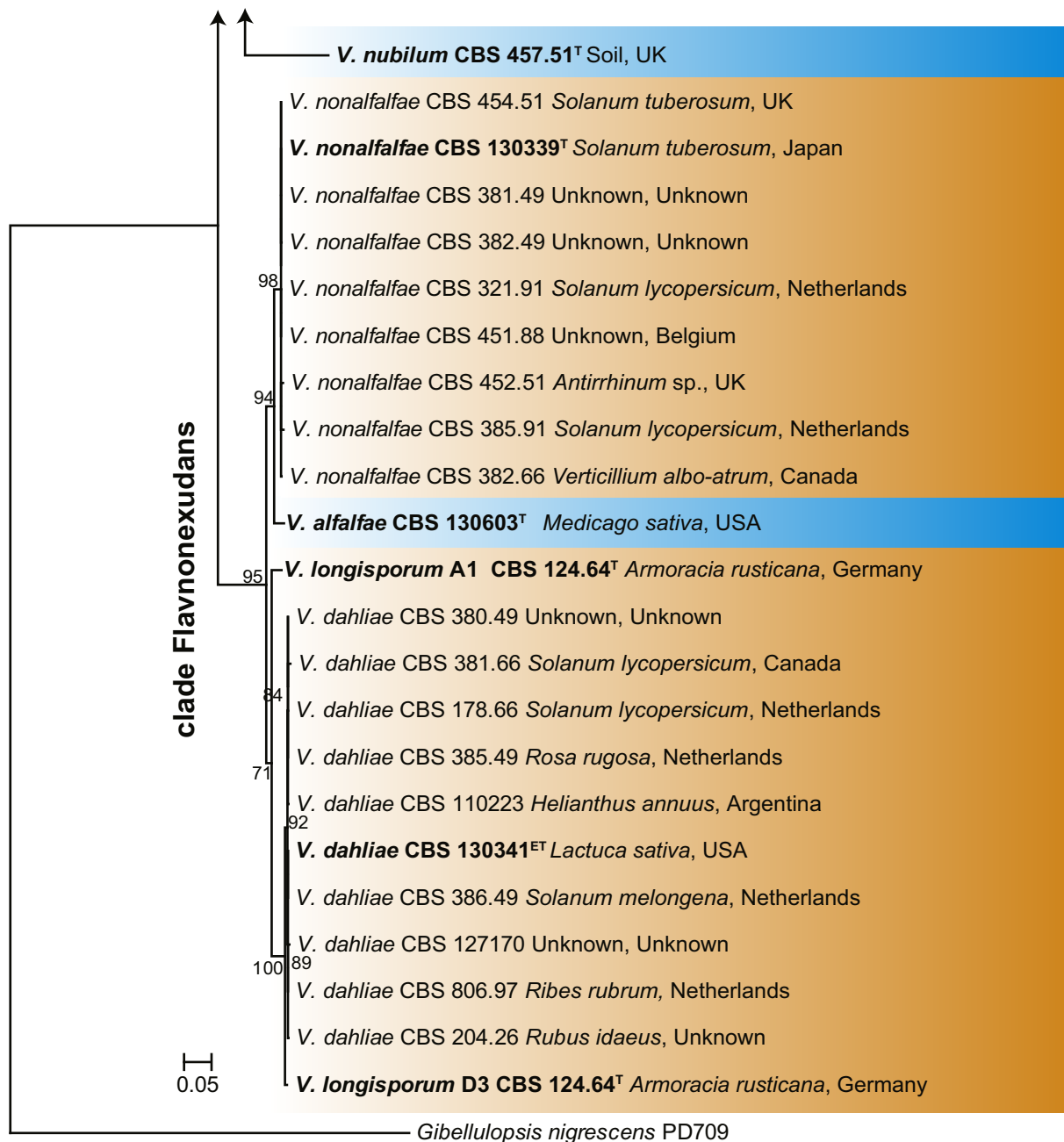


Fig. 2. (Continued).

6.9–13.7 × 2.5–4 µm, arranged in slimy heads. *Chlamydo*spores lateral or intercalary, single or in pairs, with or without intermittent hyaline cells, subglobose, ellipsoidal or obpyriform, brown, smooth- and thick-walled, 6.5–10 × 4.7–6.7 µm. *Sexual morph* not observed.

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 40–42 mm diam, flat, velvety, white, reverse becoming grey to black with age. On OA reaching 57–59 mm diam, flat, felty, white, reverse becoming grey with age. On PCA reaching 34–38 mm diam, flat, scarce aerial mycelium, white, reverse uncoloured. On MEA reaching 51–53 mm diam, raised, cottony, white, reverse dark brown to black.

Specimens examined: **Germany**, Giessen, from *Apium graveolens*, unknown date and collector, CBS 308.38. **India**, Banaras, from soil, Dec. 1962, M.J. Thirumalachar (**holotype** CBS H-19291, culture ex-type CBS 560.65 = ATCC

16090 = HACC 149 = IMI 112791). **Iran**, Mashad, from *Beta vulgaris*, unknown date and collector, CBS 120818. **Netherlands**, Baarn, from *Aegopodium podagraria*, unknown date, H.A. van der Aa, CBS 402.80; from *Apium graveolens*, unknown date and collector, CBS 747.83.

Notes: This clade contains two isolates from *Apium graveolens* (CBS 308.38 and CBS 747.83), one from *Beta vulgaris* (CBS 120818), one from *Aegopodium podagraria* (CBS 402.80) and one from plant debris (CBS 560.65); which form a basal clade (82 % BS) to the remaining species from the genus. Since this clade includes the ex-type strain of *Cephalosporium serrae* var. *fuscum* (CBS 560.65, Sukapure & Thirumalachar 1966), which we have demonstrated is a different species from *C. serrae* (treated here as *Gibellulopsis serrae*), the new combination *Gibellulopsis fusca* is proposed. Strains CBS 560.65 and CBS 120818 were also studied by Zare *et al.* (2007), who

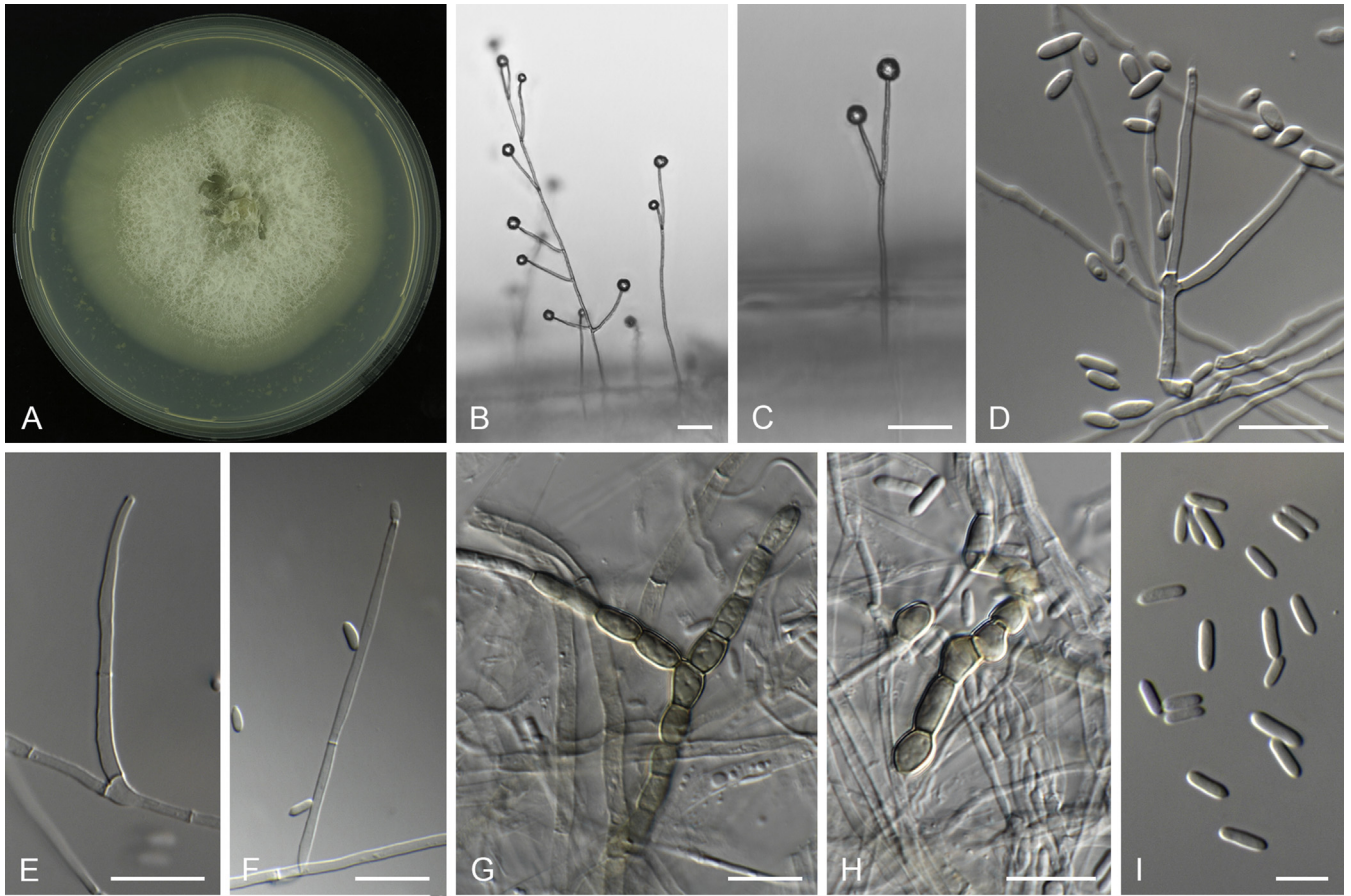


Fig. 3. *Gibellulopsis aquatica* (ex-type CBS 117131). A. Colony on PDA after 14 d at 25 °C. B–F. Conidiophores. G, H. Chlamydospores. I. Conidia. Scale bars: B, C = 20 µm; D–H = 10 µm; I = 5 µm.

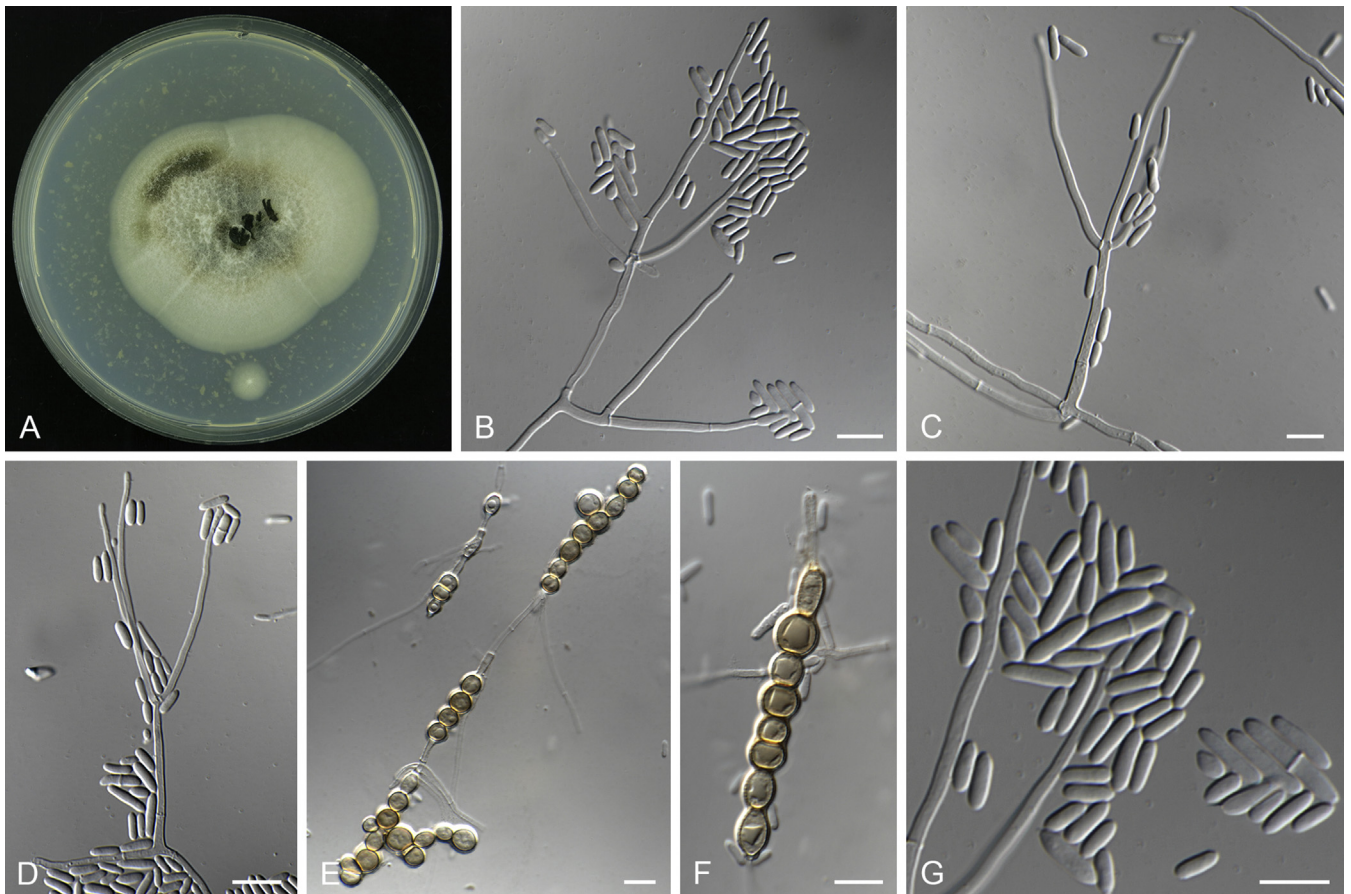


Fig. 4. *Gibellulopsis catenata* (ex-type CBS 113951). A. Colony on PDA after 14 d at 25 °C. B–D. Conidiophores. E, F. Chlamydospores. G. Conidia. Scale bars = 10 µm.

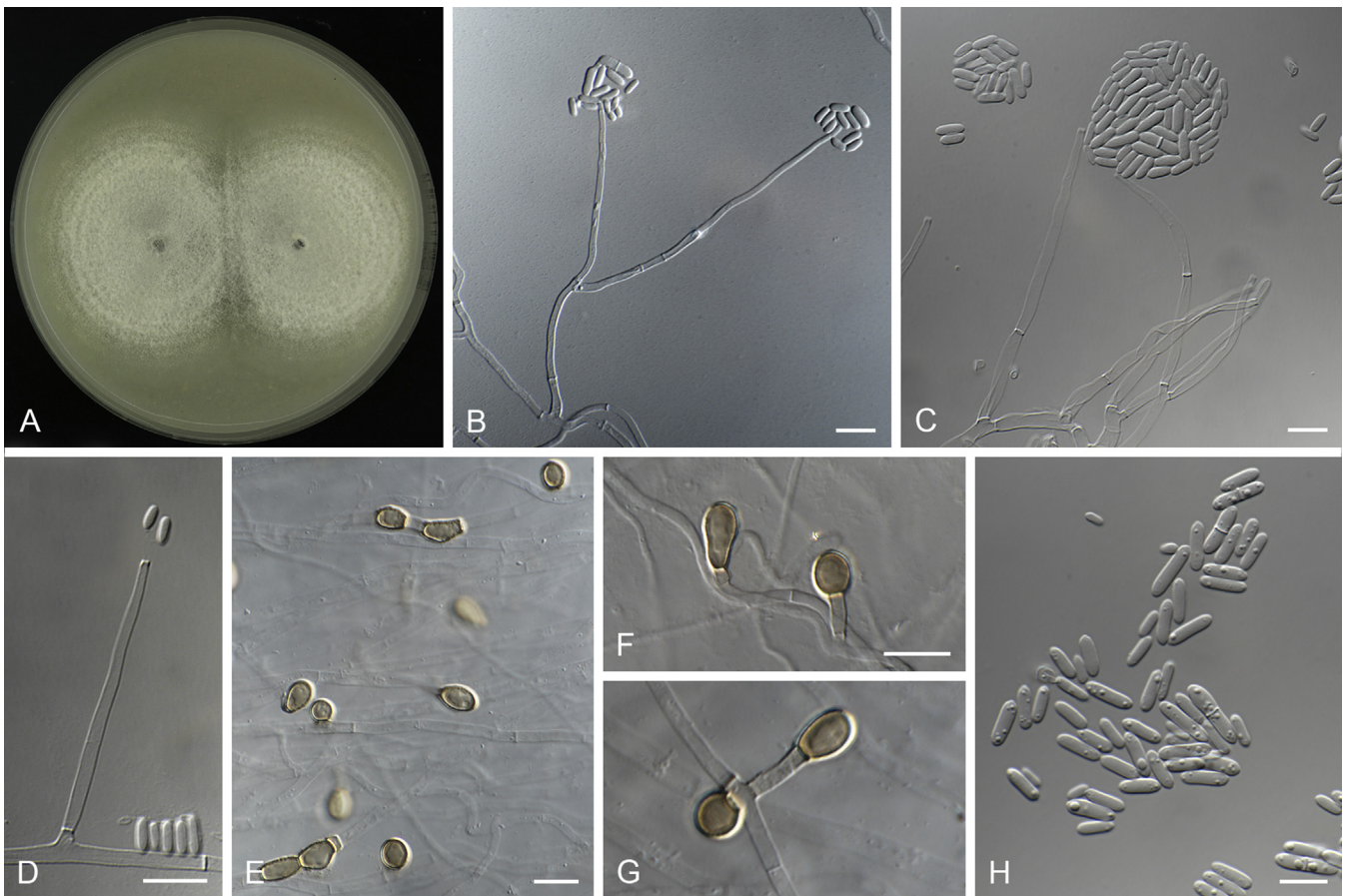


Fig. 5. *Gibellulopsis fusca* (ex-type CBS 560.65). A. Colony on OA after 14 d at 25 °C. B–D. Conidiophores. E–G. Chlamydospores. H. Conidia. Scale bars = 10 µm.

demonstrated their genetic differences from *G. nigrescens* and *G. piscis* (treated here as *G. serrae*) in ITS and *TEF1-α* sequences, as well as their different growth patterns at 27 °C and 33 °C.

Cephalosporium apii (currently *Acremonium apii*) was described from *Apium graveolens* based on the strain CBS 130.51 (= ATCC 10837 = IMI 92629), as the causal agent of brown spot of celery (Smith & Ramsey 1951). The species is morphologically similar to *G. fusca* in the chlamydospore's shape and colour, and in the production of cylindrical septate conidia, which was also noticed by Gams (2017). According to Zare *et al.* (2007) and Summerbell *et al.* (2011) the LSU and ITS sequences derived from CBS 130.51 falls with *Verticillium albo-atrum*, being considered as synonym of this species.

We have sequenced three different batches of CBS 130.51 from the culture collection, obtaining the same molecular results as Zare *et al.* (2007) and Summerbell *et al.* (2011). However, the examination of the culture led us to conclude that the strain was swapped at some point before or after it was deposited, since the micromorphology does not match that what was originally described and illustrated as *Acremonium apii* (Gams 1971).

Gibellulopsis nigrescens (Pethybr.) Zare *et al.*, Nova Hedwigia 85: 477. 2007. Fig. 6.

Basionym: *Verticillium nigrescens* Pethybr., Trans. Brit. Mycol. Soc. 6: 177. 1919.

Synonym: *Verticillium dahliae* f. *zonatum* J.F.H. Beyma, Antonie van Leeuwenhoek 6: 43. 1940.

Mycelium consisting of branched, septate, smooth, hyaline and thin-walled hyphae, up to 2 µm wide. *Conidiophores* arising from submerged or superficial hyphae, (sub-)erect, mostly

irregularly branched, bearing 1–4 levels with 1–3 phialides per node, ca. up to 100 µm long, 1.5–2.5 µm wide at the base, hyaline, smooth-walled, with cell walls usually thicker than those of the vegetative hyphae. *Phialides* terminal, lateral, aculeate, hyaline, thick- and smooth-walled, 21–44 µm long, 1–2 µm wide at the base, with conspicuous collarette and a distinct periclinal wall thickening at the conidiogenous locus. *Conidia* cylindrical with rounded ends, sometimes with a slightly protuberant basal end, 1-celled, hyaline, becoming pale brown with age, thin- and smooth-walled, 4.1–5.6 × 1.6–2.3 µm, arranged in slimy heads. *Chlamydospores* terminal, lateral or intercalary, mostly single, globose to subglobose, olivaceous brown, smooth- and thick-walled, 4.1–6.1 × 3.7–4.6 µm. *Sexual morph* not observed.

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 47–53 mm diam, flat, finely floccose, olivaceous black with a smoke-grey mycelium at centre and white towards the periphery, reverse olivaceous grey to black. On OA reaching 38–40 mm diam, flat, membranous, surface and reverse greenish black. On PCA reaching 18–19 mm diam, flat, glabrous, surface and reverse greenish black. On MEA reaching 30–33 mm diam, radially folded, felty, with white, buff and grey concentric rings, reverse iron grey.

Specimens examined: **Denmark**, Klippinge, from *Linum usitatissimum*, 1964, A. Jensen CBS 469.64. **Finland**, from moisture damaged building insulator wool, unknown date, VTT, CBS 123176. **France**, from *Medicago sativa*, *idem.*, A. Jensen, CBS 470.64. **Israel**, Kerem-Shalom, from *Solanum tuberosum*, 1994–1996, N. Korolev, CBS 100829, CBS 100844; Lahav, from soil, *idem.*, CBS 100832, CBS 100833. **Netherlands**, Baarn, from soil under lawn, Feb. 2007, W. Gams (neotype of *Verticillium nigrescens* CBS-H 19845, culture ex-neotype CBS 120949, designated in Zare *et al.* 2007); Kwade Hoek, from sandy soil, 2002, F.X.

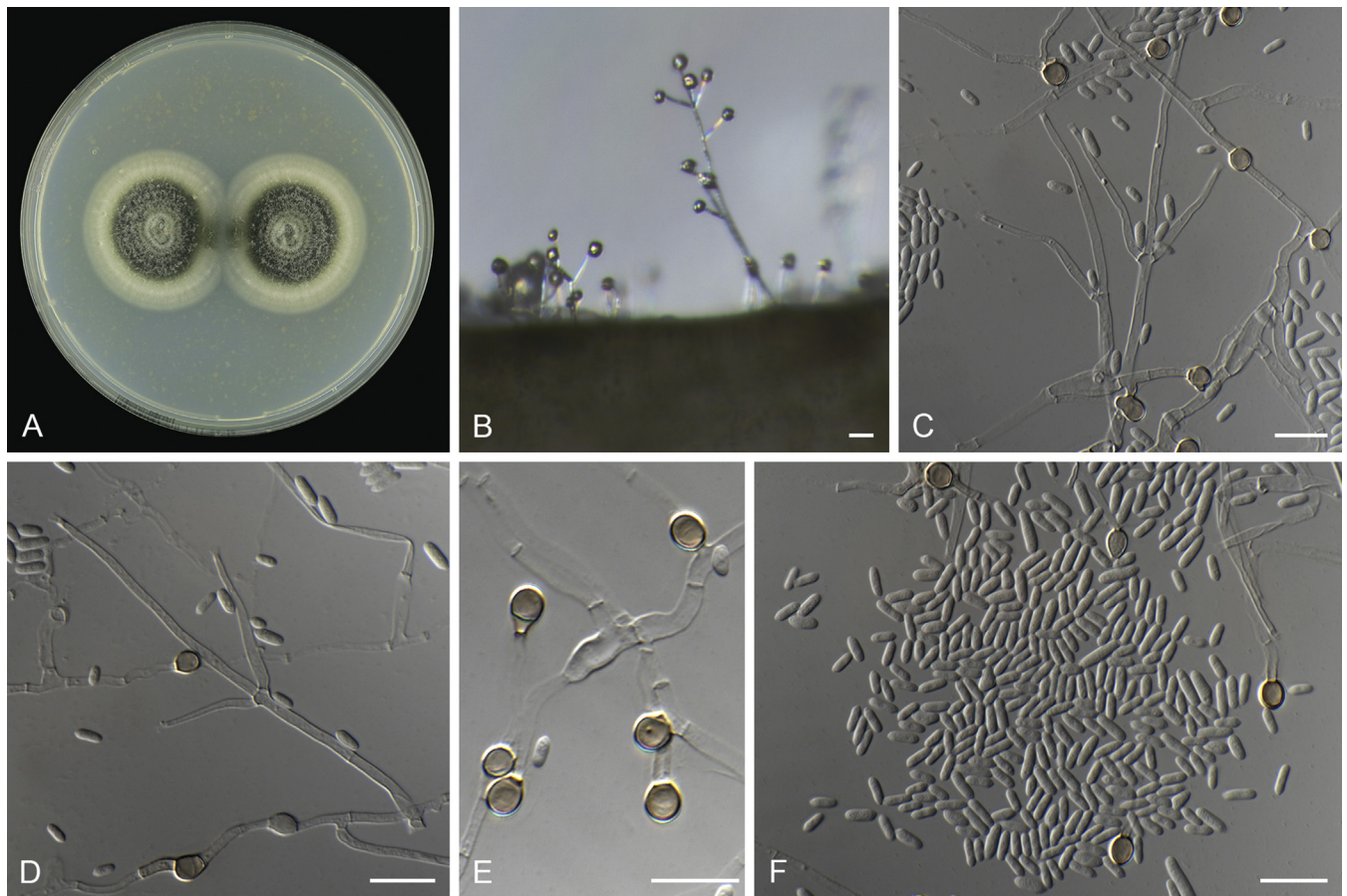


Fig. 6. *Gibellulopsis nigrescens* (ex-neotype CBS 120949). **A.** Colony on PDA after 14 d at 25 °C. **B–D.** Conidiophores. **E.** Chlamydospores. **F.** Conidia. Scale bars: B = 20 µm; C–F = 10 µm.

Prenafeta-Boldú, CBS 110719; Rotterdam, from wrapping material, unknown date and collector (**holotype** of *Verticillium dahliae* f. *zonatum* CBS 179.40 culture permanently preserved in a metabolically inactive state) culture ex-type CBS 179.40 = MUCL 9783; from nail, unknown date, A. van Duin, CBS 119666. **UK**, soil under *Humulus lupulus*, *idem.*, I. Isaac, CBS 577.50; from *Solanum tuberosum*, *idem.*, I. Isaac, CBS 455.51 = MUCL 9790.

Notes: This species was originally described as *Verticillium nigrescens* from potato tubers in England (Pethybridge 1919) and later on, neotypified with a soil isolate (CBS 120949) from the Netherlands (Zare *et al.* 2007). However, Zare *et al.* (2007) demonstrated that it is not congeneric with *Verticillium* s. str., being conspecific with the type species of *Gibellulopsis*, *G. piscis*. As a consequence, the new combination *Gibellulopsis nigrescens*, was introduced. The isolates studied by Zare *et al.* (2007) were phenotypically and genetically variable, clustering in different subclades according to partial *TEF1-α* sequences. One of them comprised the ex-types of *Cephalosporium serrae* CBS 290.30 and *G. piscis* CBS 892.70, and other one held the neotype of *G. nigrescens*. The authors did not consider those differences significant enough to justify renaming those clades and they treated all isolates as *G. nigrescens*. According to our multilocus phylogenetic analyses and morphological examination, these subclades correspond to *G. serrae* and *G. nigrescens*, respectively (Fig. 1).

Gibellulopsis serrae (Maffei) Giraldo López & Crous, **comb. nov.** MycoBank MB828040. Fig. 7.

Basionym: *Cephalosporium serrae* Maffei, Atti Ist. Bot. Pavia. Ser. 4: 196. 1930.

Synonyms: *Verticillium serrae* (Maffei) F.H. Beyma, Antonie van Leeuwenhoek 6: 40. 1939.

Hyalopus serrae (Maffei) Barbosa, Subsídios para o Estudo parasitológico do Genero *Hyalopus*. Thesis, Recife: 19. 1941.

Verticillium amaranthi Verona & Ceccar., Phytopathol. Z. 8: 373. 1935 (as '*amaranti*').

Gibellulopsis piscis Bat. & H. Maia, Anais. Soc. Biol. Pernambuco 16: 156. 1959.

Mycelium consisting of branched, septate, hyaline, smooth- and thin-walled hyphae, up to 2 µm wide. **Conidiophores** arising from submerged or superficial hyphae, (sub-)erect, simple or branched, bearing 1–2 levels with 2–3 phialides per node, ca. up to 300 µm long, 2.5–3 µm wide at the base, hyaline, smooth-walled, with cell walls usually thicker than those of the vegetative hyphae. **Phialides** terminal, lateral, cylindrical or aculeate, hyaline, thick- and smooth-walled, 23–72 µm long, 1.5–2 µm wide at the base, with inconspicuous collarette and a distinct periclinal thickening at the conidiogenous locus. **Conidia** ellipsoidal to cylindrical with rounded ends, 1-celled, hyaline, thin- and smooth-walled, 3.5–7.4 × 1.7–2.3 µm, arranged in slimy heads. **Chlamydospores** mostly intercalary, singly or in pairs, globose to subglobose with a truncate base, pale brown, smooth- and thick-walled, 5–5.5(–7) × 2(–2.5)–5 µm. **Sexual morph** not observed.

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 50–65 mm diam, flat, felty or floccose, completely white or pale mouse grey at centre and colourless to the periphery, reverse uncoloured or dark mouse grey. On OA reaching 42–50 mm diam, flat, felty at centre, glabrous or membranous at periphery, slightly zonate, entire margin, white, reverse uncoloured. On PCA reaching 30–42 mm diam, flat, glabrous or membranous to

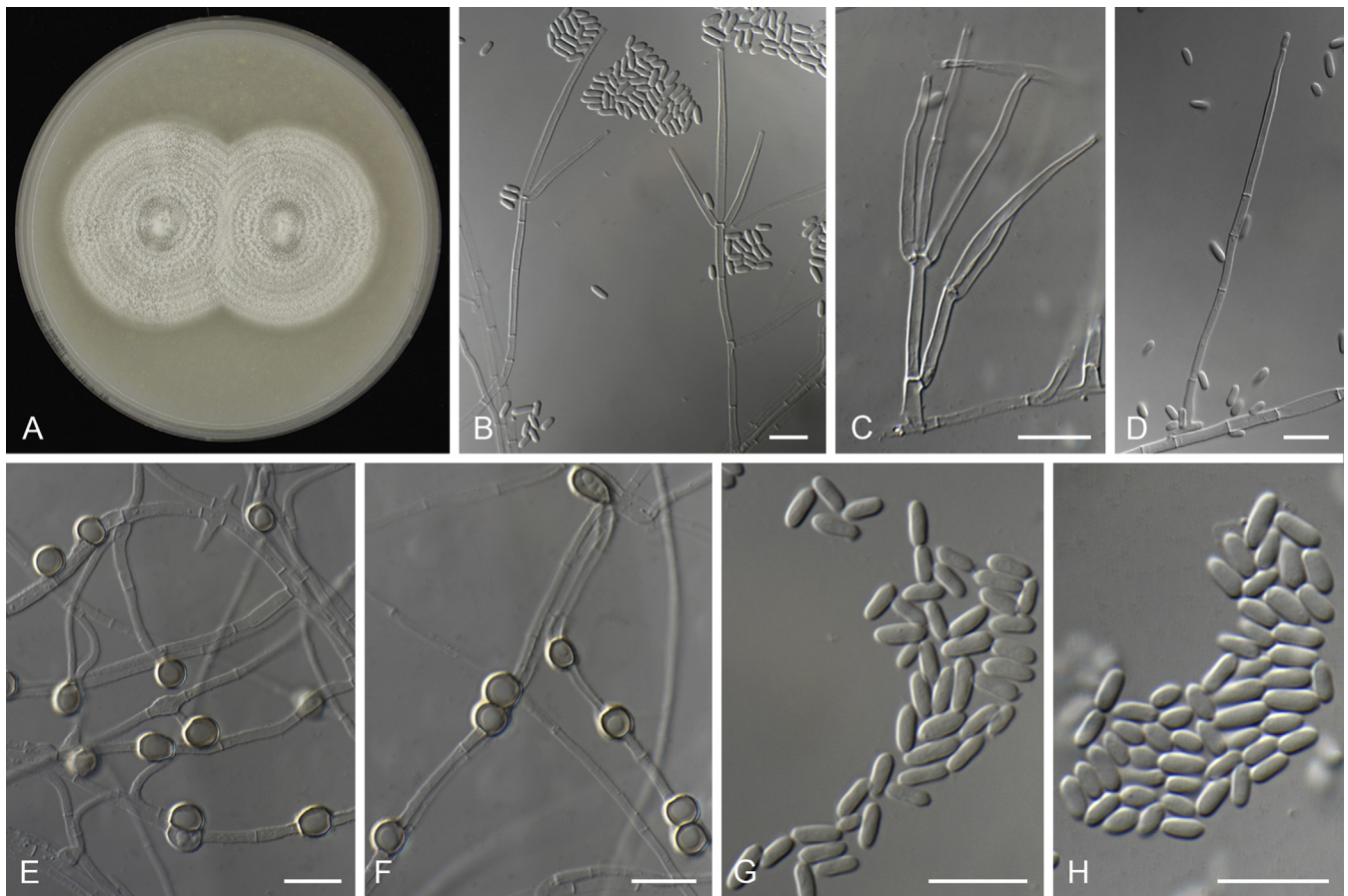


Fig. 7. *Gibellulopsis serrae*. B, D, G. CBS 892.70. A, C, E, F. CBS 101221. H. CBS 565.78C. A. Colony on OA after 14 d at 25 °C. B–D. Conidiophores. E, F. Chlamydozoospores. G, H. Conidia. Scale bars = 10 µm.

finely floccose, entire margin white, reverse uncoloured. On MEA reaching 28–30 mm diam, raised, felty to downy, entire margin, white, reverse uncoloured. In cultures older than 20 d the reverse becomes more or less dark grey due to formation of chlamydozoospores.

Specimens examined: **Argentina**, Buenos Aires, from seed, unknown date and collector, CBS 493.82B, CBS 493.82D; Chaco, *idem.*, CBS 493.82C; Misiones, from soil, unknown date and collector, CBS 493.82A. **Brazil**, Recife, from granuloma in goldfish (*Carassius auratus*), 28 Jul. 1957, Batista (**holotype** of *Gibellulopsis piscis* I.M.U.R. 891, culture ex-type CBS 892.70 = ATCC 16168 = IFO 6653). **Canada**, Quebec, from *Beta vulgaris* var. *altissima*, unknown date and collector, CBS 383.66. **Cuba**, Santiago de Las Vegas, from seed of *Abelmoschus esculentus*, unknown date, R.F. Castañeda, CBS 392.89 = INIFAT C88-362. **Germany**, from *Solanum tuberosum*, *idem.*, K.H. Schramm, CBS 175.75 = BBA 12362. **Greece**, Thessaloniki, from human blood, *idem.*, E. Roilides, CBS 109724. **India**, Bangoan, from leaf of *Musa* sp., unknown date and collector, CBS 120008; unknown, substrate, date and collector, CBS 416.76. **Israel**, Ein-Shemer, from soil, 1994–1996, N. Korolev, CBS 100830, CBS 100831; from soil in cotton field, *idem.*, CBS 101221; Gilat, from *Solanum tuberosum*, *idem.*, CBS 100826; Ramat-David, from soil in cotton field, *idem.*, CBS 100827. **Italy**, from human eye, unknown date, G.M. Serra (**holotype** of *Cephalosporium serrae* CBS 290.30 culture permanently preserved in a metabolically inactive state) culture ex-type CBS 290.30 = MUCL 7973; from *Amaranthus tricolor*, unknown date, O. Verona (**holotype** of *Verticillium amaranthi* CBS H-19312, culture ex-type CBS 387.35 = MUCL 9784). **Japan**, from *Solanum tuberosum*, unknown date and collector, CBS 120177 = NBRC 32001. **Moldavia**, from *Cercospora beticola*, *idem.*, CBS 565.78B = VKM F-481. **New Zealand**, Havelock North, from soil, *idem.*, CBS 125.79. **Russia**, Astrakhan, from *Erysiphe* sp., *idem.*, CBS 565.78C = VKM F-241; Odessa, from *Oidium* sp., *idem.*, CBS 565.78A = VKM F-53. **Sweden**, from wood pulp, *idem.*, CBS 345.39.

Notes: Most of the isolates in this clade were previously identified as *Gibellulopsis nigrescens*. However, the neotype of that species falls in a different clade, and therefore, these isolates represent a species distinct from *G. nigrescens*. This clade

harbours the ex-types of *Cephalosporium serrae* CBS 290.30, *G. piscis* CBS 892.70 and *Verticillium amaranthi* CBS 387.35, which were previously considered as synonyms of *G. nigrescens* (Zare *et al.* 2007). Since *C. serrae* is the oldest epithet, we propose *G. serrae* comb. nov. for the isolates included in this clade. Although the isolates in this clade are genetically heterogeneous we were not able to separate them and we prefer to keep them as a single species until more studies are performed.

Clade II

***Furcasterigmium* Giraldo López & Crous gen. nov.** MycoBank MB828041.

Etymology: From the Latin *furcatus*, meaning fork, and modern Latin, from Greek *stērigma*, meaning support. In reference to the forked-like appearance of the conidiogenous cell characteristically formed by these fungi.

Mycelium consisting of branched, septate, hyaline and thick-walled hyphae. **Conidiophores** erect, unbranched or poorly branched, often proliferating sympodially, showing conidiogenous cells as short lateral and cylindrical asymmetrical projections. **Conidiogenous cells** enteroblastic, mono- and polyphialidic, terminal, lateral, subulate, hyaline, with conspicuous collarette and periclinal thickening at the conidiogenous locus. **Conidia** ellipsoidal, 1-celled, hyaline, smooth-walled, arranged in slimy heads. **Sexual morph** unknown.

Type species: *Furcasterigmium furcatum* (W. Gams) Giraldo López & Crous.

Furcasterigmium furcatum (W. Gams) Giraldo López & Crous, **comb. nov.** MycoBank MB828042. Fig. 8.

Basionym: *Acremonium furcatum* W. Gams, Nova Hedwigia 18: 3. 1969.

Synonym: *Cephalosporium furcatum* Moreau & R. Moreau, Rev. Mycol. 6: 65. 1941. Nom. inval., Art. 39.1 (Melbourne).

Mycelium consisting of branched, septate, hyaline and thick-walled hyphae, 2–2.5 µm wide. **Conidiophores** erect, unbranched or proliferating sympodially, showing conidiogenous cells as short lateral and cylindrical asymmetrical projections, up to 36 µm long, 2.5 µm wide at the base, hyaline, smooth-walled. **Phialides** lateral, terminal, subulate, hyaline, thick- and smooth-walled, 18–36 µm long, 2–2.5 µm wide at the base, with cylindrical collarette and conspicuous periclinal thickening at the conidiogenous locus, polyphialides with up to three conidiogenous loci commonly present. **Conidia** ellipsoidal, sometimes with a slightly apiculate base, 1-celled, hyaline, thick- and smooth-walled, 2.7–3.8 × 1.5–2.1 µm, arranged in slimy heads. **Sexual morph** unknown.

Culture characteristics: After 14 d at ca. 25 °C: On OA reaching 35–41 mm diam, flat, dusty, dirty white, reverse uncoloured. On MEA reaching 26–35 mm diam, radially folded, hairy at the centre, floccose at periphery, entire margin, dirty white, reverse uncoloured.

Specimens examined: **France**, Normandie, Pointe du Siège, from young dunes under *Calystegia soldanella*, unknown date and collector (**holotype** of *Cephalosporium furcatum* CBS 122.42 culture permanently preserved in a metabolically inactive state) culture ex-type CBS 122.42 = IAM 14647 = MUCL 9745. **Germany**, from Loamy löss soil, unknown date, A. von Klopotek, CBS 299.70C; Kr. Plön, Schüttbrehm, from *Gymnopilus* sp., unknown date and collector CBS

299.70F; Lübeck, from moist house, unknown date, R.A. Samson, CBS 116550. **Iran**, from *Vitis vinifera*, Aug. 2004, T. Gräfenhan & R. Zare, CBS 116548. **Italy**, Turin, from agricultural soil, unknown date and collector, CBS 299.70A.

Notes: Twenty isolates labelled as *Acremonium furcatum* were included in this study. They were genetically heterogenous and were distributed in different clades along the tree (Fig 1). Six of them, including the ex-type CBS 122.42, formed a monophyletic lineage (100 % BS) within clade II which is proposed here as the new monotypic genus, *Furcasterigmium*. The remaining isolates were placed in the clades representing the genera *Chordomyces*, *Theobromium* and *Phialoparvum*, which will be discussed below.

Furcasterigmium furcatum was originally described as *Cephalosporium furcatum* from young dunes in France (Moreau & Moreau 1941), but invalidly published because of the lack of a Latin diagnosis. The species was validated by Gams (Gams & Domsch 1969) and transferred to the genus *Acremonium* as one of the species from the section Nectrioidea (Gams 1971). Among the species in that section, *A. furcatum* resembles *A. hyalinulum* in the production of schizopialides, but the conidia of the latter species are arranged in chains. According to Gams (1971), *A. furcatum* sometimes produces synnemata in culture, linking the species with *Tilachlidium*. However, no synnemata were observed by us among the representative isolates of *Furcasterigmium*.

Summerbellia Giraldo López & Crous, **gen. nov.** MycoBank MB828043.

Etymology: In honour of Richard Summerbell, who made a huge contribution towards the modern taxonomy of *Acremonium* species.

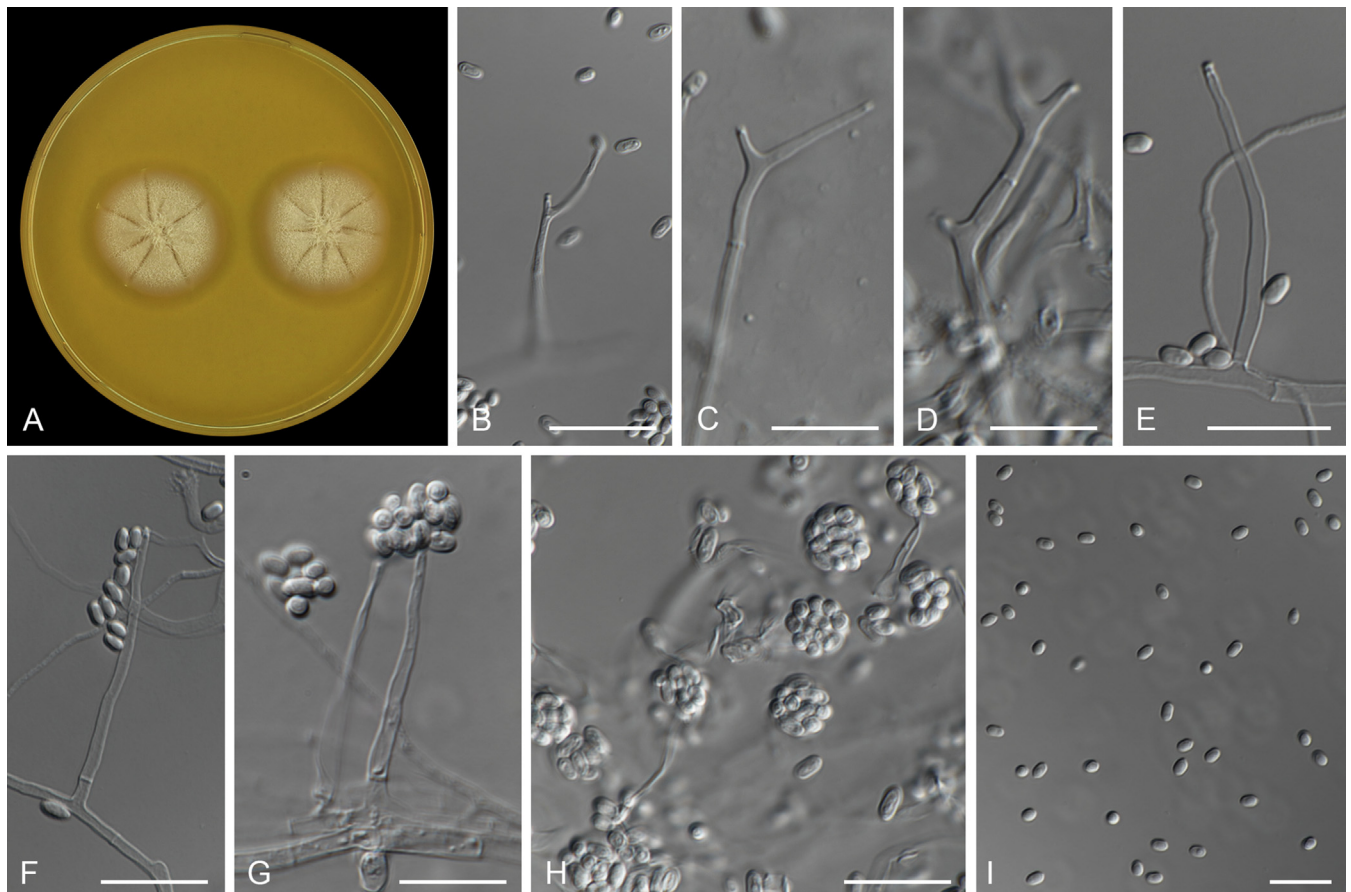


Fig. 8. *Furcasterigmium furcatum* (ex-type CBS 122.42). A. Colony on MEA after 14 d at 25 °C. B–F. Conidiophores. G, H. Slimy heads. I. Conidia. Scale bars = 10 µm.

Mycelium consisting of branched, septate, hyaline and thick-walled hyphae. *Conidiophores* erect or (sub-)erect, unbranched or poorly branched. *Conidiogenous cells* enteroblastic, monopialidic, terminal, lateral, sub-cylindrical, hyaline, with minute cylindrical collarette, and an inconspicuous periclinal thickening at the conidiogenous locus. *Conidia* ellipsoidal or cylindrical, 1-celled, hyaline, smooth-walled, arranged in slimy heads. *Chlamydo-spores* terminal or intercalary, mostly in chains, pale to dark brown, smooth- and thick-walled. *Sexual morph* unknown.

Types species: *Summerbellia oligotrophica* Giraldo López & Crous.

Summerbellia oligotrophica Giraldo López & Crous, **sp. nov.** MycoBank MB828044. Fig. 9.

Etymology: Referring to the oligotrophic nature of the fungus.

Mycelium consisting of branched, septate, hyaline and thick-walled hyphae, up to 2 µm wide. *Conidiophores* erect or (sub-)erect, simple or poorly branched, up to 50 µm long, 2 µm wide at the base, hyaline, smooth-walled. *Phialides* terminal, lateral, sub-cylindrical, hyaline, thin- and smooth-walled, often borne on short cylindrical subtending cells; 13–50 µm long, 1.5–2 µm wide at the base, with minute cylindrical collarette, and an inconspicuous periclinal thickening at the conidiogenous locus. *Conidia* ellipsoidal or cylindrical, 1-celled, hyaline, thin- and smooth-walled, 2.3–4.3 × 1.2–2 µm, arranged in slimy heads. *Chlamydo-spores*, terminal or intercalary, mostly in chains, subglobose, light to dark brown, smooth- and thick-walled, 3–4 × 3–4 µm.

Culture characteristics: After 14 d at ca. 22 °C: On OA attaining 40–44 mm diam, flat, dusty, dirty white, reverse slightly buff. On MEA attaining 35–38 mm diam, raised, radially folded, hairy, diffuse margin, buff, uncoloured reverse.

Specimens examined: **Australia**, New South Wales, unknown substratum, date and collector, CBS 620.76. **Indonesia**, from alkaline soil, unknown date, K. Nagai (**holotype** CBS-H-23648, culture ex-type CBS 657.94). **USA**, Florida, from grapefruit juice can, unknown date and collector, CBS 299.70G = QM 2995; from bath towel, *idem.*, CBS 299.70H = QM 3222.

Notes: The genus *Summerbellia* is proposed here for a group of isolates clustering in a well-supported monophyletic lineage in clade II (Fig. 1). All isolates were previously identified as *Gliocladium cibotii* based on morphological characters. However, the ex-type strain of this species falls in a phylogenetically distant clade (named here *Brunneochlamydosporium*). In addition, *G. cibotii* differs by having a faster growth rate on OA and MEA, frequently branched conidiophores, and larger conidia and chlamydo-spores than those of *S. oligotrophica*.

Among the isolates included in *Summerbellia*, CBS 657.94 and CBS 299.70H were also treated by Zare *et al.* (2007), who found them to be genetically different from the ex-type strain of *G. cibotii*. However, the authors could not correlate the molecular difference with any phenotypic feature.

Musidium Giraldo López & Crous **gen. nov.** MycoBank MB828045.

Etymology: From Latin *Musa*, meaning banana, the most frequent host.

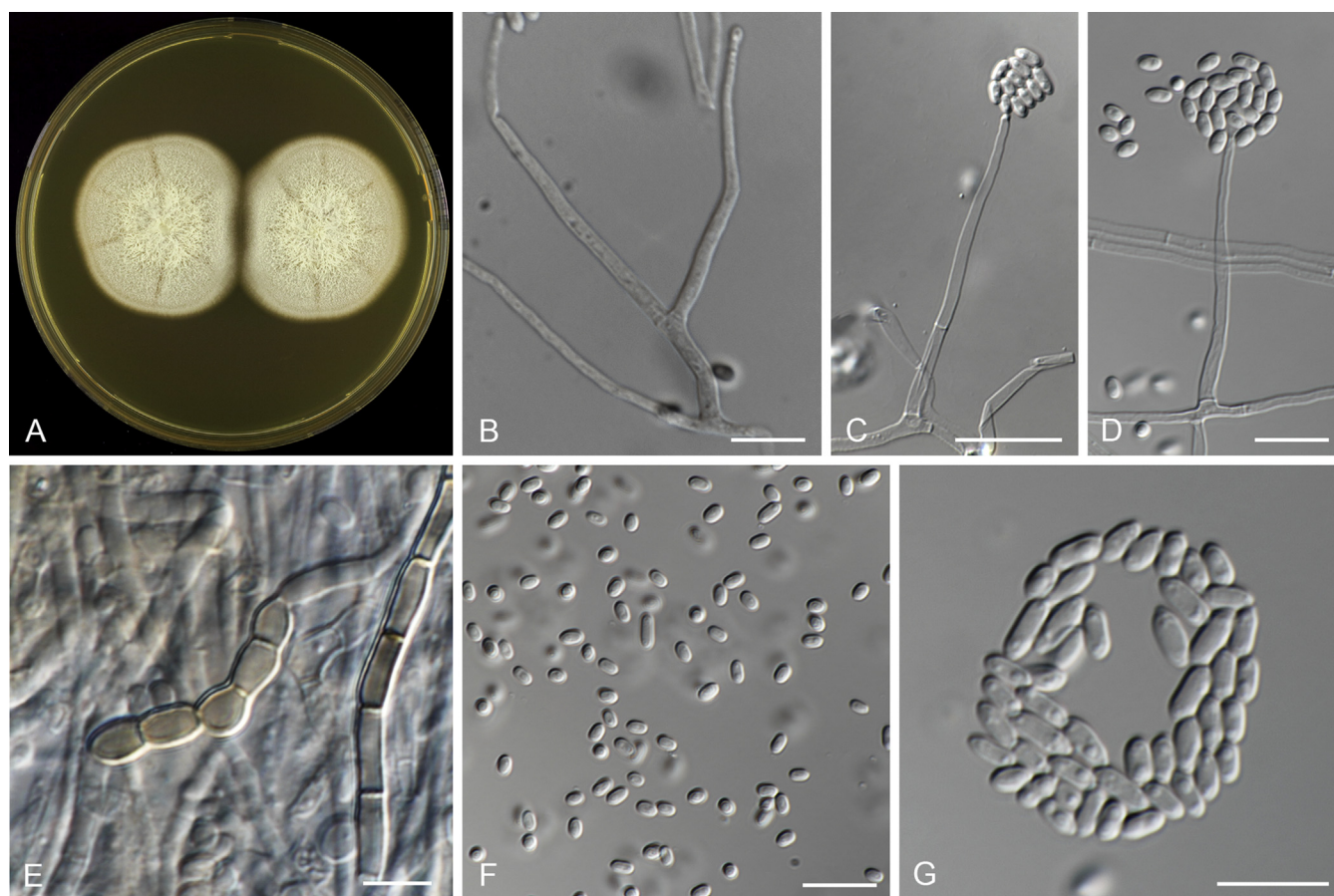


Fig. 9. *Summerbellia oligotrophica* (ex-type CBS 657.94). **A.** Colony on MEA after 14 d at 25 °C. **B–D.** Conidiophores. **E.** Chlamydo-spores. **F, G.** Conidia. Scale bars: B–D, F, G = 10 µm; E = 5 µm.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae. *Conidiophores* erect, unbranched or poorly branched. *Conidiogenous cells* enteroblastic, monopialidic, terminal, lateral, subulate, hyaline, with short cylindrical collarette, and with a distinct periclinal thickening at the conidiogenous locus. *Conidia* cylindrical or ellipsoidal, 1-celled, hyaline, smooth-walled, arranged in slimy heads. *Stromatic hyphae* branched or unbranched, dark olivaceous, incrustated or smooth and thick-walled, produced on the bottom of plate cultures or at the edge of agar slants. *Sexual morph* unknown.

Type species: Musidium stromaticum (W. Gams & R.H. Stover) Giraldo López & Crous.

Musidium stromaticum (W. Gams & R.H. Stover) Giraldo López & Crous, **comb. nov.** MycoBank MB828046. Fig. 10.

Basionym: Acremonium stromaticum W. Gams & R.H. Stover, Trans. Brit. Mycol. Soc. 64: 400. 1975.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae, 2–2.5 µm wide. *Conidiophores* erect, lateral, unbranched or basitonously branched, up to 59 µm long, 2.5 µm wide at the base, hyaline, smooth-walled, with cell walls usually thicker than those of the vegetative hyphae. *Conidiogenous cells* lateral, subulate, hyaline, thick- and smooth-walled, 23–55 µm long, 2–2.5 µm wide at the base, with cylindrical collarette, and with a distinct periclinal thickening at the conidiogenous locus, commonly with a percurrent proliferation. *Conidia* cylindrical with rounded ends or ellipsoidal, 1-celled, hyaline, thin- and smooth-walled, 4.2–6.2 × 1.4–2.3 µm, arranged in slimy heads. *Stromatic hyphae* branched, dark

olivaceous, smooth- and thick-walled, produced on the bottom of plate cultures or at the edge of agar slants. *Sexual morph* unknown (Adapted from Gams 1975).

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 70–71 mm diam, flat, felty, fimbriate margin, dirty white, reverse uncoloured. On OA reaching 69–72 mm diam, flat, membranous with scarce aerial mycelium, dirty white, reverse uncoloured. On MEA reaching 28–42 mm diam, flat, wrinkled, woolly to cottony, filiform margin, dirty white, reverse gradually becoming dark grey by the stromatic tissue.

Specimens examined: **Colombia**, Turbo, from *Musa* sp., unknown date, R.H. Stover, CBS 135.74D. **Costa Rica**, Coto valley, *idem.*, CBS 132.74, CBS 133.74. **Honduras**, Lula valley, *idem.*, unknown date, R.H. Stover, CBS 134.74, CBS 135.74C; from *Musa sapientum* root lesions, Dec. 1962, R.H. Stover (*isotype* IML 185381, culture ex-type CBS 863.73 = ATCC 32187). **Panama**, Changumola, from *Musa* sp., unknown date, R.H. Stover, CBS 135.74A. **Philippines**, Mindanao, from rhizosphere of *Musa* sp., *idem.*, R.H. Stover, CBS 135.74F. **Tanzania**, from *Musa* sp., 1953, G.B. Wallace, CBS 135.74H. **UK**, England, Kew, Royal Botanical Gardens, from leaf of *Musa* sp. (in a greenhouse), 1969, W. Gams, CBS 135.74G.

Notes: The monotypic genus *Musidium* is established here to accommodate a group of isolates previously classified as *Acremonium stromaticum*, which was described based on isolates from *Musa* sp. in Honduras (Gams 1975). The genus formed a well-supported clade (99 % BS), closely related (Fig. 1) to *Sayamraella*, *Summerbellia* and *Theobromium* (94 % BS), but morphologically differentiable by the production of branched stromatic hyphae. All the isolates in this clade are from root and rhizome lesions from banana growing in the tropics, specially from Central America, except CBS 135.74G which comes from

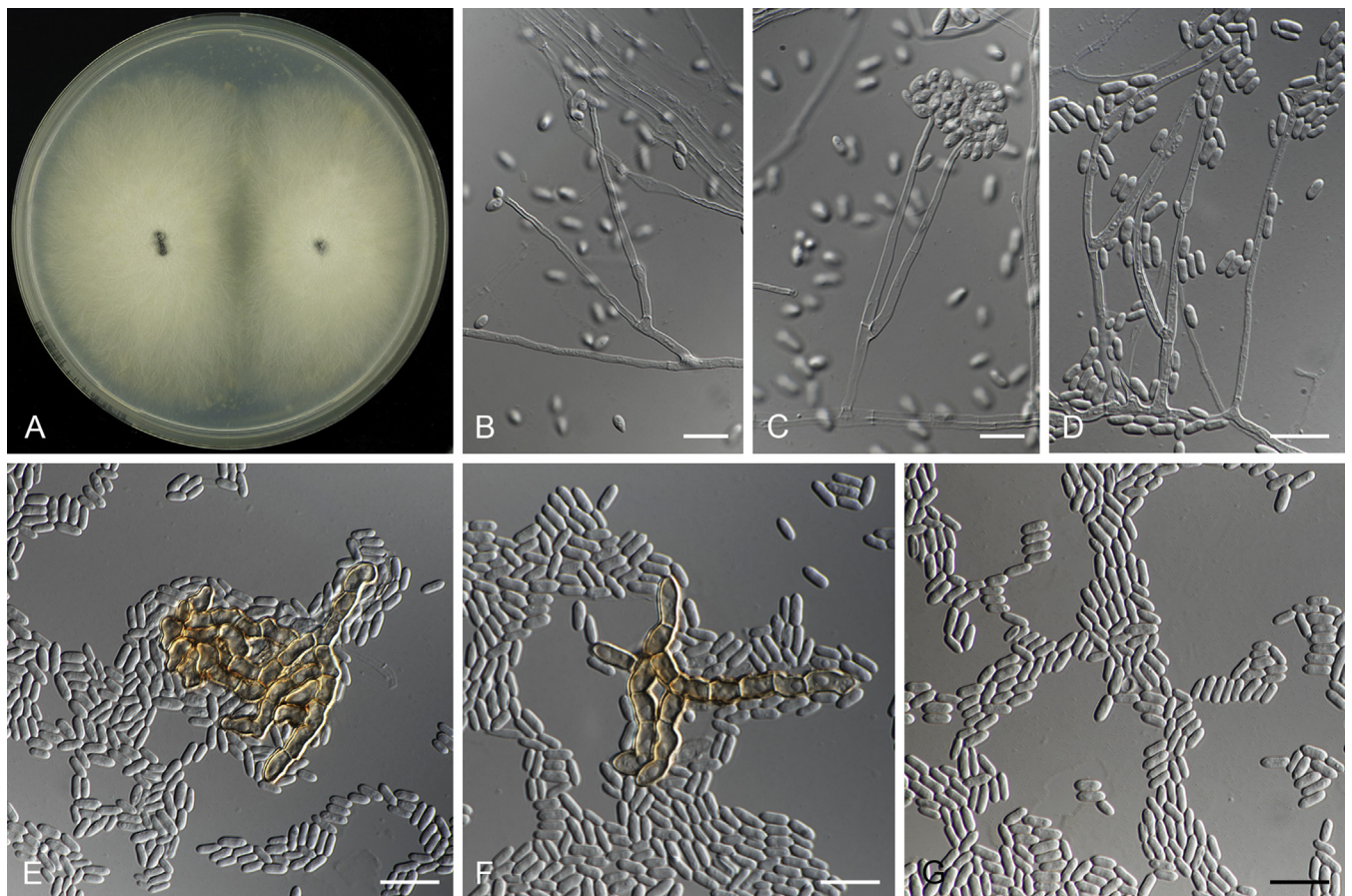


Fig. 10. *Musidium stromaticum* (ex-type CBS 863.73). A. Colony on PDA after 14 d at 25 °C. B–D. Poorly branched conidiophores with percurrent proliferations. E, F. Stromatic hyphae. G. Conidia. Scale bars = 10 µm.

Europe and is placed in a separate branch, basal to the clade containing the tropical isolates. All the isolates included in *Musidium stromaticum* were studied by Stover (1966), who treated them as *Cephalosporium* sp. Stover (1966) commonly recorded the isolates in lesions produced by the nematode *Rodopholus similis*, and stated that they can constitute up to 50 % of the isolates in such lesions in some areas. Attempts to grow the species are not always successful, since the host material (roots and rhizomes) must be macerated before plating (Gams 1975).

Sayamraella Giraldo López & Crous, **gen. nov.** MycoBank MB828047.

Etymology: Name derived from the combination of *Sayam* and *Ra*; in Thai meaning Thailand and fungus, respectively; where this fungus was first discovered.

Mycelium consisting of branched, septate, hyaline and thick-walled hyphae. **Conidiophores** erect, unbranched or poorly branched, often proliferating sympodially, showing conidiogenous cells as short lateral and cylindrical asymmetrical projections. **Conidiogenous cells** enteroblastic, mono- and polyphialidic, terminal, lateral, subulate, hyaline, with minute cylindrical collarette, and an inconspicuous periclinal thickening at the conidiogenous locus. **Conidia** ellipsoidal, 1-celled, hyaline, smooth-walled, arranged in slimy heads. **Sexual morph** unknown.

Type species: *Sayamraella subulata* Giraldo López & Crous.

Sayamraella subulata Giraldo López & Crous, **sp. nov.** MycoBank MB828048. Fig. 11.

Etymology: Referring to the subulate shape of its phialides.

Mycelium consisting of branched, septate, hyaline and thick-walled hyphae, 2–2.5 µm wide. **Conidiophores** erect, unbranched or poorly branched, often proliferating sympodially, showing conidiogenous cells as short lateral and cylindrical asymmetrical projections, up to 74 µm long, 3 µm wide at the base, hyaline, smooth-walled. **Phialides** terminal, lateral, subulate, hyaline, thin- and smooth-walled, 20.3–73.7 µm long, 2.1–3 µm wide at the base, with minute cylindrical collarette, and an inconspicuous periclinal thickening at the conidiogenous locus, polyphialides with up to two conidiogenous loci commonly present. **Conidia** ellipsoidal, 1-celled, hyaline, thin- and smooth-walled, 3.6–4.7 × 1.7–2.4 µm, arranged in slimy heads. **Sexual morph** unknown.

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 60–64 mm diam, flat, floccose to woolly, dirty white, reverse uncoloured, strong geosmin odour. On OA reaching 49–50 mm diam, flat, floccose at centre with concentric rings at periphery, dirty white, reverse uncoloured.

Specimen examined: Thailand, Lopburi province, Wang Kan Lueang waterfall, from soil around *Hopea odorata*, 14 Jul. 2015, A. Giraldo (**holotype** BCC 78964 culture permanently preserved in a metabolically inactive state) culture ex-type BCC 78964.

Notes: *Sayamraella subulata* is introduced as a monotypic genus for a fungus isolated from soil collected around roots of *Hopea odorata* in Thailand. The isolate clustered in a single branch within clade II, separated from, but related to, *Summerbellia*, *Musidium* and *Theobromium* (Fig. 1).

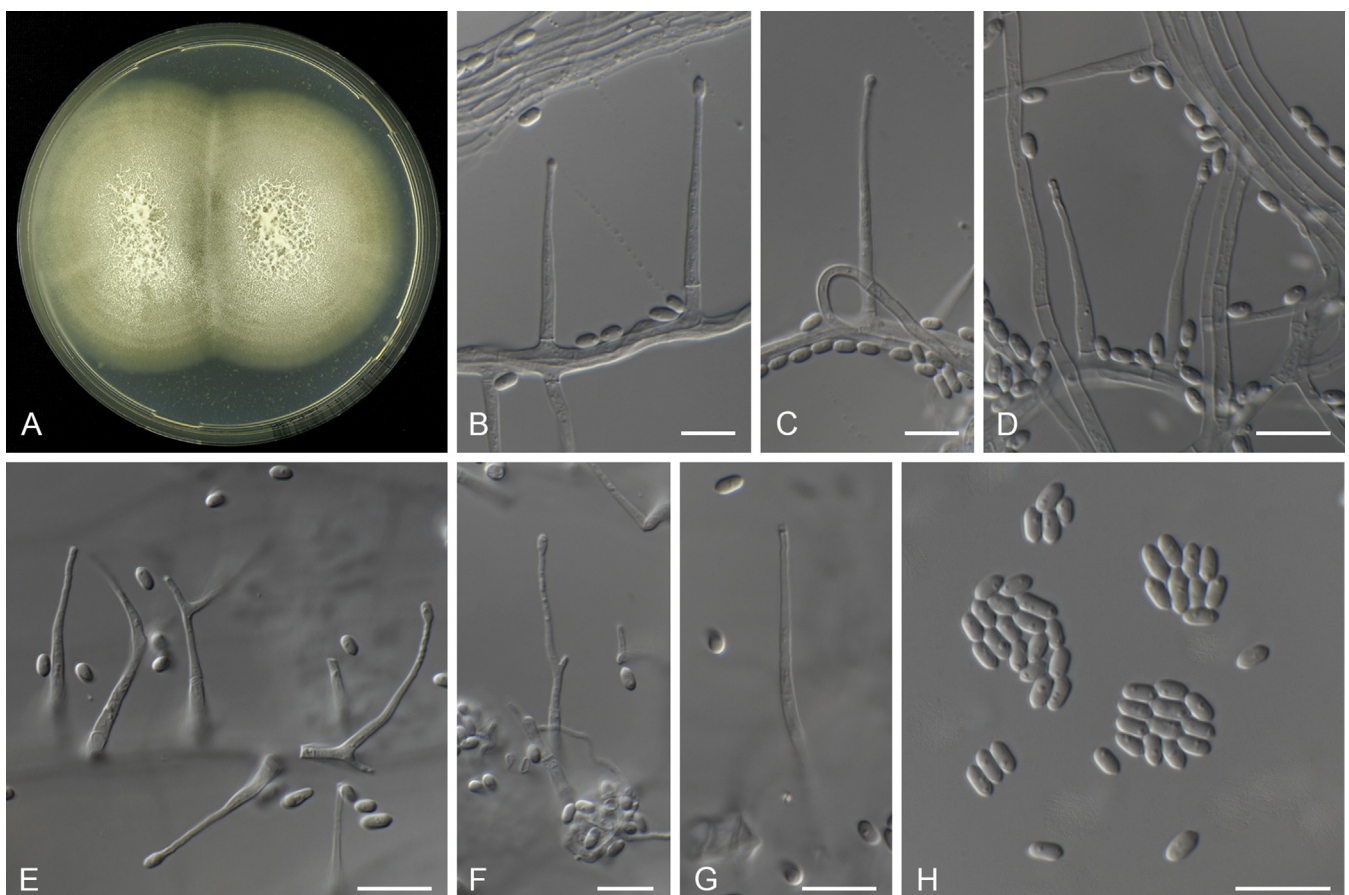


Fig. 11. *Sayamraella subulata* (ex-type BCC 78964). **A.** Colony on PDA after 14 d at 25 °C. **B–D.** Simple conidiophores. **E, F.** Polyphialides. **G.** Phialide with minute collarette. **H.** Conidia. Scale bars = 10 µm.

Theobromium Giraldo López & Crous, **gen. nov.** MycoBank MB828049.

Etymology: From Latin *Theobroma*, meaning cacao, the source of isolation of the ex-type strain.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae, becoming light brown and thick-walled with age. **Conidiophores** erect, unbranched or poorly branched, often proliferating sympodially, showing conidiogenous cells as short lateral and cylindrical asymmetrical projections. **Conidiogenous cells** enteroblastic, mono- and polyphialidic, lateral, subulate, hyaline, with minute cylindrical collarette, and an inconspicuous periclinal thickening at the conidiogenous locus. **Conidia** cylindrical or ellipsoidal, 1-celled, hyaline, smooth-walled, arranged in slimy heads. **Sexual morph** unknown.

Type species: *Theobromium fuscum* Giraldo López & Crous.

Theobromium fuscum Giraldo López & Crous, **sp. nov.** MycoBank MB828050. Fig. 12.

Etymology: From Latin *fuscus*, meaning brownish. Referring to the production of brownish pigmented hyphae.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae, 2–2.5 µm wide, becoming pale brown (especially at the septa) and thick-walled with age, 2.4–4 µm wide. **Conidiophores** erect, unbranched or basitonously branched, bearing up to two phialides, commonly proliferating sympodially, showing conidiogenous cells as short lateral and cylindrical asymmetrical projections, up to 57 µm long, 3 µm wide at the base, hyaline, smooth-walled. **Phialides** lateral, subulate, hyaline,

thin- and smooth-walled, 23–38 µm long, 2–3 µm wide at the base, with minute cylindrical collarette, and an inconspicuous periclinal thickening at the conidiogenous locus, commonly with a percurrent proliferation, polyphialides with up to two conidiogenous loci. **Conidia** cylindrical or ellipsoidal, 1-celled, hyaline, thin- and smooth-walled, 2.7–4.1 × 1.3–2 µm, arranged in slimy heads. **Sexual morph** unknown.

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 38–44 mm diam, flat, floccose at centre, diffuse margin, dirty white, reverse uncoloured. On OA reaching 38–40 mm diam, flat, felty at the inoculation point, membranous at the periphery, dirty white, reverse uncoloured. On MEA reaching 31–34 mm diam, raised, radially folded, felty to powdered, dirty white to pale luteous, with an amber exudate and strong geosmin odour.

Specimen examined: Ecuador, Pichincha province, Vicente Maldonado, from *Theobroma* sp., unknown date, H.C. Evans & K.A. Holmes (**holotype** CBS H-23657, culture ex-type CBS 112271).

Notes: The monotypic genus *Theobromium* is proposed here to accommodate a single strain, isolated from *Theobroma* sp., that is phylogenetically related (94 % BS) with *Summerbellia*, *Musidium* and *Sayamraella*. *Theobromium fuscum* resembles *Sayamraella subulata* in the production of polyphialides and conidial morphology. However, the former species has phialides with percurrent proliferation, shorter conidiophores and conidia, and a slower growth rate than *Sayamraella subulata*.

Clade III

Chordomyces Bilanenko *et al.*, Fungal Diversity 76: 55. 2016.

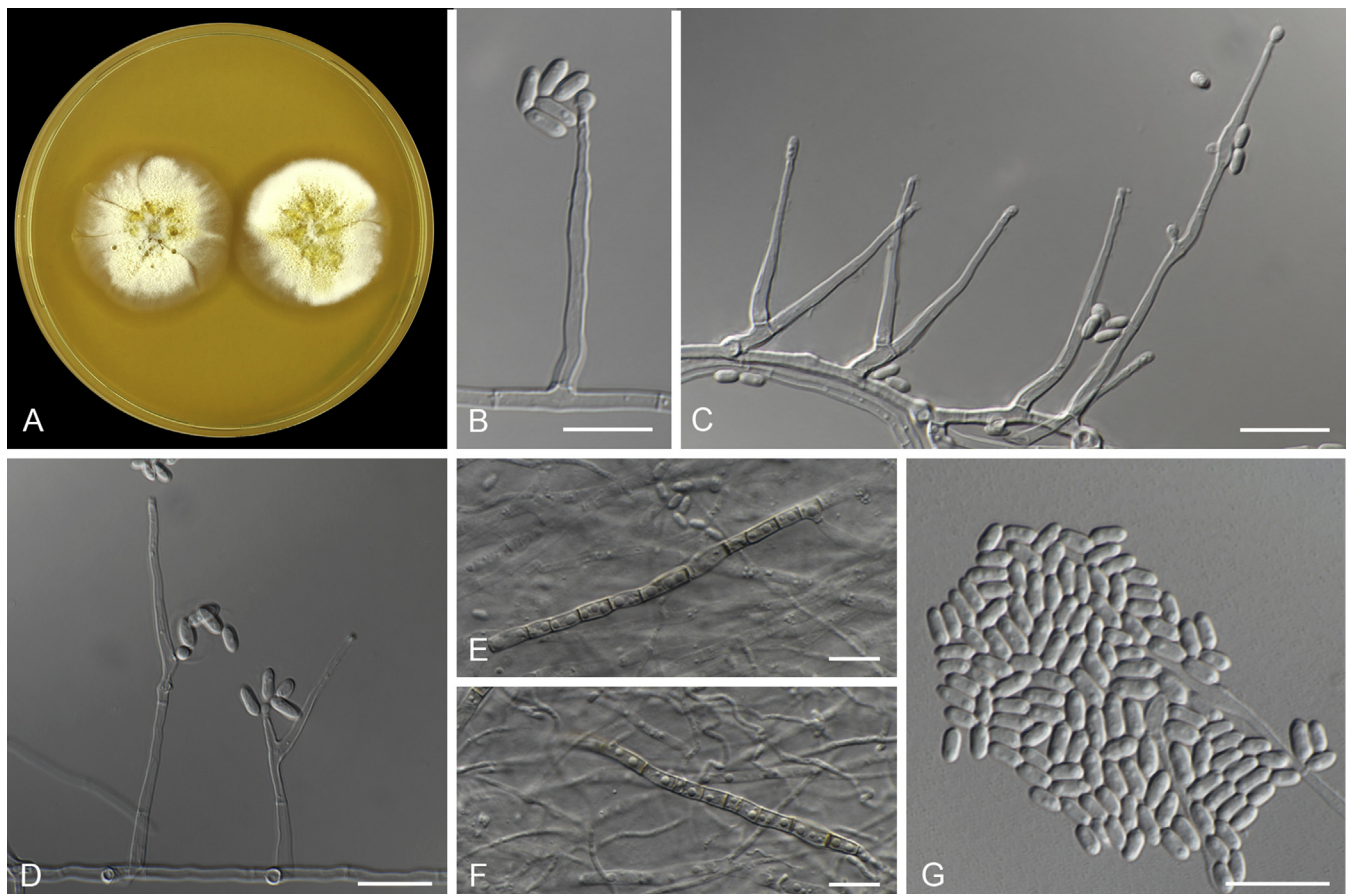


Fig. 12. *Theobromium fuscum* (ex-type CBS 112271). **A.** Colony on MEA after 14 d at 25 °C. **B.** Simple conidiophore. **C.** Conidiophores with percurrent proliferation. **D.** Polyphialides. **E, F.** Hyphae. **G.** Conidia. Scale bars = 10 µm.

Mycelium consisting of septate, hyaline, thin- and smooth-walled hyphae. *Conidiophores* erect, solitary or forming synemata, unbranched or branched. *Synnemata* when present sometimes branched, indeterminate, fimbriate, hyaline. *Conidiogenous cells* enteroblastic, mono- or polyphialidic, tapering towards the apex, hyaline, often proliferating sympodially. *Conidia* subglobose, limoniform, ellipsoidal to cylindrical, rounded at the apex, sometimes with protuberant hilum, 1(–2)-celled, hyaline, smooth-walled, arranged in slimy heads. *Sexual morph* unknown. Description adapted from that of [Giraldo et al. 2017](#).

Type species: Chordomyces antarcticus Bilanenko et al.

Chordomyces albus Giraldo et al., Mycol. Progr. 16: 359. 2017.

Specimens examined: **Belgium**, Heverlee, from garden soil, 1964, G.L. Hennebert, CBS 741.69. **France**, Grignon from agricultural soil, unknown date and collector, CBS 299.70E. **Germany**, Kiel, Botanical Garden, from moist wall, 1965, W. Gams, CBS 206.70; Bottsand, from rhizosphere soil of *Ammophila arenaria*, *idem.*, CBS 205.70; Kitzberg, from dead stem of *Angelica archangelica*, *idem.*, CBS 204.70. **Ireland**, from peat, unknown date, C.H. Dickinson, CBS 742.69. **Luxembourg**, Hautecharage, on *Hypogymnia physodes*, Dec. 1987, G. Marson (**holotype** CBS H-8083, culture ex-type CBS 987.87 = FMR 10886). **Netherlands**, Baarn, on dead leaf of *Canna indica*, 21 May 1968, W. Gams, CBS 409.70; from forest humus soil, 1964, G.L. Hennebert, CBS 508.65; Wageningen, from soil, unknown date, J.H. van Emden, CBS 743.69. **UK**, England, Egham, on leaf litter of *Viscum album*, unknown date, T. Gräfenhan & W. Gams, CBS 580.97.

Notes: *Chordomyces albus* is the second species described in the genus, from a lichen in Luxembourg ([Giraldo et al. 2017](#)). In our study, all the isolates placed in *C. albus* clade (CBS 204.70, CBS 205.70, CBS 206.70, CBS 299.70E, CBS 409.70, CBS 508.65, CBS 580.97, CBS 741.69, CBS 742.69 and CBS 743.69) were formerly identified as *Acremonium furcatum*, which is treated here as *Furcaterigium furcatum*. Both species share the conidial morphology and the production of polyphialides. However, in *C. albus* the polyphialides have up to two conidiogenous loci, while in *F. furcatum* they have maximum three conidiogenous loci.

The distribution of *C. albus* seems to be restricted to Europe and the USA, commonly being isolated from soil, but also found in *Canna indica* (*Cannaceae*), *Viscum album* (*Santalaceae*) and *Angelica archangelica* (*Apiaceae*). Only one isolate is presently known from human sources; it was isolated from sputum in the USA ([Giraldo et al. 2017](#)).

Chordomyces antarcticus Bilanenko et al., Fungal Diversity 76: 57. 2016.

Description and illustrations: [Grum-Grzhimaylo et al. \(2016\)](#).

Specimens examined: **Kazakhstan**, from *Suaeda salsa* on the coast of the Aral lake, Dec. 2003, F.V. Sapozhnikov, CBS 137610 = A141. **Mongolia**, North Gobi, Bayan-Zag area, from soda soil, Aug. 2003, I.A. Yamnova, CBS 120042 = M10 = VKM FW-3039. **Portugal**, Lisboa, from cork, unknown date and collector, CBS 610.69. **Russia**, Altai, Kulunda steppe, from soda soil at the edge of Berdabay lake, Aug. 2005, D.Y. Sorokin, CBS 137607 = A135; at the edge of Bezimyannoe lake, Aug. 2002, D.Y. Sorokin, CBS 137630 = V213; at the edge of Karakul Lake, Nov. 2002, M. Georgieva (**holotype** CBS H-21956, culture ex-type CBS 120045 = VKM FW-3041); at the edge of Petuchovskoe lake, Aug. 2002, D.Y. Sorokin, CBS 137606 = A134; at the edge of Solyonoe lake, *idem.*, CBS 120047 = M31 = VKM FW-3906; at the edge of Uzkoie lake, *idem.*, CBS 120046 = M30 = VKM FW3042.

Notes: The genus *Chordomyces* was introduced by [Grum-Grzhimaylo et al. \(2016\)](#) based on *C. antarcticus* as type species, isolated from soda soils of Russia. The genus was recently emended by [Giraldo et al. \(2017\)](#) to include species with subglobose to limoniform conidia. The majority of isolates of *C. antarcticus* were recovered from soils with a pH ranging from

8.9 to 10.1, and were alkalitolerant according to [Grum-Grzhimaylo et al. \(2016\)](#).

Clade IV

Plectosphaerella Kleb., Phytopathol. Z. 1: 43. 1930.

Ascomata perithecial, solitary or gregarious, superficial, subglobose to pyriform, dark-brown in the basal part, paler at the neck, with or without sparse setae around the base of the neck, surface with *textura angularis*. *Setae* cylindrical with wider base, rounded to pointed ends, golden brown, thick- and smooth-walled. *Asci* unitunicate, cylindrical, clavate, thin-walled, lacking an apical differentiation, 8-spored. *Ascospores* ellipsoidal, 2-celled, hyaline, smooth to slightly warted. *Conidiophores* simple and poorly branched, hyaline, smooth, thin-walled. *Conidiogenous cells* enteroblastic, mono- and polyphialidic, terminal, lateral, cylindrical, tapering gradually towards the apex, hyaline, with cylindrical collarette and conspicuous periclinal thickening at the conidiogenous locus. *Conidia* cylindrical 1- or 2-celled, hyaline, smooth-walled, arranged in slimy heads (adapted from [Uecker 1993](#), [Domsch et al. 2007](#) and [Zare et al. 2007](#)).

Type species: Plectosphaerella cucumerina (Lindf.) W. Gams.

Plectosphaerella cucumerina (Lindf.) W. Gams, Persoonia 5: 179. 1968. [Fig. 13](#).

Basionym: *Venturia cucumerina* Lindf., Meddn. CentAnst. Försväs. JordbrÖmrad., Stockholm 193/17: 7. 1919.

Synonyms: *Monographella cucumerina* (Lindf.) Arx, Trans. Brit. Mycol. Soc. 83: 374. 1984.

Plectosphaerella cucumeris Kleb., Phytopathol. Z. 1: 43. 1930.

Micronectriella cucumeris (Kleb.) C. Booth, The genus Fusarium: 39. 1971.

Cephalosporium tabacinum J.F.H. Beyma, Zentralbl. Bakteriöl., 2 Abt. 89: 240. 1933.

Fusarium tabacinum (J.F.H. Beyma) W. Gams, Persoonia 5: 179. 1968.

Microdochium tabacinum (J.F.H. Beyma) Arx, Trans. Brit. Mycol. Soc. 83: 374. 1984.

Plectosporium tabacinum (J.F.H. Beyma) M.E. Palm, W. Gams & Nirenberg, Mycologia 87: 399. 1995.

Cephalosporium ciferrii Verona, Studio sulle cause microbiche che dannegiano la carte ed i libri, Roma: 30. 1939.

Cephalosporiopsis imperfecta Moreau & R. Moreau, Rev. Mycol. 6: 67.1941. Nom. inval., Art. 39.1 (Melbourne).

Descriptions and illustrations: [Domsch et al. \(2007\)](#), [Carlucci et al. \(2012\)](#).

Specimens examined: **Belgium**, Heverlee, from *Nicotiana tabacum* rootlet in greenhouse, unknown date and collector, CBS 286.64. **Canada**, from *Solanum lycopersicon*, unknown date and collector, CBS 400.58; Alberta, from leaf and stem of *Galium spurium*, unknown date, W. Zhang, CBS 101958. **Egypt**, from *Viola odorata*, unknown date and collector, CBS 367.73 = IMI 151458. **Italy**, Foggia, Borgo Cervaro, from collar of *Cucumis melo*, 2004, A. Carlucci (**neotype** of *Venturia cucumerina* designated here CBS H-20896, MBT383650, culture ex-type CBS 131739 = Plect 11); unknown locality, from paper, unknown date, O. Verona, (**holotype** of *Cephalosporium ciferrii* CBS 137.37 culture permanently preserved in a metabolically inactive state) culture ex-type CBS 137.37 = MUCL 9704. **Netherlands**, from root of *Viola tricolor*, *idem.*, T. van Eek, CBS 355.36. **Switzerland**, Basel, from leaf of *Pyrus malus*, 3 Oct 1974, F. Stadelmann, CBS 619.74; unknown locality, from *Arabidopsis* sp., unknown date, B. Mauch-Mani, CBS 632.94; from *Arabidopsis thaliana*, *idem.*, CBS 101014. **USA**, unknown origin and date, M.A. Pisano, CBS 139.60. **USSR**, from unknown fungus, unknown date and collector, CBS 567.78 = VKM F-156. **UK**, England, Bristol, from

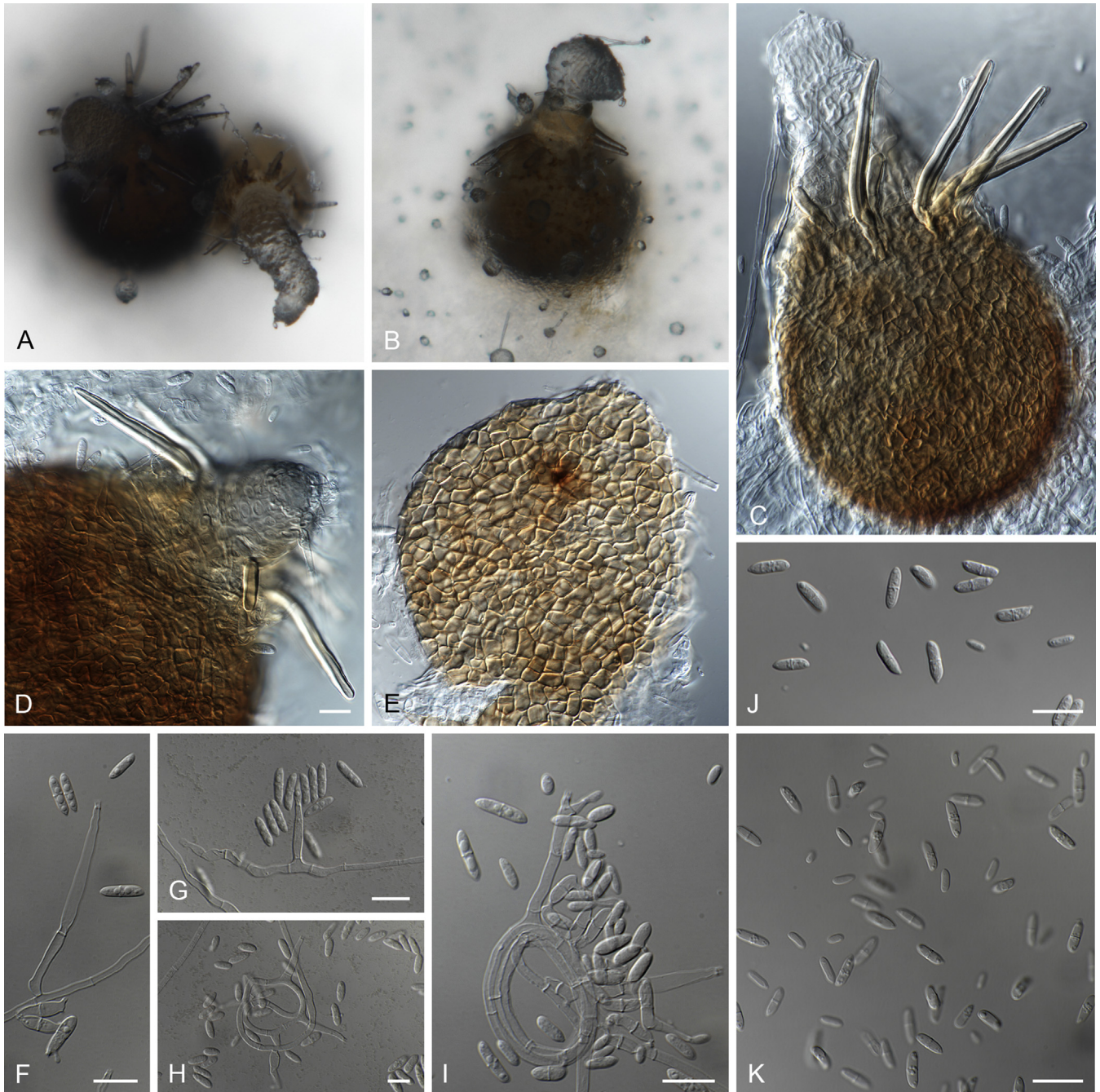


Fig. 13. *Plectosphaerella cucumerina*. A–E. Sexual morph (ex-neotype CBS 131739). F–K. Asexual morph (CBS 137.37). A–C. Sporulating ascomata on OA. D, E. Details of the ostiolar region and peridium, respectively. F–H. Monophialides (note the microcyclic conidiation on F). I. Polyphialide. J, K. Septate and aseptate conidia. Scale bars = 10 µm.

Nicotiana tabacum, unknown date, Jollyman (neotype of *Cephalosporium tabacinum* CBS H-7656, culture ex-neotype CBS 137.33, designated in Palm *et al.* 1995).

Notes: *Plectosphaerella cucumerina*, the type species of *Plectosphaerella* was originally described as *Venturia cucumerina* from *Cucumis sativus* (*Cucumeris sativae*, in the protologue) in Sweden, based on the sexual morph (Lindfors 1919). The genus *Plectosphaerella* was established 10 yr later by Klebahn (1929), based on *P. cucumeris*, also obtained from *Cucumis sativus* in Germany. Elbakyan (1970) regarded both species as conspecific, but the formal combination, *Plectosphaerella cucumerina* was only later introduced by Gams (Domsch & Gams 1972). A detailed development study of *P. cucumerina* was carried out by Uecker (1993), based on isolate CBS 101607 (= ATCC 96328 = G.J.S. 84-531), recovered from *Nicotiana tabacum* in New Zealand. This isolate was then designated as neotype for both

Plectosphaerella cucumeris and *Venturia cucumerina* (Rossman *et al.* 1999).

The asexual morph was described as *Cephalosporium tabacinum* from *Nicotiana tabacum* (van Beyma 1933), and was then transferred to *Fusarium* and *Microdochium* as *F. tabacinum* (Gams & Gerlagh 1968) and *M. tabacinum* (von Arx 1984), respectively. Finally, Palm *et al.* (1995) introduced the genus *Plectosporium*, based on *P. tabacinum* with the ex-neotype CBS 137.33. After the abolishment of dual nomenclature, the name *Plectosphaerella* took priority over *Plectosporium*.

In our phylogeny, the isolates of *P. cucumerina* clustered in a single clade (95 % BS), including the ex-type of *Plectosporium tabacinum* CBS 137.33 and *Cephalosporium ciferri* CBS 137.37; while the neotype of *Venturia cucumerina* CBS 101607 falls in the *P. plurivora* clade (Fig. 1). In order to stabilize the species epithet, which is very important to the plant pathology community, the

selection of a new neotype that correctly represents the species is necessary. Among the isolates included in the *P. cucumerina* clade, CBS 131739 was able to produce the sexual morph in culture (Fig. 13), morphologically matching the protologue of *V. cucumerina*. Thus, we have selected CBS 131739, from *Cucumis melon*, grown in Italy, as the neotype of this taxon.

Plectosphaerella humicola Giraldo López & Crous, sp. nov. MycoBank MB828052. Fig. 14.

Etymology: Name refers to the substrate from which this fungus was isolated, soil.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae. 1.5–2 µm wide. **Conidiophores** solitary, unbranched or rarely branched, hyaline, smooth, thin-walled, sometimes radiating out from sterile coils formed by the mycelium. **Phialides** terminal, lateral, cylindrical, sub-cylindrical or ampulliform, hyaline, thick- and smooth-walled, 11–41 µm long, 2.3–3.3 µm wide at the base, with cylindrical collarette and conspicuous periclinal thickening at the conidiogenous locus, adelophialides 2.8–13.7 × 1.5–4 µm, polyphialides with up to two conidiogenous loci commonly present. **Septate conidia** cylindrical or ellipsoidal, with obtuse apices and apiculate bases, 2-celled, hyaline, thick- and smooth-walled, 7.5–11 × 2.5–3.5 µm, arranged in slimy heads. **Aseptate conidia** cylindrical or ellipsoidal, acute at apex and base, 1-celled hyaline, thick- and smooth-walled, 5–8 × 2.1–3.3 µm, arranged in slimy heads.

Culture characteristics: After 14 d at ca. 25 °C: On PDA attaining 74–75 mm diam, flat, floccose at centre, membranous at periphery, surface and reverse dirty white. On OA attaining

56–70 mm diam, flat, glabrous, entire margin, pale luteous with ochraceous shades.

Specimen examined: Zaire, Katanga, from soil, unknown date, M. Lanneau (holotype CBS H-23655, culture ex-type CBS 423.66 = DSM 62443 = NRRL 20448.)

Notes: The isolate CBS 423.66 is nestled in the same clade (100 % BS) as *P. pauciseptata* and *P. plurivora*. The species can be morphologically distinguished by the colony colour on PDA being buff or pink in *P. pauciseptata* and *P. plurivora*, and dirty white in *P. humicola*. This strain was examined by Gams & Gerlagh (1968), being one of the isolates of *P. cucumerina* able to produce perithecia in culture. However, the sexual morph was not observed in our study.

Plectosphaerella plurivora A.J.L. Phillips *et al.*, Persoonia 28: 44. 2012. Fig. 15.

Synonym: *Plectosphaerella niemeijerum* L. Lombard, Persoonia 39: 459. 2017.

The description of the sexual morph complements the previous species concept based on the asexual morph (Carlucci *et al.* 2012), thus providing a holomorphic species concept.

Ascomata perithecial solitary or gregarious, superficial, sub-globose to pyriform, dark brown in the basal part, paler at the neck, 100.3–209 × 86–156 µm, without setae around the neck, *textura angularis*. **Asci** unitunicate, clavate, thin-walled, lacking iodine reaction, 8-spored, 31.4–43 × 6.2–8.2 µm. **Ascospores** biseriate, ellipsoidal, 1- or 2-celled hyaline, smooth-walled, 6.1–13.2 × 2.4–3.7 µm. Descriptions and illustrations of the asexual morph: Carlucci *et al.* (2012).

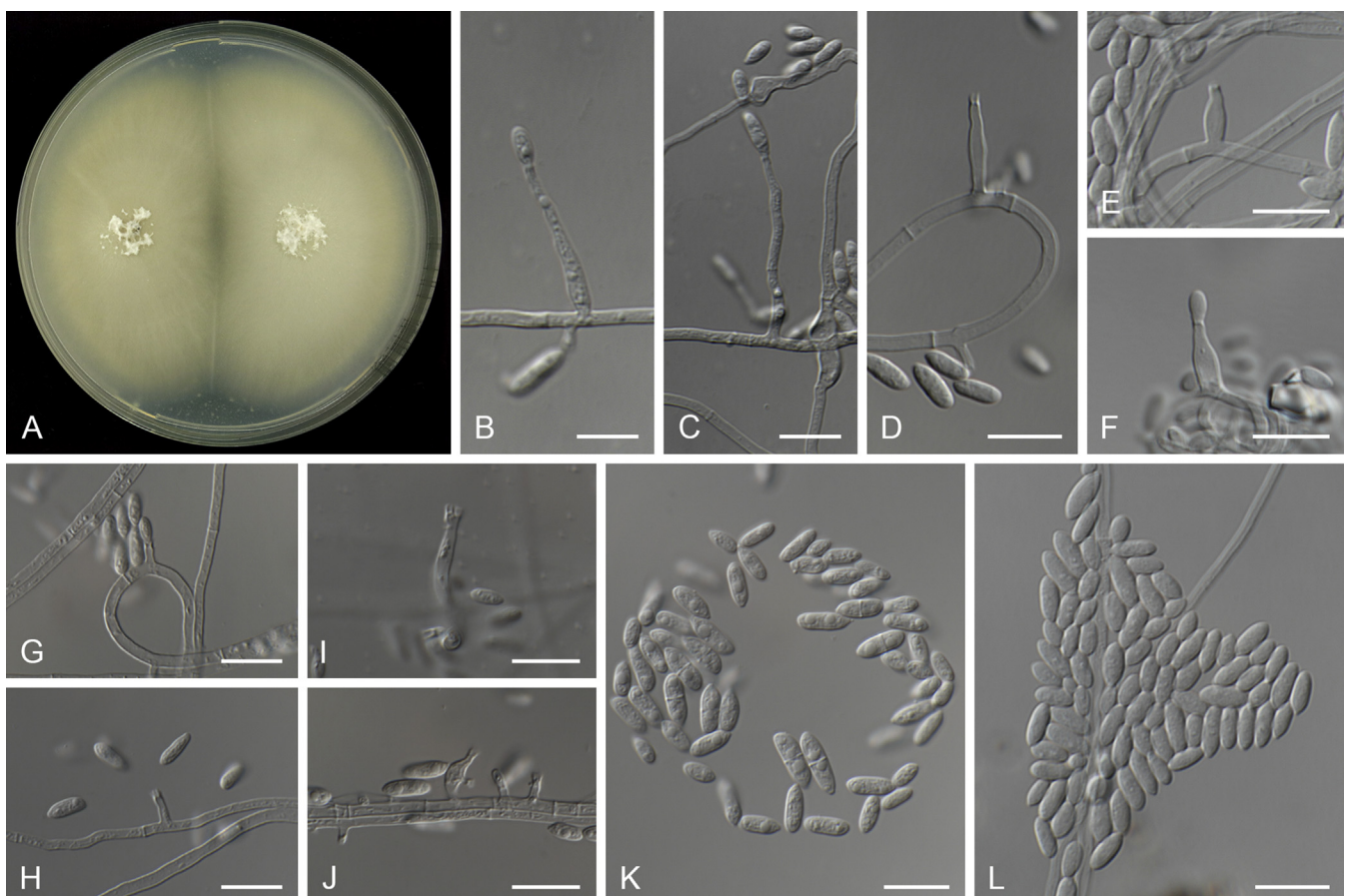


Fig. 14. *Plectosphaerella humicola* (ex-type CBS 423.66). A. Colony on PDA after 14 d at 25 °C. B–D. Monophialides. E–H. Adelophialides. I, J. Polyphialides. K, L. Septate and aseptate conidia, respectively. Scale bars = 10 µm.

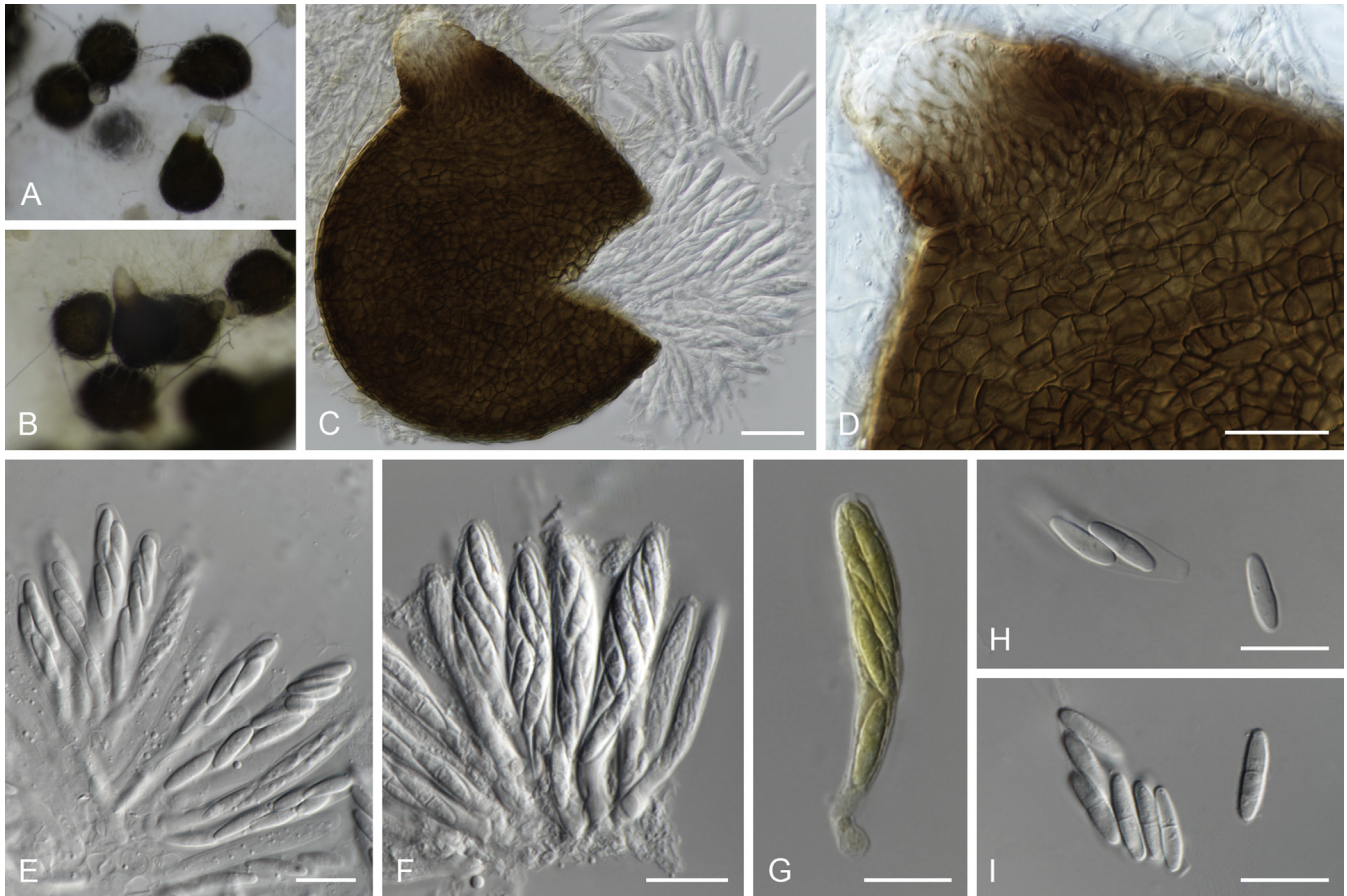


Fig. 15. *Plectosphaerella plurivora* sexual morph (CBS 101607). **A, B.** Sporulating ascomata on OA. **C.** Ascoma releasing the asci. **D.** Details of the ostiolar region and peridium. **E, F.** Asci. **G.** Ascus stained with Melzer's reagent. **H, I.** Ascospores. Scale bars: C, D = 20 μ m; E–I = 10 μ m.

Specimens examined: **Australia**, New South Wales, from *Lolium perenne*, unknown date, M. Priest, CBS 101.87. **Belgium**, from soil, unknown date and collector, CBS 642.63. **Germany**, from soil, unknown date, H. Nirenberg, CBS 260.89; *idem.*, CBS 261.89. **Italy**, Apulia, Borgo Cervaro, on asparagus apex turion, 2006, A. Carlucci (**holotype** CBS H-20899, culture ex-type CBS 131742); Rignano Garganico, from *Solanum lycopersicum*, unknown date, A. Carlucci, CBS 131860. **Netherlands**, Haren, from *Solanum tuberosum*, unknown date and collector, CBS 406.85; Nieuwegein, from garden soil, Feb. 2017, F. & R. Niemeijer, CBS 143233 = JW 5012 (ex-type of *Plectosphaerella niemeijerum*); Oostelijk Flevoland, from agricultural soil, unknown date and collector, CBS 215.84; from wheat field soil, May 1966, W. Gams, CBS 386.68; from soil, 1966, M. Gerlagh, CBS 292.66; from soil, unknown date, G.J. Bollen, CBS 757.68. **New Zealand**, Auckland, from *Nicotiana tabacum*, Oct. 1984, G.J. Samuels, CBS 101607 = ATCC 96328 = G.J.S. 84–531. **UK**, Scotland, Lona, from *Solanum tuberosum*, unknown date and collector, CBS 417.81. **USA**, Tennessee, from *Solanum tuberosum*, unknown date, Wollenweber, CBS 291.38 = ATCC 13425.

Notes: *Plectosphaerella plurivora* was described from *Asparagus* by Carlucci *et al.* (2012), based on the production of the asexual morph. In our study, among the isolates examined, only CBS 101607 from *Nicotiana tabacum* and CBS 101.87 from *Lolium perenne* were able to produce the sexual morph in culture. This finding makes *P. plurivora* the second holomorphic species described in the genus. Strain CBS 101607 was designated by Rossman *et al.* (1999) as neotype of *P. cucumerina*, a placement that is rejected by us based on our phylogenetic results (Art. 9.18 Shenzhen Code, see notes under *P. cucumerina*). Morphologically, the ascomata of *Plectosphaerella plurivora* are wider, have a darker peridium and a shorter neck than those of *P. cucumerina*. Although we have not seen setae in these isolates, according to the observations of Uecker (1993) and Palm *et al.* (1995) a few golden-brown setae were present at the base of the neck of some ascomata formed by those strains. At the

same time Palm *et al.* (1995) stated that the production of setae did not appear to be a stable character.

According to our phylogeny the isolates CBS 101.87, CBS 215.84, CBS 260.89, CBS 261.89, CBS 291.38, CBS 292.66, CBS 386.68, CBS 406.85, CBS 417.81, CBS 642.63, CBS 757.68 and CBS 101607, previously identified as *P. cucumerina*, are re-identified here as *P. plurivora*. Among these isolates, CBS 292.66 and CBS 386.68 were examined by Gams & Gerlagh (1968), who found that they were able to produce perithecia in culture at that time.

Plectosphaerella niemeijerum was recently described from soil in the Netherlands, based on ITS, LSU, *TEF1- α* and beta-tubulin sequences (Crous *et al.* 2017). However, the multilocus sequence analysis performed in this study shows this species falls within the range of variation accepted for *P. plurivora* (Fig. 1).

Brunneochlamydosporium Giraldo López & Crous, **gen. nov.** MycoBank MB828053.

Etymology: From Latin *brunneus* = brown, referring to the brownish chlamydo-spores produced by species in this genus.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae, often becoming pigmented and thick-walled with age. **Conidiophores** erect, lateral, simple or poorly branched. **Conidiogenous cells** enteroblastic, monophialidic, sometimes polyphialidic, terminal, lateral, (sub)cylindrical to subulate, hyaline, with conspicuous collarette and a periclinal thickening at the conidiogenous locus. **Conidia** ellipsoidal, cylindrical, 1-celled, hyaline, smooth-walled, arranged in slimy heads. **Chlamydo-spores** lateral, terminal, intercalary, solitary, in

pairs or short chains, 1–2-celled, pale to dark brown, smooth- and thick-walled. *Sexual morph* unknown.

Type species: Brunneochlamydosporium nepalense (W. Gams) Giraldo López & Crous

Brunneochlamydosporium cibotii (J.F.H. Beyma) Giraldo López & Crous, **comb. nov.** MycoBank MB828054. Fig. 16.

Basionym: Gliocladium cibotii J.F.H. Beyma, *Antonie van Leeuwenhoek* 10: 47. 1944.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae, becoming green-brown to brown-black and thick-walled with age, up to 2 µm wide, forming bundles. *Conidiophores* arising from submerged, erect, simple or poorly branched hyphae, bearing 2–3 phialides at the middle, up to 84 µm long, 2–2.5 µm wide at the base, hyaline, smooth-walled. *Phialides* terminal, lateral, cylindrical, hyaline, thick- and smooth-walled, 13–58 µm long, 2 µm wide at the base, with cylindrical to flared collarette and a distinct periclinal thickening at the conidiogenous locus, adelophialides commonly present, up to 7.5 µm long. *Conidia* ellipsoidal, 1-celled, hyaline, thin- and smooth-walled, 2.9–4.5 × 1.6–2.2 µm, containing two guttules, arranged in slimy heads. *Chlamydo-spores* mostly terminal, intercalary, solitary, rarely in pairs, subglobose or obovoid, sometimes 2-celled, pale brown, smooth- and thick-walled, 3.9–6.2 × 2.6–4.3 µm.

Culture characteristics: After 14 d at ca. 25 °C: On OA reaching 60–65 mm diam, flat, dusty, with concentric rings, buff, reverse isabelline. On MEA reaching 59–62 mm diam, wrinkled, radially

folded, membranous, isabelline at centre and buff at periphery, becoming fuscous black with age, reverse uncoloured. Strong geosmin odour in both media.

Specimen examined: Netherlands, Delft, from *Cibotium schiedei*, unknown date and collector (**isotype** CBS H-12850, culture ex-isotype CBS 109240 = DSM 2529 = MUCL 7576).

Notes: *Brunneochlamydosporium cibotii* was originally described as *Gliocladium cibotii* by van Beyma (1944) from *Cibotium schiedei* (Mexican tree fern) in the Netherlands. However, this species is not congeneric with the type species of *Gliocladium*, *G. penicillioides* (currently *Sphaerostilbella*, Lombard *et al.* 2015), which belongs to *Hypocreaceae* (*Hypocreales*, *Sordariomycetes*). According to our phylogenetic inference the ex-type of *G. cibotii* CBS 109240 falls in a fully supported clade (100 % BS) together with the ex-isotype of *Acremonium nepalense* CBS 971.72, and therefore the new genus *Brunneochlamydosporium* is proposed here to accommodate these taxa. Both species are easily distinguished by their colony colour on OA at 14 d, which is dark grey to almost black with the reverse becoming dark grey in *B. nepalense* and buff in *B. cibotii*. In addition, the conidiophores and phialides of *B. cibotii* are longer than those of *B. nepalense*.

In the protologue of *G. cibotii*, van Beyma (1944) described and illustrated the conidiophores as dichotomously bifurcated, arising from pigmented hyphae grouped in bundles, just as we observed here. However, no mention was made of the production of chlamydo-spores. These structures were observed in the present study after 14 d in all media tested.

Brunneochlamydosporium macroclavatum Giraldo López & Crous, **sp. nov.** MycoBank MB828055. Fig. 17.

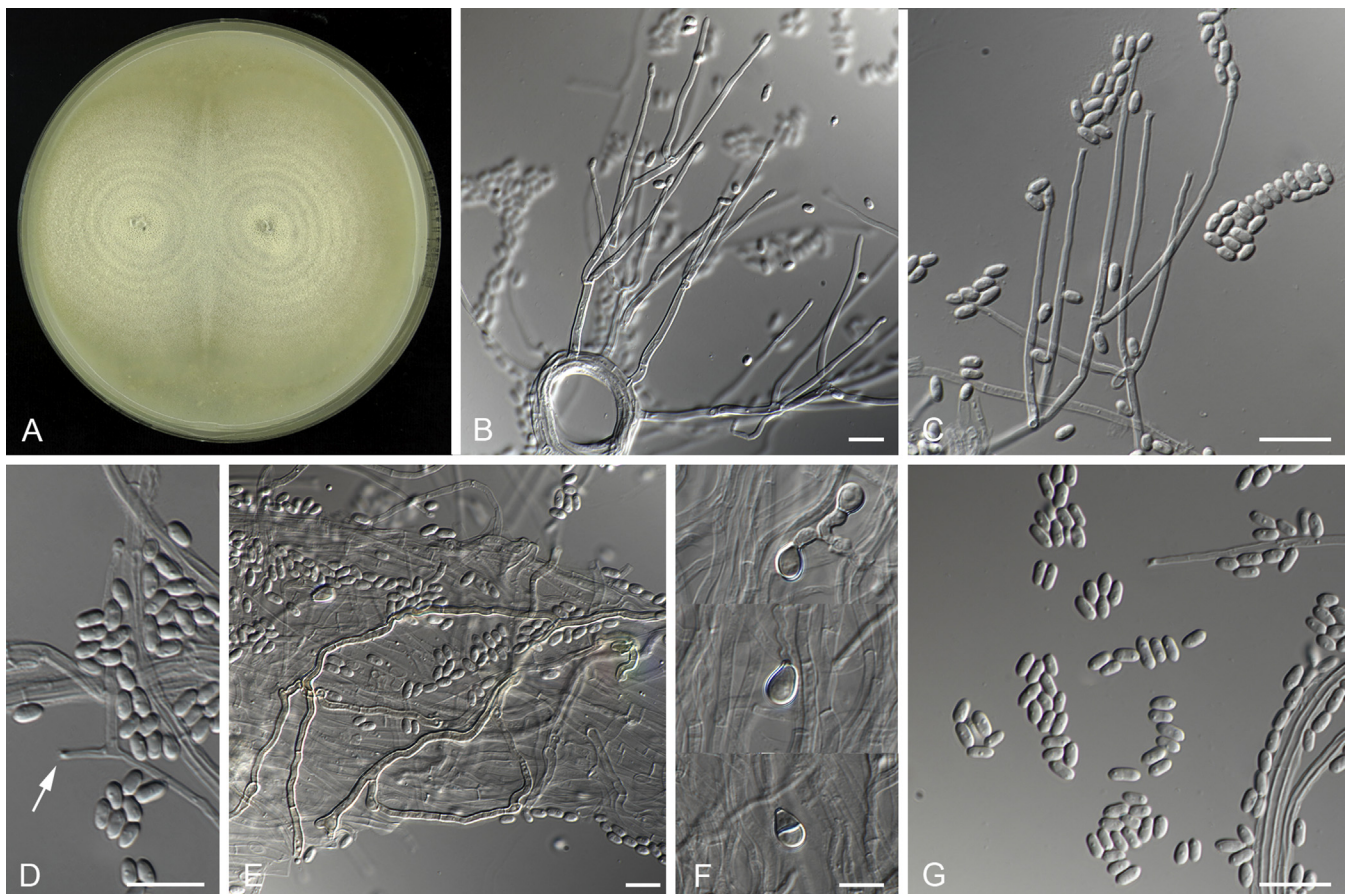


Fig. 16. *Brunneochlamydosporium cibotii* (ex-isotype CBS 109240). A. Colony on OA after 14 d at 25 °C. B–C. Conidiophores. D. Adelophialide. E. Hyphae. F. Chlamydo-spores. G. Conidia. Scale bars = 10 µm.

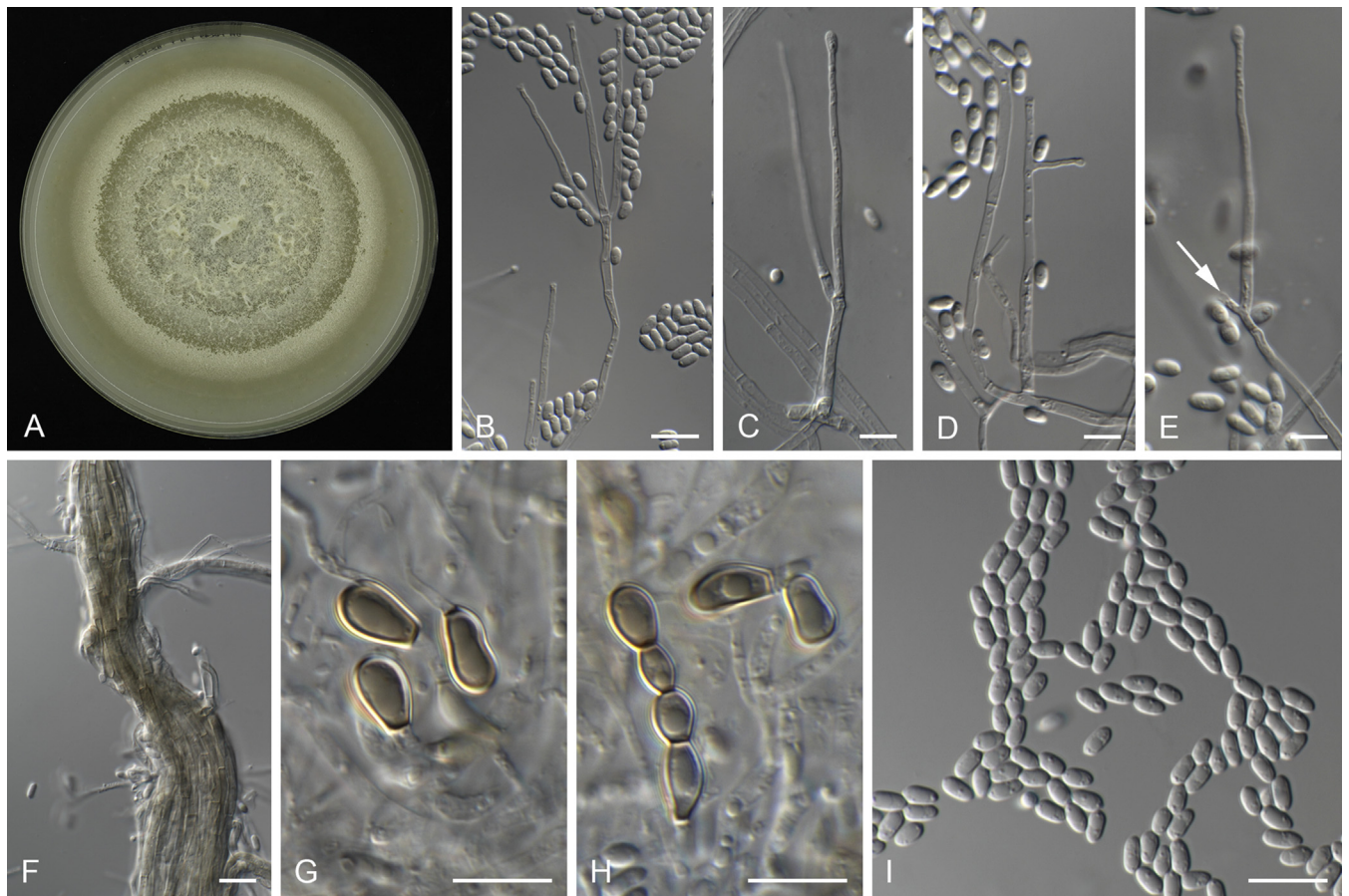


Fig. 17. *Brunneochlamydosporium macroclavatum* (ex-type CBS 101249). A. Colony on OA after 14 d at 25 °C. B–C. Conidiophores. D. Polyphialide. E. Adelophialide (arrow). F. Ropes of hyphae. G–H. Chlamydo-spores. I. Conidia. Scale bars: B, C, F–I = 10 µm. E, F = 5 µm.

Etymology: From Latin *macro*, meaning large, and *clavatus* meaning clavate, i.e., club-shaped. Referring to the large and clavate chlamydo-spores produced by this fungus.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae, becoming dark brown and thick-walled with age, up to 2 µm wide, forming bundles. **Conidiophores** arising from submerged, erect, simple or poorly branched hyphae, bearing 2–3 phialides at the middle, up to 113 µm long, 2–2.5 µm wide at the base, hyaline, smooth-walled. **Phialides** terminal, lateral, (sub)cylindrical to subulate, hyaline, thick- and smooth-walled, 27–66 µm long, 2–2.5 µm wide at the base, with cylindrical to flared collarette and a distinct periclinal thickening at the conidiogenous locus, adelophialides up to 3 µm long, polyphialides with up to two conidiogenous loci sometimes present. **Conidia** ellipsoidal, 1-celled, hyaline, thin- and smooth-walled, 4–5.2 × 2–2.5 µm, containing one or two guttules, arranged in slimy heads. **Chlamydo-spores** terminal, intercalary, solitary, in pairs or in short chains, subglobose, clavate or pyriform, 1-celled, pale to dark brown, smooth- and thick-walled, 4.6–10 × 3.3–6 µm.

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 78–80 mm diam, flat, floccose to woolly, dirty white with fuscous black shades, reverse fuscous black. On OA reaching 75–77 mm diam, flat, woolly at centre, floccose at periphery, pale luteous with pale mouse grey shades, reverse mouse grey to fuscous black. On MEA reaching 57–58 mm diam, flat, wrinkled, radially folded, downy, buff, reverse with fuscous black shades. Strong geosmin odour in all media.

Specimens examined: **India**, Bangalore, from *Salvinia auriculata*, unknown date, T. Sankaran, CBS 823.73. **Mauritius**, from a Pteridophyte, S.P.B. Madhu (**holotype** CBS H-23658, culture ex-type CBS 101249 = IMI 296138). **Switzerland**, from *Aphelandra* sp., unknown date, P. Petrini, CBS 372.93; *idem.*, CBS 373.93.

Notes: The four isolates included in this species were previously identified as *Gliocladium cibotii* (CBS 823.73) and *Verticillium* sp. (CBS 372.93, CBS 373.93 and CBS 101249). The tropical strains CBS 823.73 and CBS 101249 were isolated from fern, while the European ones (CBS 372.93 and CBS 373.93) come from a flowering plant in the family *Acanthaceae*, which is native to tropical regions of the Americas.

Morphologically, *B. macroclavatum* resembles *B. nepalense* in conidial morphology and in the production of chlamydo-spores in short chains along with pigmented ropes of hyphae. However, in *B. macroclavatum* the conidia are longer (4–5.2 µm vs. 3.2–4.7 µm), and the chlamydo-spores are larger (4.6–10 × 3.3–6 µm vs. 4.4–5 × 3.5–3.6 µm) than those of *B. nepalense*.

Brunneochlamydosporium nepalense (W. Gams) Giraldo López & Crous, **comb. nov.** MycoBank MB828056. Fig. 18.

Basionym: *Acremonium nepalense* W. Gams, Trans. Brit. Mycol. Soc. 64: 400. 1975.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae, becoming brown and thick-walled with age, up to 2 µm wide, forming bundles. **Conidiophores** arising from submerged or superficial hyphae, erect, simple or poorly branched, up to 55 µm long, 2–2.5 µm wide at the base, hyaline, smooth-walled. **Phialides** terminal, lateral, cylindrical or subulate,

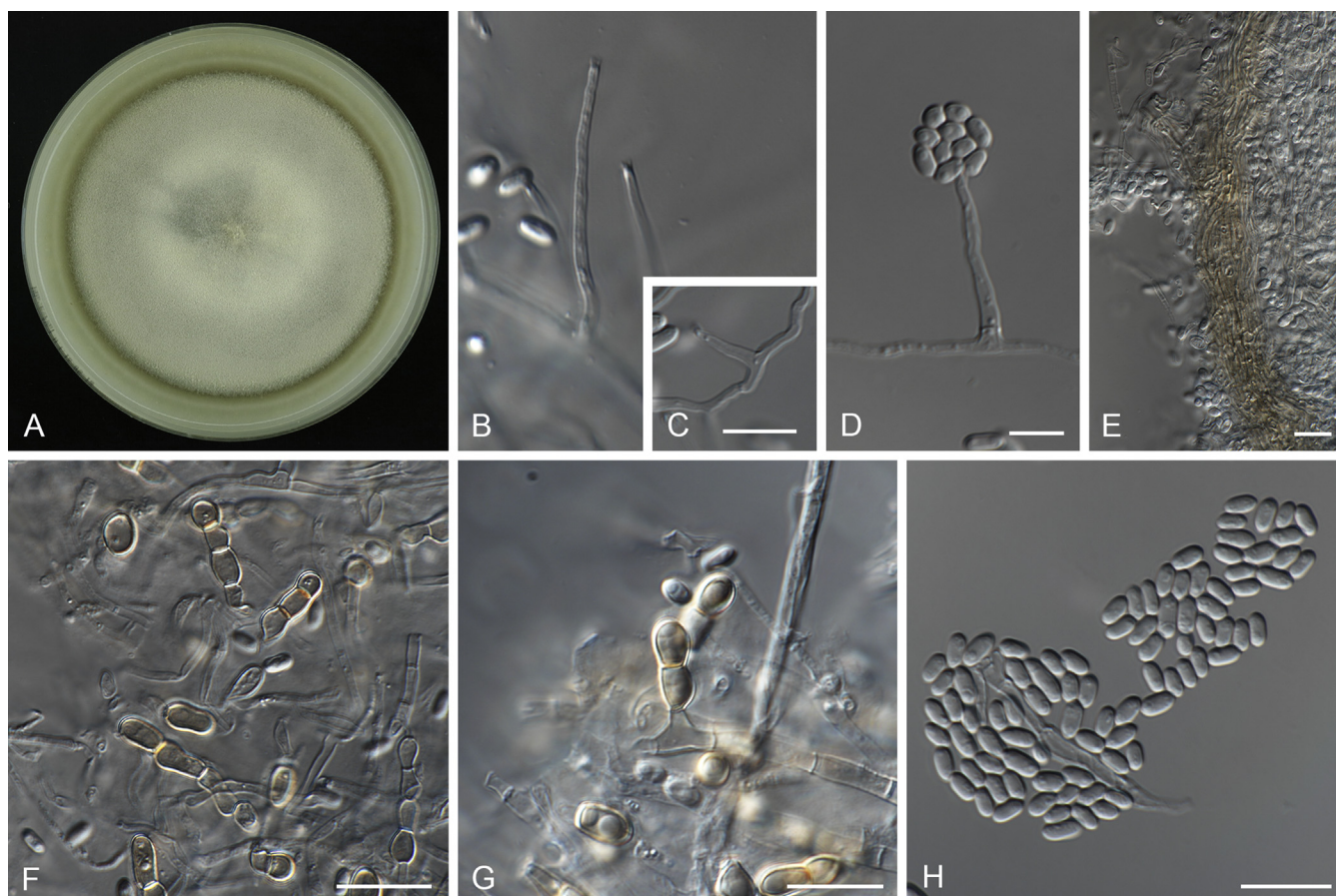


Fig. 18. *Brunneochlamydosporium nepalense* (ex-isotype CBS 971.72). **A.** Colony on OA after 14 d at 25 °C. **B–D.** Conidiogenous cells. **C.** Adelophialide. **E.** Hyphae. **F–G.** Chlamydospores. **H.** Conidia. Scale bars: C (applies to B), F–H = 10 µm; D, E = 5 µm

hyaline, thick- and smooth-walled, 25–55 µm long, 2–2.5 µm wide at the base, with minute cylindrical collarette and a distinct periclinal thickening at the conidiogenous locus, adelophialides up to 6 µm long, polyphialides with up to two conidiogenous loci sometimes present. *Conidia* cylindrical with rounded ends to ellipsoidal, 1-celled, hyaline, thin- and smooth-walled, 3.2–4.7 × 1.9–2.4 µm, containing two guttules, arranged in slimy heads. *Chlamydospores* lateral, terminal, solitary, in pairs, rarely in short chains, subglobose or irregularly shaped, sometimes 2-celled, light brown, smooth- and thick-walled, 4.4–5 × 3.5–3.6 µm (adapted from Gams 1975).

Culture characteristics: After 14 d at ca. 20 °C: On PDA reaching 49–53 mm diam, flat, floccose, whitish to cream, turning grey-brown in patches. On OA reaching 60–63 mm diam, flat, dusty, zonate, with mouse grey and fuscous black shades, reverse fawn to dark grey. On MEA reaching 50–52 mm diam, raised, hairy at centre, floccose at periphery, dirty white with dark brown shades, reverse dark brown to black. Strong geosmin odour in all media.

Specimens examined: **Nepal**, Himalaya septentrional, from soil under *Pinus* sp., unknown date, G. Franz (isotype CBS H-8260, culture ex-isotype CBS 971.72 = ATCC 32182 = IMI 185380). **Netherlands**, Kwade Hoek, from sandy soil, 22 May 2002, F.X. Prenafeta-Boldú, CBS 112045, CBS 113254, CBS 116720, CBS 116721, CBS 116722. **Unknown** locality, date and collector, from soil, CBS 277.89.

Notes: *Brunneochlamydosporium nepalense* was originally described as *Acremonium nepalense* by Gams (1975) from soil in Nepal, as a tropical species of *Acremonium* section *Nectrioidea*. In its original description the chlamydospores were described as scarce, terminal, solitary or in pairs and no mention

was made of the hyphal colour or the production of adelophialides or polyphialides. However, we have observed that the chlamydospores were abundantly produced, in terminal and lateral position, and sometimes they formed short chains. In addition, the hyphal colour become brown with age, and short adelophialides and polyphialides were produced. This species as well as *B. cibotii* and *B. catenatum* produces a strong geosmin odour in all media.

Brunneochlamydosporium terrestre Giraldo López & Crous, **sp. nov.** MycoBank MB828057. **Fig. 19.**

Etymology: Name refers to the substrate from which this fungus was isolated, soil.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae, up to 2 µm wide. **Conidiophores** arising from submerged, erect, simple or poorly branched hyphae, bearing 2–3 phialides at the middle, up to 96 µm long, 2–2.5 µm wide at the base, hyaline, smooth-walled. **Phialides** terminal, lateral, (sub) cylindrical to subulate, hyaline, thick- and smooth-walled, 26–61 µm long, 2–2.5 µm wide at the base, with cylindrical collarette and a distinct periclinal thickening at the conidiogenous locus. **Conidia** ellipsoidal, 1-celled, hyaline, thin- and smooth-walled, 3–6 × 1.7–2.4 µm, arranged in slimy heads. **Chlamydospores** lateral, terminal, intercalary, solitary or in pairs, subglobose or clavate, sometimes 2-celled, pale to dark brown, smooth- and thick-walled, 2.6–5.5 × 2.3–4 µm.

Culture characteristics: After 14 d at ca. 25 °C: On OA reaching 70–72 mm diam, flat, woolly, dirty white, reverse isabelline. On MEA reaching 57–58 mm in 14 d, flat, slightly

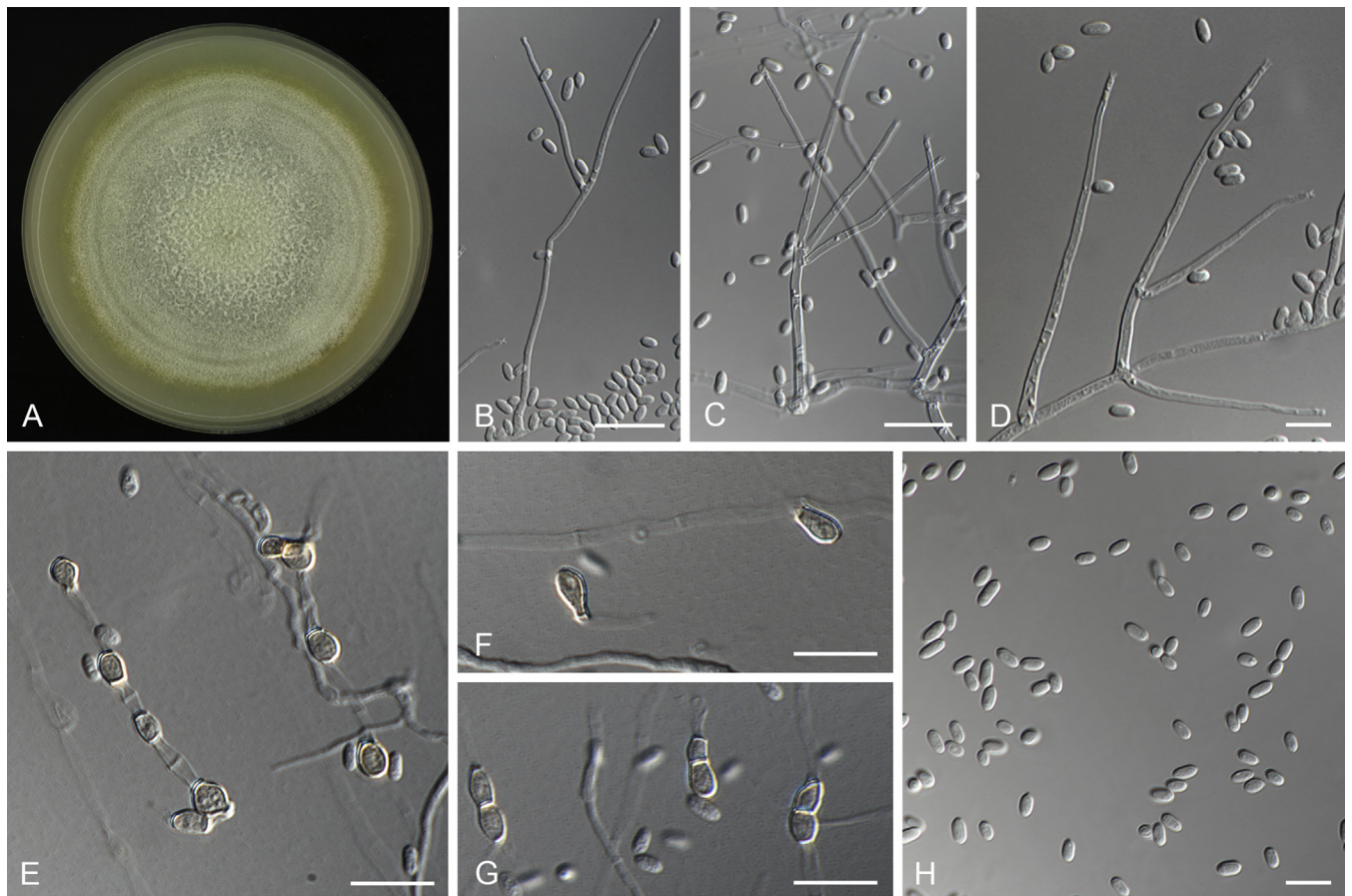


Fig. 19. *Brunneochlamydosporium terrestre* (ex-type CBS 112777). **A.** Colony on OA after 14 d at 25 °C. **B–D.** Conidiophores. **E–G.** Chlamydo-spores. **H.** Conidia. Scale bars = 10 µm.

hairy at centre, floccose toward the periphery, dirty white, reverse dark mouse grey.

Specimen examined: **French Polynesia**, Moorea, Vallée de Toto, soil under *Manihot*, 22 Jan 2003, T. Gräfenhan (**holotype** CBS H-23659, culture ex-type CBS 112777).

Notes: *Brunneochlamydosporium terrestre* is placed on a single branch, basal to *B. nepalense*. Both species come from the same substratum and are morphologically similar in colony aspect on OA and conidial morphology. Unlike *B. nepalense*, *B. terrestre* lacks of the strong smell of geosmin, and also lacks adelophialides and polyphialides; its hyphae remain hyaline with age, and its conidiophores are longer than those of *B. nepalense*.

Fuscohypha Giraldo López & Crous, **gen. nov.** MycoBank MB828058.

Etymology: Referring to the production of brown hyphae.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae, becoming dark brown and thick-walled with age. *Conidiophores* erect, simple or verticillate. *Conidiogenous cells* enteroblastic, monophialidic, terminal, lateral, cylindrical to subulate, hyaline, with cylindrical collarette and a conspicuous periclinal thickening at the conidiogenous locus. *Conidia* subglobose or ellipsoidal, 1-celled, hyaline, smooth-walled, arranged in slimy heads. *Sexual morph* unknown.

Type species: *Fuscohypha expansa* Giraldo López & Crous.

Fuscohypha expansa Giraldo López & Crous, **sp. nov.** MycoBank MB828059. [Fig. 20.](#)

Etymology: From the Latin *expansio*-, expansion, referring to the fast growth of the colonies.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae often becoming dark brown and thick-walled with age, 1.8–2 µm wide. *Conidiophores* erect, simple or branching once or twice, bearing whorls of 3–4 phialides per branch, up to 67 µm long, 2 µm wide at the base, hyaline, smooth-walled. *Phialides* simple or in whorls of 3–4, terminal, lateral, cylindrical to subulate, hyaline, thin- and smooth-walled, 18–34 µm long, 1.5–2 µm wide at the base, with cylindrical collarette and a conspicuous periclinal thickening at the conidiogenous locus. *Conidia* subglobose or ellipsoidal, 1-celled, hyaline, thin- and smooth-walled, 1.9–3.7 × 1.5–2.1 µm, arranged in slimy heads. *Sexual morph* unknown.

Culture characteristics: After 7 d at ca. 25 °C: On PDA reaching 50–51 mm diam, flat, felty, fimbriate margin, mouse grey at the centre and olivaceous black to the border, reverse black. On OA reaching 40–41 mm diam, flat dusty, entire margin, vinaceous buff to greyish sepia at centre and honey at periphery, reverse fawn. On MEA reaching 48–50 mm diam, flat, dusty, entire margin, mouse grey with white shades, reverse black.

Specimens examined: **Brazil**, from soil, unknown date, L. Pfenning, CBS 103.95 = CCT 3987. **Martinique**, from tuber of *Dioscorea* sp., *idem.*, B. Hostachy (**holotype** CBS H-5073, culture ex-type CBS 418.89).

Notes: *Fuscohypha* is proposed here to accommodate a single species, *F. expansa*. The phylogenetic inference used in this study places the ex-type strain of *F. expansa* (CBS 418.89) basal

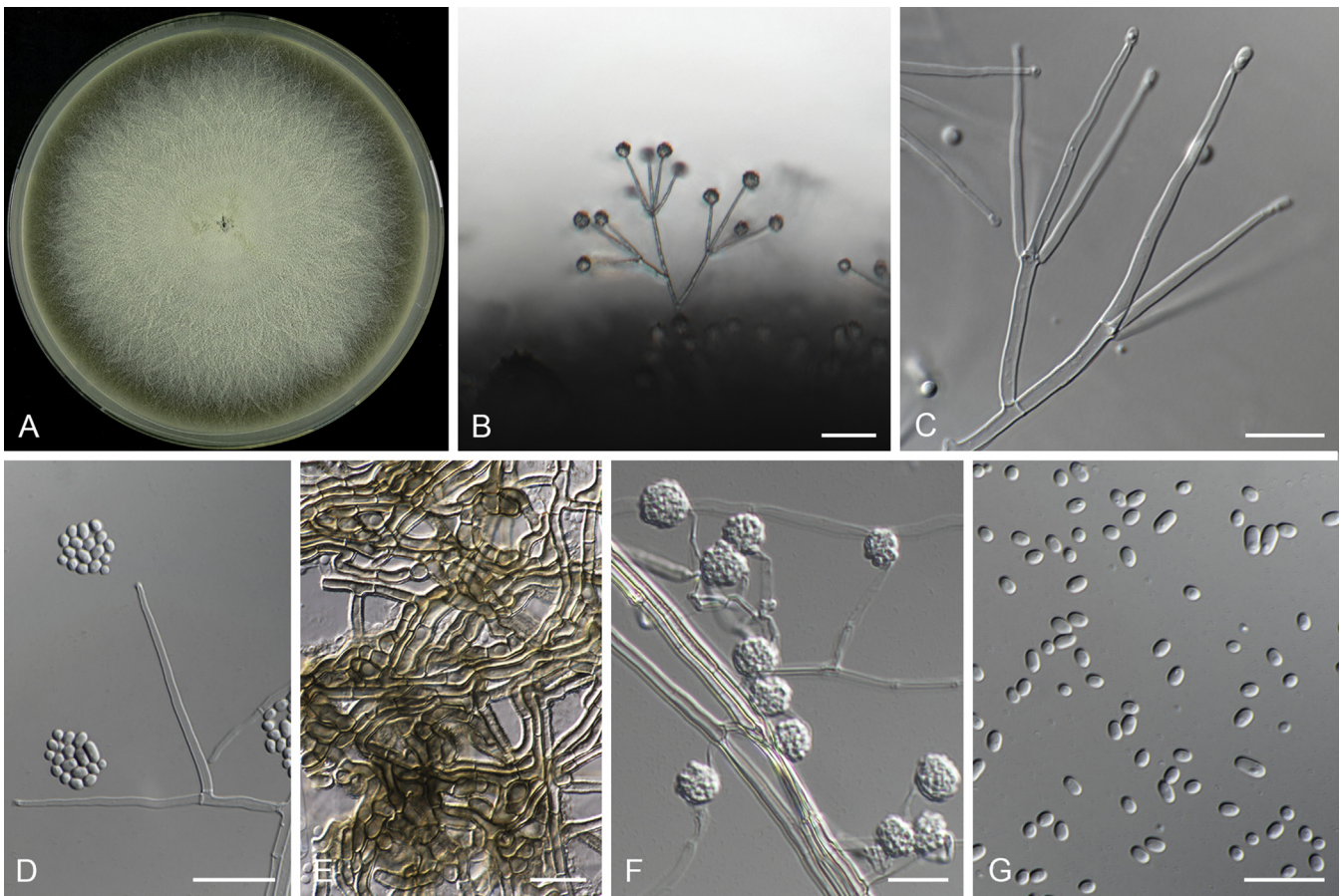


Fig. 20. *Fuscohypha expansa* (ex-type CBS 419.89). A. Colony on PDA after 14 d at 25 °C. B–D. Conidiophores. E. Hyphae. F. Slimy heads. G. Conidia. Scale bars: B = 20 µm; C–G = 10 µm.

to the clade containing *Plectosphaerella* and *Brunneo-chlamydosporium* (100 % BS).

Fuscohypha has some morphological similarities with *Verticillium*, especially in the production of verticillate conidiophores and melanised resting structures. Its conidiophores branch only once or twice and they are shorter (up to 67 µm long) than those of *Verticillium* species, which range from 480 to 800 µm long (Inderbitzin *et al.* 2011a). In addition, the melanised resting structures produced by *Fuscohypha* are restricted to dark brown hyphae, while *Verticillium* species also produce dark brown chlamydo-spores and microsclerotia.

Clade V

Paragibellulopsis Giraldo López & Crous, **gen. nov.** MycoBank MB828060.

Etymology: Referring to its morphological similarity with *Gibellulopsis*.

Mycelium consisting of branched, septate, hyaline and smooth-walled hyphae. **Conidiophores** arising from submerged or superficial hyphae, erect or slanted, simple or poorly branched. **Conidiogenous cells** monophialidic, terminal, lateral, cylindrical to aculeate, hyaline, with funnel-shaped collarette and a distinct periclinal thickening at the conidiogenous locus. **Conidia** cylindrical with tapering ends, straight or slightly curved, 2-celled, hyaline, smooth-walled, produced in slimy heads. **Chlamydo-spores** intercalary, single or in short in chains, becoming grey-brown, smooth-walled. **Sexual morph** unknown.

Type species: *Paragibellulopsis chrysanthemi* (Hirooka *et al.*) Giraldo López & Crous

Paragibellulopsis chrysanthemi (Hirooka *et al.*) Giraldo López & Crous, **comb. nov.** MycoBank MB828062.

Basionym: *Gibellulopsis chrysanthemi* Hirooka *et al.*, Mycol. Progr. 13: 16. 2014.

Description and illustrations: Hirooka *et al.* (2014).

Type details: Japan, Osaka, Kishiwada, on rotten leaves of *Chrysanthemum coronarium* var. *spatiosum*, 5 Nov. 2009, M. Kawaradani (**holotype** TFM FPH-8116; isotype BPI 884204; culture ex-type MAFF 242621 = Y.H. 11–88).

Notes: In our study, the ex-type strain of *Gibellulopsis chrysanthemi* (MAFF 242621) falls in a separate clade from *Gibellulopsis* s. str., demonstrating that they are not congeneric. Therefore, a new genus is proposed here to accommodate this taxon.

Paragibellulopsis chrysanthemi differs from *Gibellulopsis* by the production of less branched conidiophores, longer phialides with a funnel-shaped collarette, and larger conidia [(10.8–) 12.5–15.5(–17) × (1.9–)2.7–3.7(–4.2) µm] and chlamydo-spores [(7.8–)10.2–11.6(–13.2) × (6.1–)7.1–9.1(–9.7) µm] (Hirooka *et al.* 2014).

Lineage I

Phialoparvum Giraldo López & Crous, **gen. nov.** MycoBank MB828063.

Etymology: From Latin *parvus*, meaning small. Name reflects the small-sized phialides in this genus.

Mycelium consisting of branched, septate, hyaline and thick-walled hyphae. **Conidiophores** erect, arising directly from vegetative hyphae or ropes of hyphae, unbranched or poorly branched. **Conidiogenous cells** enteroblastic, mono- and polyphialidic, terminal, lateral, subulate to ampulliform, hyaline, with conspicuous collarette and periclinal thickening at the conidiogenous locus. **Conidia** cylindrical, 1-celled, hyaline, smooth-walled, arranged in slimy heads. **Sexual morph** unknown.

Type species: *Phialoparvum bifurcatum* Giraldo López & Crous.

Phialoparvum bifurcatum Giraldo López & Crous, **sp. nov.** MycoBank MB828064. Fig. 21.

Etymology: Referring to the production of phialides with a bifurcate apex.

Mycelium consisting of branched, septate, hyaline and thick-walled hyphae. 1.5–2 µm wide. **Conidiophores** erect, arising directly from vegetative hyphae or ropes of hyphae, unbranched or poorly branched, up to 15 µm long, 2.7 µm wide at the base, hyaline, smooth-walled. **Phialides** lateral, terminal, subulate to ampulliform, hyaline, thick- and smooth-walled, 8–15 µm long, 1.5–2.7 µm wide at the base, with cylindrical collarette and conspicuous periclinal thickening at the conidiogenous locus, adelophialides sometimes present, up to 4 µm long; polyphialides with up to two symmetrical conidiogenous loci are commonly present. **Conidia** cylindrical, 1-celled, hyaline, thick- and smooth-walled, 2.8–4.4 × 1.2–1.8 µm, occasionally with one or two guttules, arranged in slimy heads. **Sexual morph** unknown.

Culture characteristics: After 14 d at ca. 20 °C: On PDA reaching 16–17 mm diam, flat, membranous, rhizoid margin, dirty white, reverse uncoloured. On OA reaching 29–30 mm diam, flat, glabrous, dirty white, reverse uncoloured, with brown irregular accumulations of melanin. On MEA reaching 25–28 mm diam, raised and radially folded with a mycelium tufts at centre, membranous at periphery, buff, reverse uncoloured.

Specimen examined: Belgium, Heverlee, from soil, unknown date, J. Meyer (holotype CBS H-8167, culture ex-type CBS 299.70B)

Notes: The only isolate representing *Phialoparvum bifurcatum* was formerly identified as *A. furcatum*. However, it falls in a single lineage, phylogenetically distant from the type strain of that species (Fig. 1). In addition, the polyphialides in *A. furcatum* are produced as short lateral and cylindrical asymmetrical projections, while in *P. bifurcatum* they are dichotomously and symmetrically distributed at the apex of the conidiogenous cells. CBS 299.70B was stated by Gams (1971) to deviate from the type of *Acremonium furcatum*, CBS 122.42, by its longer conidia. This morphological feature was also observed here and correlates with the molecular differences shown in Fig. 1.

Clade VI

Musciillum Zare & W. Gams, Nova Hedwigia 85: 482. 2007.

Mycelium consisting of branched, septate, hyaline or centrally pale brown and thin-walled hyphae. **Conidiophores** arising from submerged hyphae, erect, septate, repeatedly verticillate towards the apex, distinctly brown pigmented throughout (slightly pale only near the tip). **Conidiogenous cells** enteroblastic, monopialidic,

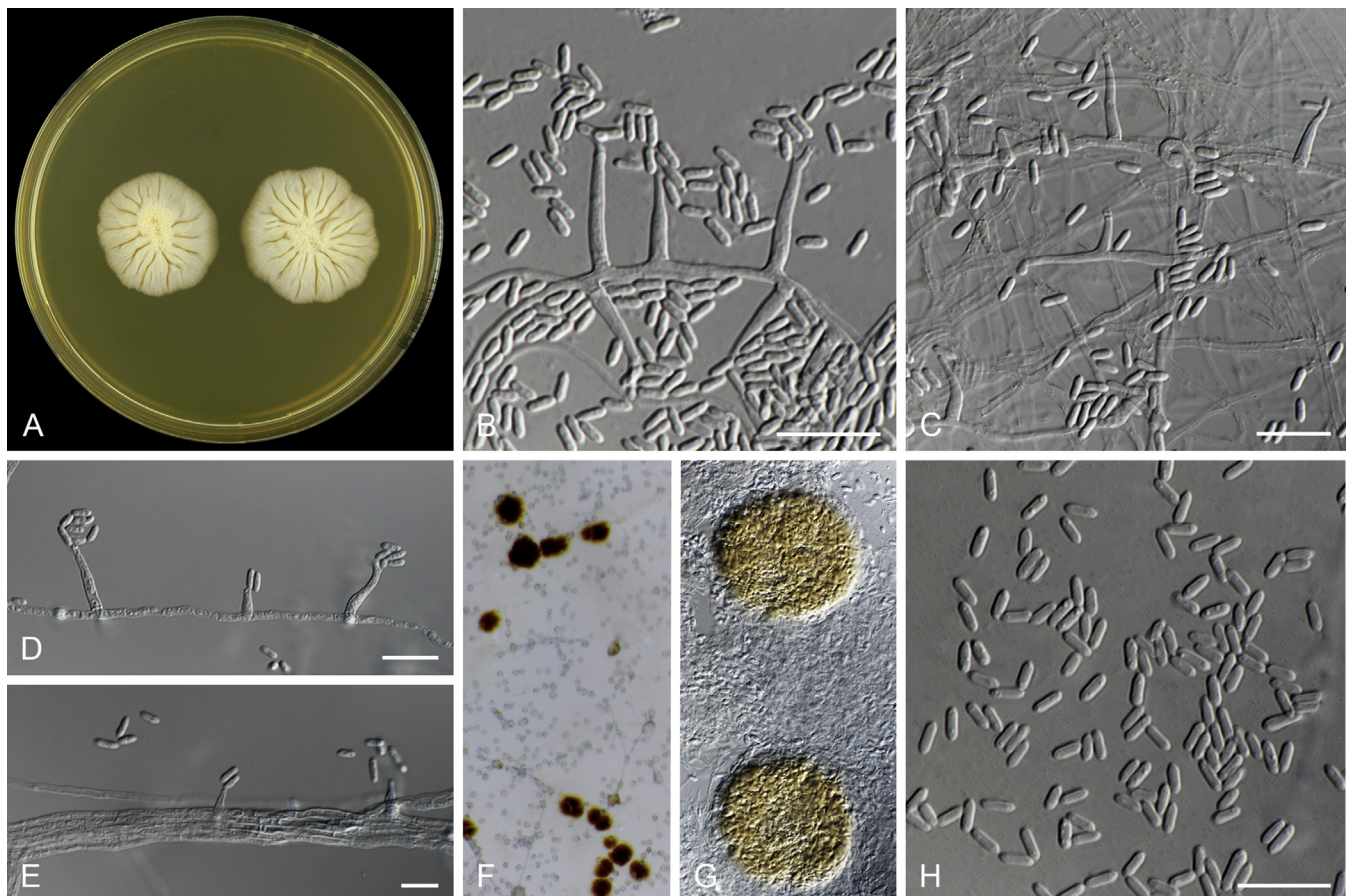


Fig. 21. *Phialoparvum bifurcatum* (ex-type CBS 299.70B). **A.** Colony on MEA after 14 d at 25 °C. **B–E.** Conidiogenous cells. **F, G.** Melanin precipitations on OA. **H.** Conidia. Scale bars = 10 µm.

solitary or in whorls, terminal, lateral, subulate, hyaline to (sub) hyaline, with minute collarette and a distinct periclinal thickening at the conidiogenous locus. *Conidia* ellipsoidal to cylindrical, 1-celled, hyaline, smooth-walled, produced in slimy heads. *Chlamydozoospores* absent, but moniliform hyphae, initially subhyaline, later turning brown, commonly formed after 2 wk and longer. *Sexual morph* unknown (modified from Zare *et al.* 2007).

Type species: Musicillium theobromae (Turconi) Zare & W. Gams.

Musicillium elettariae Giraldo López & Crous, **sp. nov.** MycoBank MB828065. Fig. 22.

Etymology: Refers to *Elettaria*, the host genus from which the type culture of this fungus was isolated.

Mycelium consisting of branched septate, smooth, pale brown with age, thin-walled hyphae, 2–3.5 µm wide. *Moniliform hyphae* formed after 2 wk, subhyaline, turning brown, 8–10 µm diam, and commonly aggregating into microsclerotium-like structures. *Conidiophores* arising from submerged hyphae, erect, with 4–10 septa in the lower part, simple or verticillate towards the apex, bearing up to 4 whorls of 2–5 phialides, sometimes with lateral branches, up to 640 µm long, 3–4 µm wide at the base, brown almost up to the first whorl, often tuberculate at base, with cell walls usually thicker than those of the vegetative hyphae. *Phialides* usually in divergent whorls of 2–5 (rarely solitary), terminal, lateral, (sub)cylindrical to subulate, hyaline, thick- and smooth-walled, 13.7–33.5 µm long, 1.8–2.8 µm wide at the base, with inconspicuous collarette and periclinal wall thickening at the conidiogenous locus. *Conidia* cylindrical with

rounded ends, 1-celled, hyaline, thin- and smooth-walled, 3.1–10.7 × 1.8–2.8 µm, arranged in slimy heads.

Culture characteristics: After 14 d at ca. 25 °C: On OA reaching 62–67 mm diam, flat, slightly woolly at the centre, powdery to granulose at periphery, entire margin, mouse grey to olivaceous grey, reverse dark mouse grey. On MEA reaching 65–70 mm, flat, slightly folded, felty to woolly, entire margin, with a cottony smoke grey mass at the centre, pale mouse grey at periphery, reverse dark mouse grey.

Specimens examined: **Iran**, Golestan, Forest park of Tuskestan, from dead leaf of *Carex pendula*, unknown date, W. Gams & R. Zare, CBS 140681. **Rwanda**, from *Elettaria cardomomum*, Dec. 1979, unknown collector (**holotype** CBS H-19316, culture ex-type CBS 252.80). **Thailand**, Chiang Mai, Doi Suthep Pui National Park, from leaf of *Musa acuminata*, unknown date and collector, CBS 110322.

Notes: These isolates were previously treated as *Musicillium theobromae* by Zare *et al.* (2007). However, according to our phylogenetic inference they fall into a separate clade from that holding the type species (98 % BS). Morphologically, *M. elettariae* has tuberculate conidiophores and conidia, longer (640 µm long; 3.1–10.7 × 1.8–2.8 µm) than those of *M. theobromae* (up to 220 µm long; 3.4–5.3 × 1.7–2.6 µm).

The isolates included in the *M. elettariae* clade are diverse in host range, having been obtained from *Carex pendula*, *Elettaria cardomomum* and *Musa acuminata*. In comparison, two related species, *M. theobromae* and *M. tropicale*, have mostly been isolated from *Musa* spp.

Musicillium theobromae (Turconi) Zare & W. Gams, Nova Hedwigia 85: 482. 2007. Fig. 23.

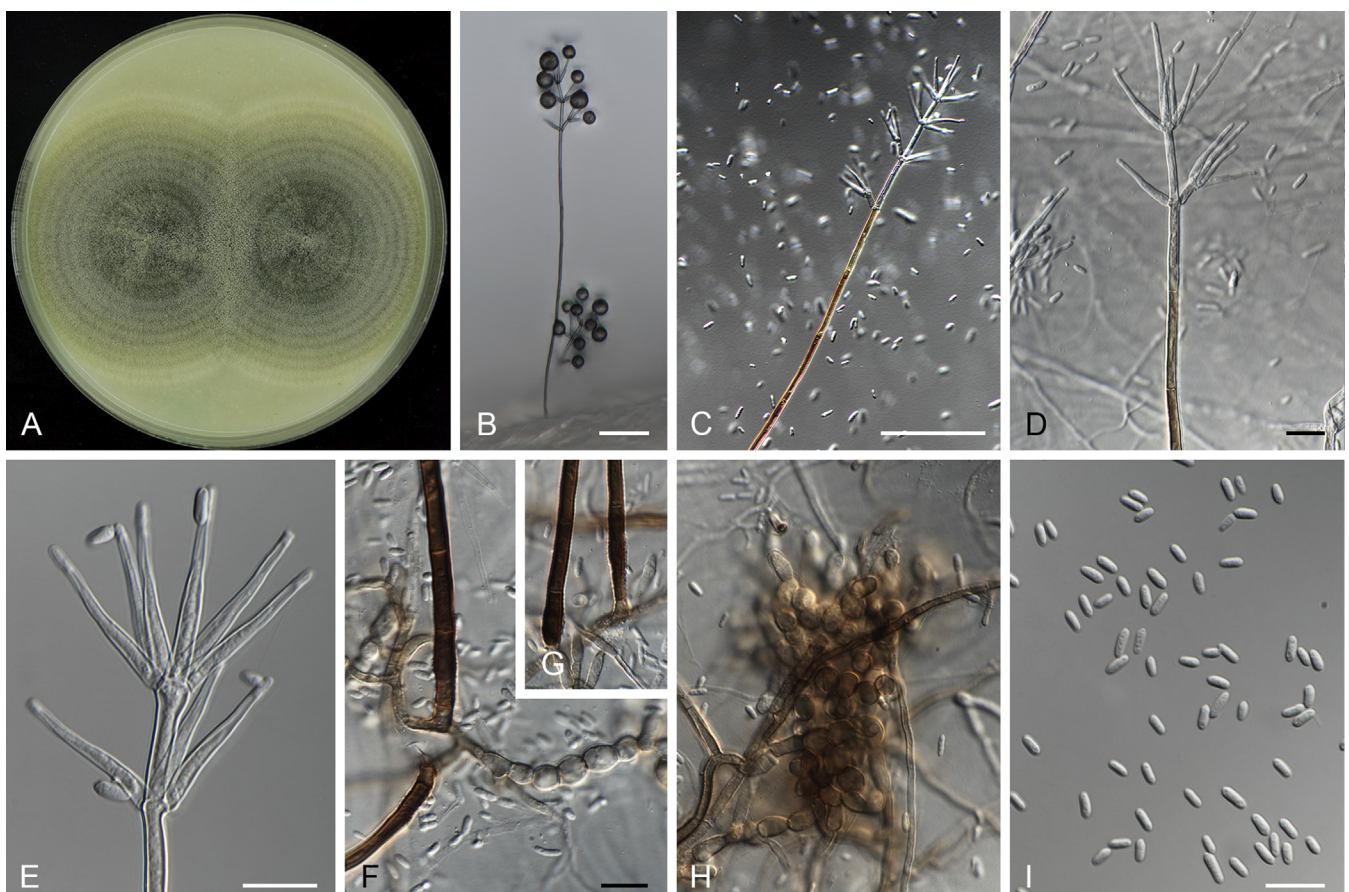


Fig. 22. *Musicillium elettariae* (ex-type CBS 252.80). **A.** Colony on OA after 14 d at 25 °C. **B–D.** Conidiophores. **E.** Conidiogenous cells. **F, G.** Base of the conidiophore and torulose hyphae developing. **H.** Torulose hyphae aggregating into microsclerotium-like structures. **I.** Conidia. Scale bars: B, C = 50 µm; D–I = 10 µm.

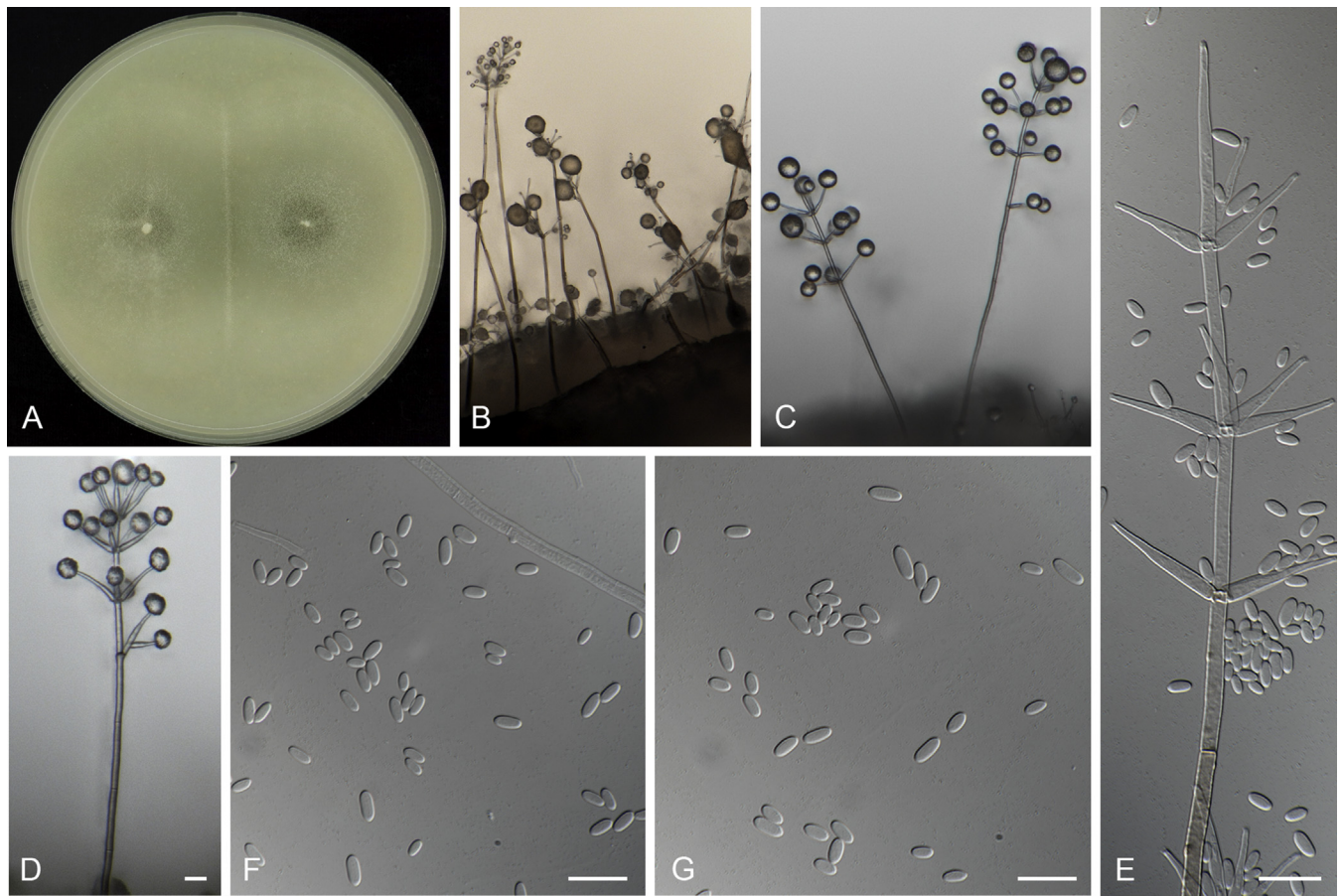


Fig. 23. *Musicillium theobromae* (ex-neotype CBS 968.72). A. Colony on OA after 14 d at 25 °C. B–D. Conidiophores. E. Conidiogenous cells. F, G. Conidia. Scale bars = 10 µm.

Basionym: *Stachylidium theobromae* Turconi, Atti Ist. bot. R. Univ. Pavia 17: 7. 1920.

Synonym: *Verticillium theobromae* (Turconi) E.W. Mason & S. Hughes, Mycol. Pap. 45: 10. 1951.

Mycelium consisting of branched, septate, smooth, pale brown with age, thin-walled hyphae, 2–3.5 µm wide. **Moniliform hyphae** formed after 2 wk, subhyaline, turning brown, 8–10 µm diam, and sometimes aggregating into microsclerotium-like structures. **Conidiophores** arising from submerged hyphae, erect, with 5–6 septa in the lower part, simple or verticillate towards the apex, bearing up to 4 whorls of 3–6 phialides, up to 220 µm long, 2–2.5 µm wide at the base, brown almost up to the first whorl, often smooth-walled, with cell walls usually thicker than those of the vegetative hyphae. **Phialides** usually in divergent whorls of 3–6 (rarely solitary), terminal, lateral, subulate, (sub)hyaline, thick- and smooth-walled, 15.8–35.4 µm long, 2.2–3.4 µm wide at the base, with minute collarette and inconspicuous periclinal wall thickening at the conidiogenous locus. **Conidia** cylindrical with rounded ends or ellipsoidal, 1-celled, hyaline, thin- and smooth-walled, 3.4–5.3 × 1.7–2.6 µm, arranged in slimy heads.

Culture characteristics: After 14 d at ca. 25 °C: On OA reaching 45–65 mm diam, flat, scarce aerial mycelium at centre, glabrous at periphery, surface with greenish olivaceous and iron grey shades, reverse iron grey. On MEA reaching 48–50 mm diam, flat, cottony, entire margin, white, reverse uncoloured, but becoming fuscous black with age (after 20 d).

Specimens examined: **Brazil**, Minas Gerais, from *Musa sapientum*, 10 Oct. 2006, O.L. Pereira, CBS 121211; unknown origin and date, L. Pfennig, CBS 122.97.

Egypt, Cairo, from *Musa* sp., unknown date, I. Jamal El-Din (neotype of *Stachylidium theobromae* CBS H-19317, culture ex-neotype CBS 968.72, designated in Zare *et al.* 2007). **Finland**, Rovaniemi, unknown origin, date and collector, CBS 360.76. **Iran**, Chabahar, from *Musa sapientum*, 2005, R. Zare, CBS 120527; *idem.*, CBS 120528; Mazandaran, from *Musa nana*, 2004, R. Zare, CBS 120528. **Jamaica**, from *Musa* sp., 1948, E.B. Martyn, CBS 397.58 = IMI 031432A. **Morocco**, Kenitra, from *Musa* sp., 1 Dec. 2015, J. Carlier, CPC 29810. **Netherlands**, Baarn, from decaying stalk of *Musa* sp., (in greenhouse), Nov. 1967, W. Gams, CBS 243.74. **Unknown** location, origin, date and collector, CBS 385.32 = ATCC 12474 = DSM 2202 = MUCL 9779.

Notes: *Musicillium* was introduced to accommodate *Verticillium theobromae*, an old synonym of *Stachylidium theobromae* (Zare *et al.* 2007). Although this species was originally described by Turconi (1920) from leaves of *Theobroma cacao*, most of the recent collections have been recovered from *Musa*, including isolates identified as *M. nana* and *M. sapientum*. *Musicillium theobromae* was neotipified by Zare *et al.* (2007) with the strain CBS 968.72, isolated from *Musa* sp. in Egypt.

Musicillium tropicale Giraldo López & Crous, **sp. nov.** MycoBank MB828066. Fig. 24.

Etymology: Refers to the tropical distribution of this fungus.

Mycelium consisting of branched, septate, smooth, pale brown with age, thin-walled hyphae, 2–3.5 µm wide. **Conidiophores** arising from submerged hyphae, erect, with 2–12 septa in the lower part, simple or verticillate towards the apex, bearing up to 7 whorls of 3–6 phialides, up to 732 µm long, 2–3 µm wide at the base, brown almost up to the first whorl, often smooth-walled, with cell walls usually thicker than those of the vegetative hyphae. **Phialides** solitary and in divergent whorls of 3–6, terminal, lateral,

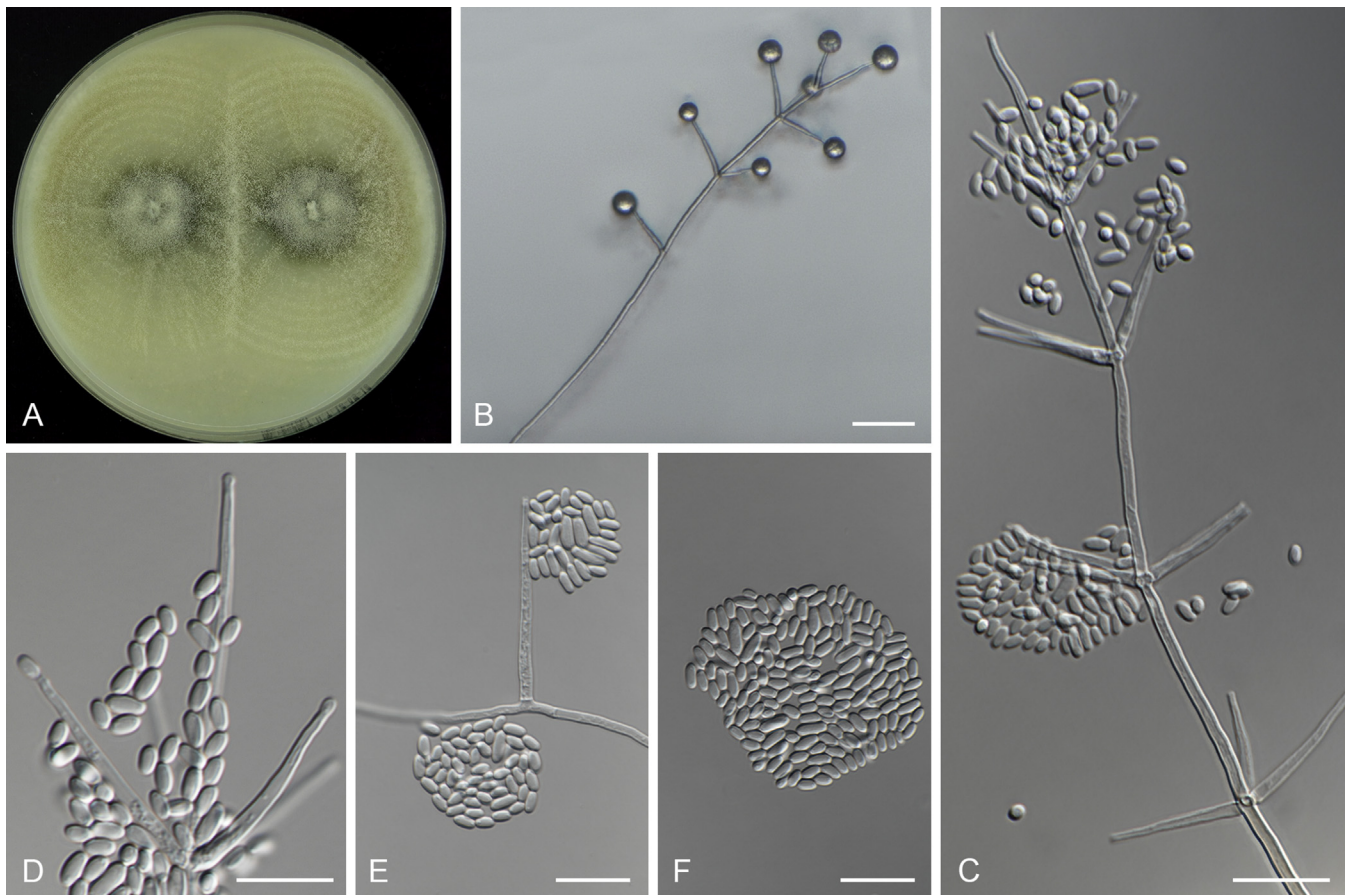


Fig. 24. *Muscillium tropicale* (ex-type CBS 120009). **A.** Colony on OA after 14 d at 25 °C. **B, C.** Conidiophores. **D.** Conidiogenous cells. **E.** Solitary phialide. **F.** Conidia. Scale bars: B = 20 µm; C–F = 10 µm.

subulate or acicular, hyaline, thick- and smooth-walled, 13.3–26.6 µm long, 1.3–2.8 µm wide at the base, with minute collarette and inconspicuous periclinal wall thickening at the conidiogenous locus. *Conidia* ellipsoidal, 1-celled, hyaline, thick- and smooth-walled, 2.5–5.3 × 1.4–2 µm, arranged in slimy heads.

Culture characteristics: After 14 d at ca. 25 °C: On OA reaching 66–78 mm diam, flat, dusty to granulose, dirty white, reverse iron grey. On MEA reaching 70–75 mm diam, flat, sometimes radially folded, cottony, diffuse margin, white, reverse uncoloured at the beginning, becoming mouse grey to dark mouse grey with age.

Specimens examined: **Bangladesh**, Bangoan, from leaf of *Musa* sp., unknown date, I. Buddenhagen (**holotype** CBS H-23653, culture ex-type CBS 120009). **Brazil**, Minas Gerais, from rotten banana, 3 Nov. 2006, O.L. Pereira, CBS 121212. **Cuba**, Estado de Agua, Parque Nacional Henry Pittie, from leaf litter, unknown date and collector, CBS 100951. **Czech Republic**, Bohemia, from *Lactarius* sp., *idem.*, CBS 395.58. **Japan**, unknown origin, date and collector, CBS 458.51. **Zambia**, from *Musa* sp., unknown date and collector, CBS 398.58.

Notes: *Muscillium tropicale* is closely related with *M. elettariae* (86 % BS). However, the former species has smaller conidia (2.5–5.3 × 1.4–2 µm vs. 3.1–10.7 × 1.8–2.8 µm) and lacks production of moniliform hyphae or microsclerotium-like structures in culture.

This species seems to have a mostly tropical distribution, having been isolated from *Musa* trees in tropical countries (Bangladesh, Brazil, Cuba, and Zambia). In contrast, however, the strains CBS 395.58 and CBS 458.51, were recovered from *Lactarius* sp. mushrooms in the Czech Republic and Japan.

Paramusicillium Giraldo López & Crous, **gen. nov.** MycoBank MB828067.

Etymology: Referring to morphological similarity to the genus *Muscillium*, along with the close phylogenetic relationship.

Mycelium consisting of branched, septate, hyaline to dark brown, thick-walled hyphae. *Conidiophores* arising from submerged hyphae, erect, septate, repeatedly verticillate towards the apex, distinctly brown pigmented throughout (slightly paler near the tip), roughened. *Conidiogenous cells* enteroblastic, moniphialidic, solitary or in whorls, terminal, lateral, cylindrical or subulate, hyaline to (sub)hyaline, with minute collarettes and a distinct periclinal thickening at the conidiogenous locus. *Conidia* ellipsoidal or cylindrical, 1-celled, pale brown in mass, smooth-walled, produced in slimy heads. *Chlamydospores* absent, but moniliform hyphae, initially subhyaline, later turning brown, commonly formed at the base of the conidiophore after 2 wk and more. *Sexual morph* unknown.

Type species: *Paramusicillium asperulatum* Giraldo López & Crous.

Paramusicillium asperulatum Giraldo López & Crous, **sp. nov.** MycoBank MB828068. [Fig. 25.](#)

Etymology: Referring to the rough wall of the conidiophores.

Mycelium consisting of branched, septate, (sub)hyaline to dark brown, thick- and rough to verrucose-walled hyphae, 2–3 µm wide. *Moniliform hyphae* formed after 2 wk, subhyaline, turning brown, 7–9 µm diam, usually aggregating into microsclerotium-like structures and formed at the base of the conidiophore. *Conidiophores* arising from submerged hyphae, erect, with 10–30 septa in the lower part, simple or repeatedly verticillate towards

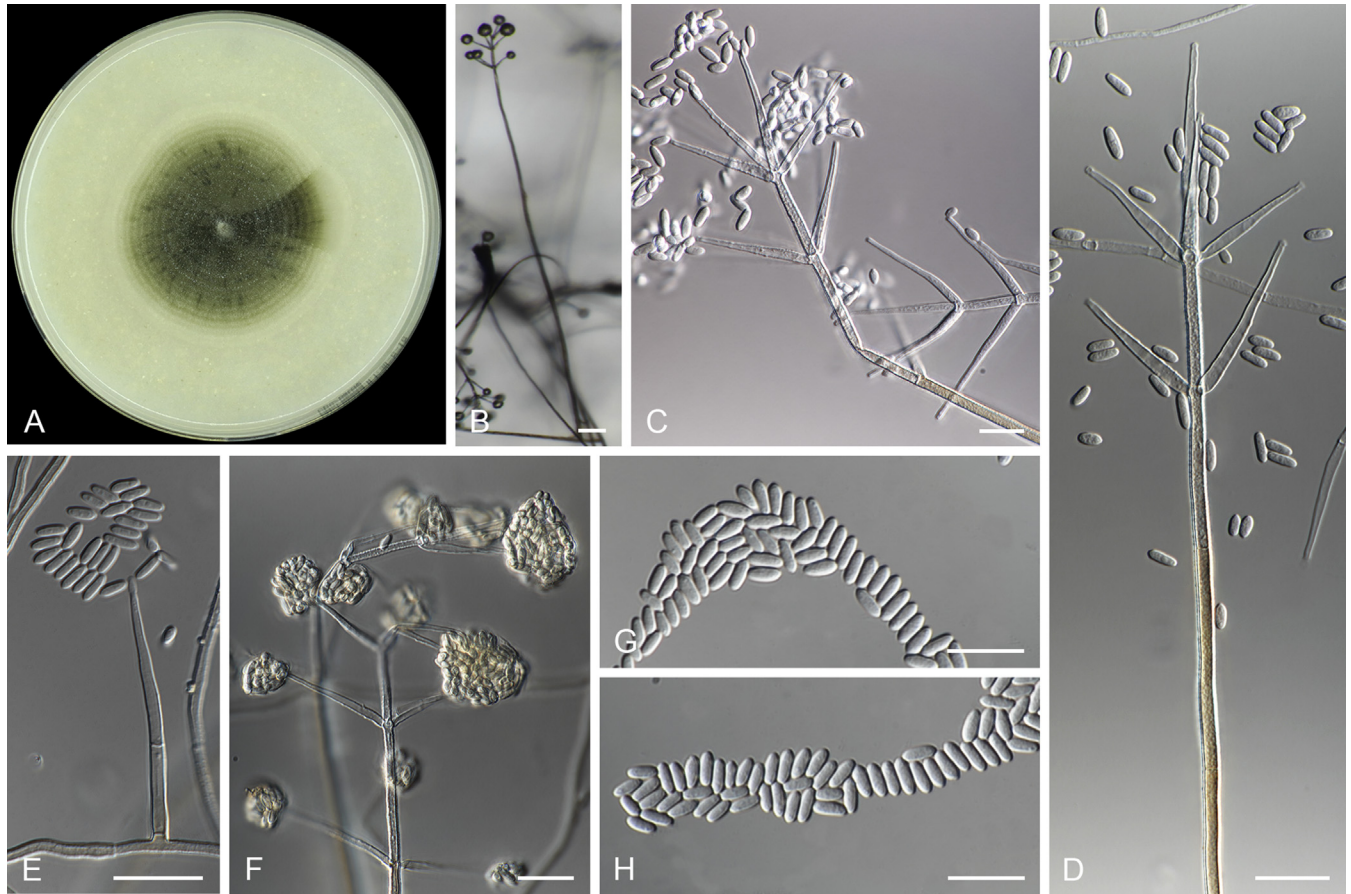


Fig. 25. *Paramusicillium asperulatum* (ex-type CBS 120158). A. Colony on OA after 14 d at 25 °C. B–D. Conidiophores. E. Solitary phialide. F. Slimy heads. G, H. Conidia. Scale bars: B = 20 µm; C–H = 10 µm.

the apex, bearing up to 4 whorls of 2–6 phialides, up to 1245 µm long, 2.7–3.7 µm wide at the base, brown almost up to the first whorl, rough-walled in the axis including the terminal phialide, with cell walls usually thicker than those of the vegetative hyphae. *Phialides* solitary and in divergent whorls of 2–6, terminal, lateral, cylindrical or subulate, hyaline to (sub)hyaline, thick- and smooth-walled, 17.4–43 µm long, 2–2.9 µm wide at the base, with minute collarette and inconspicuous periclinal wall thickening at the conidiogenous locus. *Conidia* ellipsoidal to cylindrical, sometimes with slightly truncate base, 1-celled, pale brown in mass, thick- and smooth-walled, 4.3–5.6 × 1.5–2.1 µm, produced in slimy heads.

Culture characteristics: After 14 d at ca. 25 °C: On OA reaching 40–41 mm diam, flat, slightly dusty at the centre, granulose at periphery, with concentric rings at periphery, entire margin, surface olivaceous grey, reverse dark mouse grey. On MEA reaching 65–68 mm, flat, slightly folded, felty to woolly, entire margin, with a cottony smoke grey mass at the centre, pale mouse grey at periphery, reverse dark mouse grey.

Specimen examined: Democratic Republic of São Tomé and Príncipe, Sao Tomé, Carretera as Pontes, Neves, from soil, unknown date and collector (holotype CBS H-23654, culture ex-type CBS 120158).

Notes: *Paramusicillium asperulatum* was previously identified as *Musicillium theobromae*. However, the distinctive morphological features, especially the length and rough walls of the conidiophores, plus the remarkable phylogenetic distance from the type species of *Musicillium*, led us to propose a new genus.

Clade VII

Chlamydosporiella Giraldo López & Crous, **gen. nov.** MycoBank MB828069.

Etymology: Referring to the production of chlamydo-spores.

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae. **Conidiophores** bent, unbranched or basitonously branched. **Conidiogenous cells** enteroblastic, monophialidic terminal, lateral, cylindrical, hyaline, with short collarette and inconspicuous periclinal thickening at the conidiogenous locus. **Conidia** obovoid, widely ellipsoidal, 1-celled, hyaline, smooth-walled, arranged in slimy heads. **Chlamydo-spores**, terminal or intercalary, mostly chains, dark olive green, thick-walled. **Sexual morph** unknown.

Types species: *Chlamydosporiella restricta* (J.F.H. Beyma) Giraldo López & Crous.

Chlamydosporiella restricta (J.F.H. Beyma) Giraldo López & Crous, **comb. nov.** MycoBank MB828070. Fig. 26.

Basionym: *Verticillium dahliae* f. *restrictum* J.F.H. Beyma, *Antonie van Leeuwenhoek* 7: 45. 1939.

Synonyms: *Acremonium restrictum* (J.F.H. Beyma) W. Gams, *Cephalosporium*-artige Schimmelpilze: 138. 1971.

Verticillium dahliae f. *cerebriforme* J.F.H. Beyma, *Antonie van Leeuwenhoek* 6: 43. 1939

Mycelium consisting of branched, septate, hyaline and thin-walled hyphae, 1.5–2 µm wide. **Conidiophores** bent, arising directly from vegetative hyphae, unbranched or basitonously

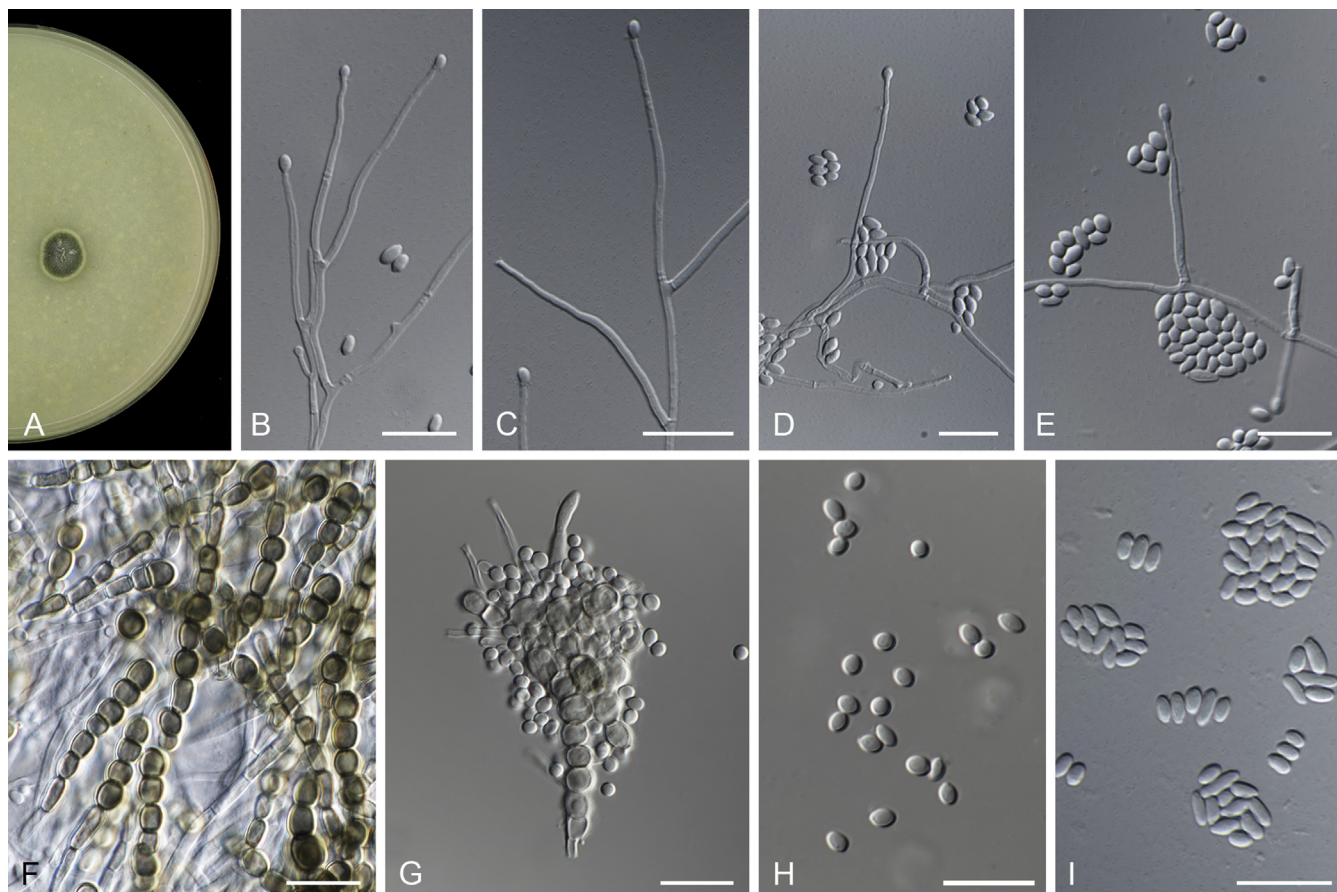


Fig. 26. *Chlamydosporiella restricta*. A, F–H. CBS 443.66. B–E, I. CBS 178.40 (culture ex-type). **A.** Colony on OA after 14 d at 25 °C. **B–E.** Conidiophores. **F, G.** Chlamydospores in chains and forming clumps. **H, I.** Conidia. Scale bars = 10 µm.

branched, up to 45 µm long, 2.5 µm wide at the base, hyaline, slightly rough in the lower part. *Phialides* terminal, lateral, cylindrical, slightly wavy at the apex, hyaline, thick- and smooth-walled, 22.7–45 µm long, 1.5–2 µm wide at the base, with short collarette and inconspicuous periclinal thickening at the conidiogenous locus. *Conidia* obovoid, widely ellipsoidal with apiculate base, 1-celled, hyaline, thick- and smooth-walled, 2.2–4.7 × 1.5–2.3 µm, arranged in slimy heads. *Chlamydospores*, terminal or intercalary, mostly in single or branched chains, sometimes clustered in coils resembling microsclerotia, subglobose, dark olive green, smooth- and thick-walled, 3–5.6 × 2.3–5.6 µm, scarce in OA and moderate to abundant in MEA. *Sexual morph* unknown.

Culture characteristics: After 14 d at ca. 25 °C: On OA reaching 8–13 mm diam, flat, felty or granulose, irregular margin, ranging from white, olivaceous grey to olivaceous black, reverse olive grey to black. On MEA reaching 4.5–10 mm diam, raised, felty to downy, lobulated margin, surface white to olivaceous grey, reverse uncoloured to greenish grey.

Specimens examined: **Brazil**, unknown origin, date and collector, CBS 119.97. **France**, from human skin, unknown date and collector, CBS 716.88. **Germany**, Kiel-Kitzeberg, from moist wall, *idem.*, CBS 443.66. **Netherlands**, Rotterdam, Unilever, from packing material, unknown date, J.F.H. van Beyma (**holotype** of *Verticillium dahliae* f. *restrictum* CBS H-6665, culture ex-type CBS 178.40 = MUCL 9801); *idem.*, (**holotype** of *Verticillium dahliae* f. *cerebriforme* CBS 177.40 culture permanently preserved in a metabolically inactive state) culture ex-type CBS 177.40 = MUCL 9791. **Sweden**, unknown origin, date and collector, CBS 434.83. **UK**, England, Newcastle on Tyne, from mineral wool packing (mainly asbestos), unknown date, H.M. Oixon, CBS 988.69 = IMI 59790.

Notes: This species was originally described by van Beyma (1940) as *Verticillium dahliae* f. *restrictum* based on the ex-

type culture CBS 178.40. It was subsequently considered by Gams (1971) as heterotypic synonym of *Verticillium dahliae* f. *cerebriforme* (with ex-type strain CBS 177.40) and transferred to *Acremonium*. According to Gams (1971) both forms can be differentiated from *V. dahliae* by the scarce branching of the conidiophores and the more pronounced production of dark olive-green chlamydospores.

We have included the original material studied by Gams (1971), i.e., CBS 177.40, CBS 178.40, CBS 443.66 and CBS 988.69 and some additional specimens. Despite the genetic similarity, some morphological variation was observed. The conidial morphology of the ex-type strain CBS 178.40 was variable, being obovoid to ellipsoidal, and the production of chlamydospores and branching of conidiophores was scarce on OA and profuse on MEA. While CBS 443.66 showed subglobose conidia and abundant chlamydospores, the colony colour was darker with a growth rate slower than that of the type.

Nigrocephalum Giraldo López & Crous, **gen. nov.** MycoBank MB828071.

Etymology: From the Latin *niger*, meaning black, and ancient Greek κεφαλή (*kephalḗ*), meaning head. Referring to the black heads of conidia produced in culture.

Mycelium consisting of branched, septate, pigmented, ornamented and thick-walled hyphae. **Conidiophores** erect, slightly bent, simple or basitonously branched. **Conidiogenous cells** enteroblastic, monophialidic terminal, lateral, sub-cylindrical to subulate, pigmented, with conspicuous funnel-shaped collarette and periclinal thickening at the conidiogenous locus. **Conidia**

ellipsoidal, concave in lateral view, 1-celled, pigmented, smooth-walled, arranged in slimy heads. *Sexual morph* unknown.

Types species: *Nigrocephalum collariferum* (Weisenb. & R. Kirschner) Giraldo & Crous.

Nigrocephalum collariferum (Weisenb. & R. Kirschner) Giraldo López & Crous, **comb. nov.** MycoBank MB828072. Fig. 27.

Basionym: *Acremonium collariferum* Weisenb. & R. Kirschner, Nova Hedwigia 90: 460. 2010.

Mycelium consisting of branched, septate, pale olive to brown, finely to roughly warted and thick-walled hyphae, 2–3 µm wide. *Conidiophores* erect, slightly bent, arising directly from vegetative and aerial hyphae, simple or basitonously branched, up to 52 µm long, 3 µm wide at the base, pale olive brown to dark brown, smooth-walled, with cell walls usually thicker than those of the vegetative hyphae. *Phialides* mostly lateral, sub-cylindrical to subulate, slightly wavy at the apex, hyaline, becoming pale olive-brown to dark-brown with age, thick- and smooth-walled, often borne on short cylindrical subtending cells, 17–51.5 µm long, 1.5–2.5 µm wide at the base, with conspicuous funnel-shaped collarette and periclinal thickening at the conidiogenous locus, commonly with a percurrent proliferation. *Conidia* widely ellipsoidal, concave in lateral view, 1-celled, pale olive-brown to dark-brown, black in masses, thick- and smooth-walled, 2.9–5 × 2.1–2.7 µm, arranged in slimy heads. *Sexual morph* unknown.

Culture characteristics: After 14 d at ca. 20 °C: On OA reaching 19–20 mm diam, flat, membranous at centre, dusty at periphery, with dark exudate droplets, diffuse margin, surface and reverse

olive black. On MEA reaching 6–7 mm diam, flat, velvety, cerebriform, diffuse margin, surface and reverse olive black.

Specimens examined: Panama, Chiriquí, Los Algarrobos, from a human toenail with onychomycosis, 1 Dec. 2007, J.L.F. Weisenborn [holotype JW016P.1 (FR, dried culture), culture ex-type CBS 124586 = JW016P.1]; *idem.*, CBS 124585 = JW013P.4.

Notes: The monotypic genus *Nigrocephalum* is proposed here to accommodate two isolates formerly described as *Acremonium collariferum*. This species was isolated from human skin and nail lesions and showed *in vitro* abilities to grow at 33 °C and to degrade keratin. The original protologue describes and illustrates conidia initially formed in chains aggregating into slimy heads (Weisenborn *et al.* 2010). Intercalary and terminal chlamydospores were also seen. According to our observations, however, the conidia were exclusively produced in heads and no chlamydospores were seen at all after 20 d of incubation in OA, MEA and SNA.

Clade VIII

Stachyldium Link: Fr., Mag. Ges. Naturf. Freunde. Berlin 3: 15. 1809: Fries, Syst. Mycol. 3: 391. 1832.

Mycelium consisting of branched, septate, brown, thick-walled hyphae. *Conidiophores* arising from submerged hyphae, erect, septate, verticillate, pale brown to brown at the base, sometimes paler to hyaline towards the apex, roughened, singly or in groups, sometimes forming lax synnemata. *Conidiogenous cells* enteroblastic, monopialidic, in whorls, terminal, lateral, cylindrical, ellipsoidal, hyaline or pale brown. *Conidia* ellipsoidal or

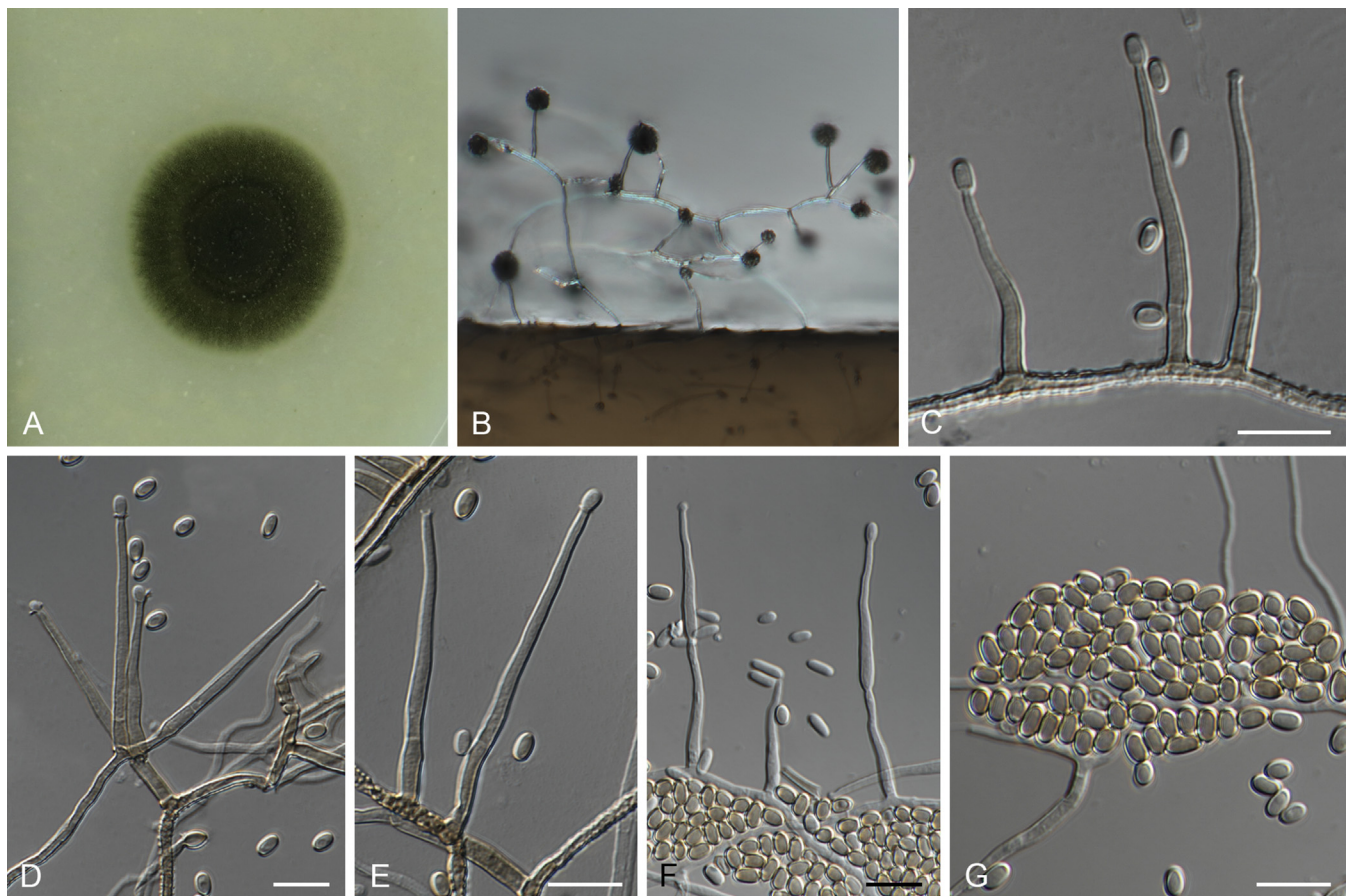


Fig. 27. *Nigrocephalum collariferum* (ex-type CBS 124586). A. Colony on OA after 14 d at 25 °C. B, C. Conidiophores. D, E. Phialides with conspicuous collarettes. F, E. Phialides with percurrent proliferations. G. Conidia. Scale bars = 10 µm.

cylindrical, 1-celled, pale brown to brown, smooth-walled, produced in slimy heads. *Sexual morph* unknown.

Type species: Stachylidium bicolor Link. [= *S. verticillatum* (Hoffm.) S. Hughes].

Stachylidium bicolor Link : Fr., Mag. Ges. Naturf. Freunde. Berlin 3: 15. 1809; Fries, Syst. Mycol. 3: 391. 1832. Fig. 28.

Synonyms: Botrytis bicolor (Link : Fr.) Pers., Mycol. eur. 1: 37. 1822.

Acremonium bicolor (Link : Fr.) Bonord., Handb. allg. Mykol: p. 92. 1851.

For additional synonyms see Index Fungorum and MycoBank.

On natural substratum. Mycelium consisting of branched, septate, initially hyaline but brown with age, thick- and smooth-walled hyphae, 2–6 µm wide. *Conidiophores* arising from submerged hyphae, erect, roughened, sometimes distinctly swollen at the base, with 4–14 septa in the lower part, verticillate, bearing up to 7 whorls of 3–4 phialides, often with additional verticillate axes emerging from the main stipe, ca. up to 700 µm long, 3.3–4.9 µm wide at the base, olive to brown at the base, hyaline

to pale olive above the middle, rough-walled in the axis including the terminal phialide. with cell walls usually thicker than those of the vegetative hyphae, singly but usually in groups. *Phialides* in divergent whorls of 3–4, cylindrical to ellipsoidal, rounded at the apex, pale brown, thick- and rough-walled, 9.4–14.8 µm long, 3.5–5.3 µm wide at the base, with minute collarette. *Conidia* cylindrical with rounded ends, 1-celled, pale brown, smooth- and thick walled, 4.6–6.5 × 1.7–3.1 µm, arranged in slimy heads. *On artificial media: Mycelium* consisting of branched, septate, hyaline to light brown, thick- and smooth-walled hyphae 1–3 µm wide. *Conidiophores* arising from submerged hyphae, erect, roughened, sometimes distinctly swollen at the base, with 7–16 septa in the lower part, verticillate, bearing up to 9 whorls of 3–5 phialides, often with additional verticillate axes emerging from the main stipe, up to 557 µm long, 2.5–4 µm wide at the base, olive to brown at the base, hyaline to pale olive above the middle, completely brown with age, rough-walled in the axis including the terminal phialide, with cell walls usually thicker than those of the vegetative hyphae, usually in groups. *Phialides* arising in divergent whorls of 3–4, cylindrical to ellipsoidal, tapering strongly

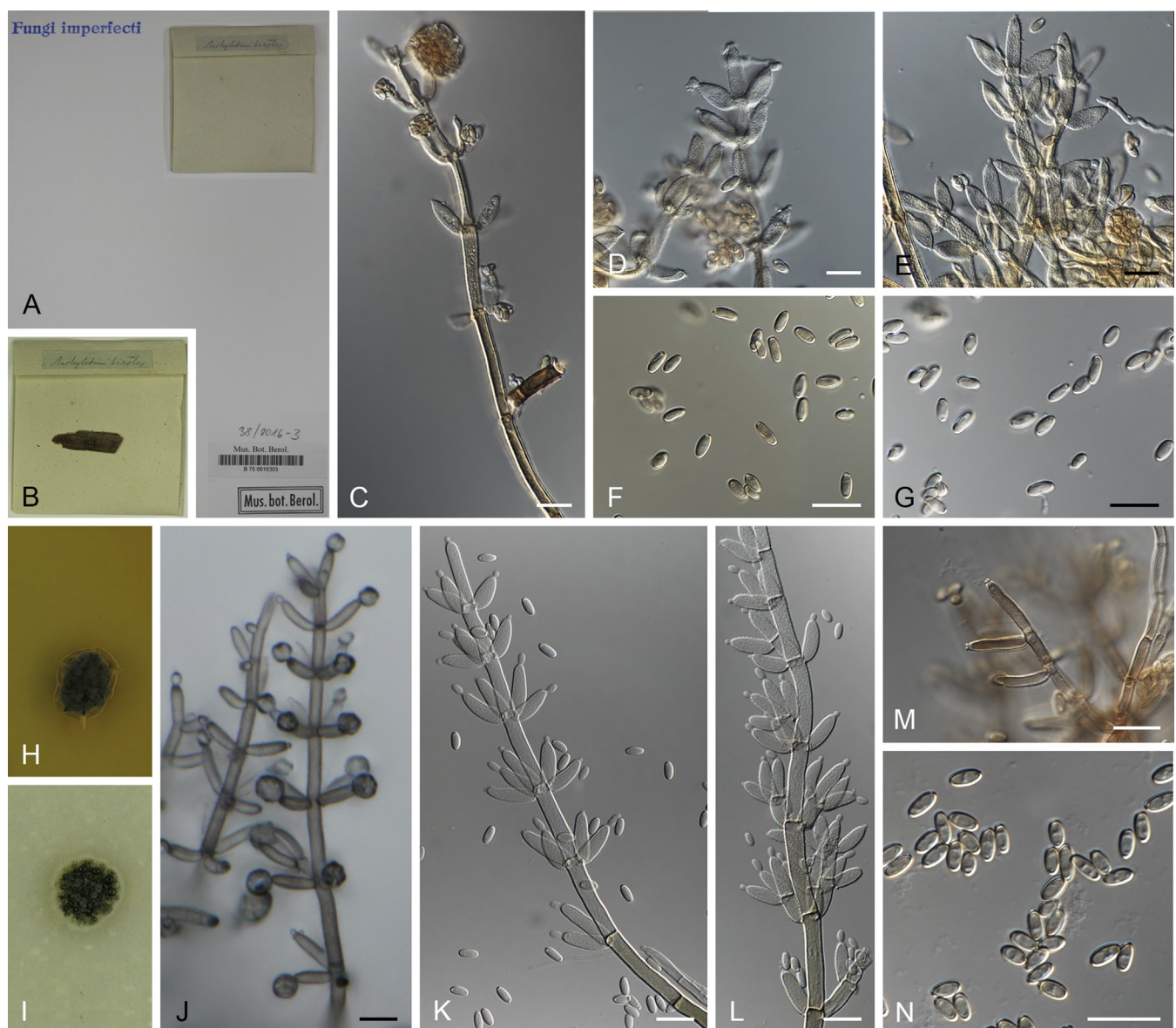


Fig. 28. *Stachylidium bicolor*. A–G. B700016303 (lectotype). H–N. CBS 121802 (ex-epitype culture). **A.** Envelope of the herbarium material B700016303. **B.** Detail of the lectotype. **C.** Conidiophore. **D, E.** Conidiogenous cells. **F, G.** Conidia. **H, I.** Colonies on MEA and OA after 14 d at 25 °C, respectively. **J–L.** Conidiophores. **M.** Details of the collarette from the conidiogenous cells. **N.** Conidia. Scale bars = 10 µm.

near the tip, light brown, thick- and rough-walled, 8.9–16.6 µm long, 2.3–4.8 µm wide at the base, with minute collarette. *Conidia* cylindrical with rounded ends, 1-celled, light brown, smooth- and thick walled, 3.7–5.1 × 1.9–2.5 µm, arranged in slimy heads.

Culture characteristics: After 14 d at ca. 25 °C: On OA reaching 4–5 mm diam, flat, granulose, surface iron-grey with black exudate, reverse uncoloured. On MEA reaching 8–10 mm diam, raised, cerebriform, incrustated in the agar, velvety, surface iron-grey, reverse uncoloured. On MEA+KOH reaching 20–22 mm diam, velvety, dark grey to black, with reddish diffusible pigment and strong smell of geosmin.

Specimens examined: **Unknown** origin and substratum, unknown date, Link, (lectotype designated here herbarium B B700016303, MBT383651), *idem.*, B700016301, B700016302, B700016304; Unknown origin, substratum, date, and collector, herbarium L 910.264-771 (Barcode L 0113657). **Spain**, Asturias, Picos de Europa National park, from plant debris, Oct. 2006, A. Mercado & C. Silvera (**epitype** designated here CBS H-23656, MBT383652, ex-epitype culture CBS 121802 = FMR 9486).

Notes: When the genus was proposed by Link (1809), based on *S. bicolor* and *S. terrestre*, no type species was designated. Hughes (1951) lectotypified the genus with *S. bicolor*, and commented about the synonymy with the older species *Dematiium verticillatum* (Hoffmann 1795), mentioning “Modern ruling, however, would be against the taking up of Hoffmann’s earlier epithet for *S. bicolor*”. Despite that, Hughes (1958) proposed the combination *Stachylidium verticillatum* [which has been followed by other authors, e.g. Whitton *et al.* (2012)] even though the species *S. bicolor* had been previously sanctioned by Fries (1832).

Holubová-Jechová (1988) described *S. bicolor* var. *caespitosum* from a dead petiole of *Calyptrogyne* in Cuba, which differs from *S. bicolor* in having narrower and longer conidia and conidiophores arising mostly in tufts. However, Index Fungorum and MycoBank list this variety as synonym of *S. bicolor*. In addition to the type, around 15 species and varieties assigned to *Stachylidium* are listed in these databases, including the more recently described taxa, i.e., *S. cubense* from dead branch of *Trichostigma octandrum* in Cuba (Mena-Portales & Mercado-Sierra 1984), and *S. pallidum* from *Dendrocalamus giganteus* in Indonesia (Dewi 2006).

Gams (2017) designated the lectotype of *S. bicolor* as L 2923. However, this accession number does not correspond with the format used by the L herbarium (Roxali Bijmoer, Senior Collections Manager, Personal communication, 7 Mar. 2018). To propose a lectotype for this species, we examined authentic

material of Link deposited in B (B700016301, B700016302, B700016303, and B700016304) and one specimen from herb. Persoon deposited in L (910.264-771). Although Hughes (1951) considered the L specimen to be “typical” and authentic for the name, he did not designate it as the lectotype. Of the Link specimens in B, we considered B700016303 to be the most suitable lectotype, noting that the label for B700016304 was labelled as “typus” by S. Hughes in March 1955, but without any subsequent formal publication that would validate this status.

Species of this genus have a worldwide distribution (Whitton *et al.* 2012), and are usually found on herbaceous and woody substrata and are more rarely reported from soil, with *S. bicolor* being the most common species (Hughes 1951, Barron 1968).

Stachylidium pallidum Dewi, Reinwardtia 12: 215. 2006. Fig. 29.

Description and illustration: Dewi (2006).

Culture characteristics: After 14 d at ca. 25 °C: On OA reaching 8–10 mm diam, flat, membranous, surface dirty white, reverse uncoloured. On MEA reaching 9–10 mm diam, raised, cerebriform, incrustated in the agar, membranous with scarce aerial mycelium, surface dirty white, reverse uncoloured.

Type details: **Indonesia**, Java, West Java, Bogor Botanical Garden, on dead leaf of *Dendrocalamus giganteus*, 15 Feb. 2006, Dewi 168 (**holotype** BO22541).

Specimens examined: **India**, from *Oryza sativa*, unknown date, G.P. White, DAOMC 226658. **Nepal**, near Goropani, from soil under *Abies* sp. and *Rhododendron* sp., unknown date, G. Franz, CBS 292.72. **Thailand**, Nakhon Nayok province, Mueang Nakhon Nayok district, Wang Trakhrui waterfall, from soil, 22 Jul. 2015, A. Giraldo, BCC 79031. **Turkey**, from soil, unknown date, G. Turhan, CBS 449.88.

Notes: *Stachylidium pallidum* was described by Dewi (2006) from a dead leaf of *Dendrocalamus giganteus* in Indonesia. Among the living cultures examined here, the strains BCC 79031, CBS 292.72 and CBS 449.88 are genetically and morphologically different from the ex-epitype strain CBS 121802. They produced whitish and slow growing colonies on OA and MEA, strongly branched conidiophores with pale apices, cylindrical phialides with pointed apices and ellipsoidal to subovoidal conidia (Fig. 29). These isolates fit the description of *S. pallidum* rather than *S. bicolor*, except that they produce phialides that have echinulate rather than smooth walls. However, no authentic cultures are presently known for *S. pallidum*, and the holotype BO22541 was not available for comparison.

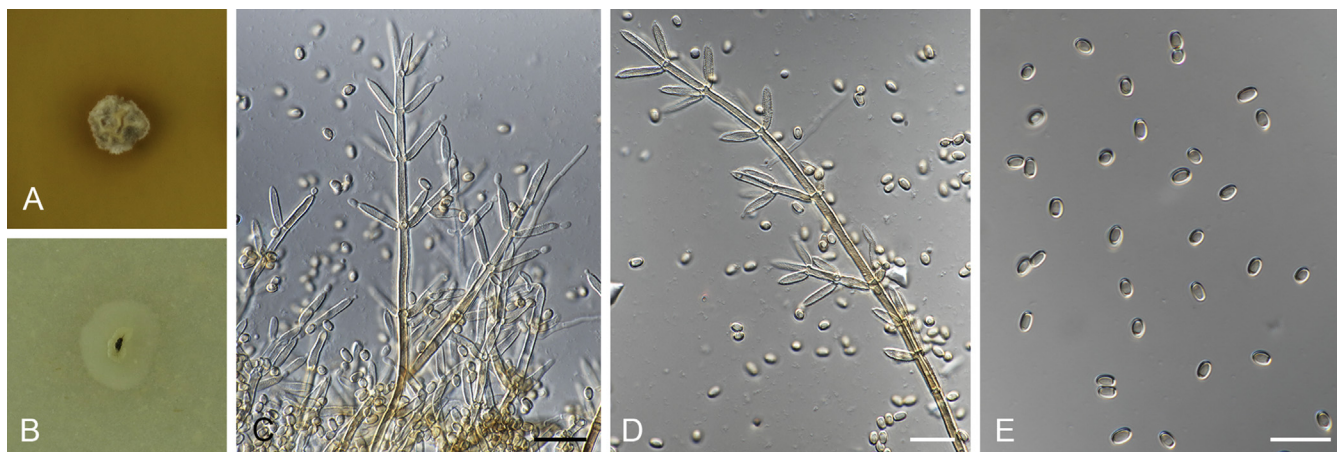


Fig. 29. *Stachylidium* aff. *pallidum* (CBS 449.88). A, B. Colonies on MEA and OA after 14 d at 25 °C, respectively. C, D. Conidiophores. E. Conidia. Scale bars = 10.

Clade IX

Brunneomyces Giraldo *et al.*, Mycol. Progr. 16: 357. 2017.

Mycelium consisting of branched, septate, dark brown hyphae, verrucose and thick-walled with age. *Conidiophores* erect, unbranched or poorly branched, often proliferating sympodially. *Conidiogenous cells enteroblastic*, mono- and polyphialidic, hyaline, terminal, lateral or intercalary, subulate, lageniform or cylindrical, subhyaline or pale brown, with short cylindrical collarette and periclinal thickening at the conidiogenous locus. *Conidia* ovoidal to ellipsoidal, 1-celled, hyaline or brown, smooth-walled, arranged in chains. *Sexual morph unknown* (adapted from Giraldo *et al.* 2017).

Type species: Brunneomyces brunnescens (W. Gams) Giraldo, Gené & Guarro

Brunneomyces brunnescens (W. Gams) Giraldo *et al.*, Mycol. Progr. 16: 357. 2017.

Basionym: Acremonium brunnescens W. Gams, Trans. Br. Mycol. Soc. 64: 398. 1975.

Description and illustration: Gams 1975, Giraldo et al. (2017).

Specimen examined: Sri Lanka, on dead stem of *Dendrocalamus giganteus*, Jan. 1973, W. Gams (*holotype* CBS H-6641, *isotype* IMI 185378, *culture ex-type* CBS 559.73).

Notes: Brunneomyces was recently proposed by Giraldo *et al.* (2017) to accommodate *Acremonium brunnescens* as the type species, along with two new species: *B. hominis* and *B. europaeus*. Species in this genus are unique in the family in producing conidial chains in culture. According to our

phylogenetic inference, they are placed in a distinct, well-supported clade (Clade IX, BS = 100 %).

Clade X

Lectera P.F. Cannon, MycoKeys 3: 28. 2012.

Conidiomata sporodochial or acervular, erumpent through host tissues and without a clear upper wall, globose to subglobose, pink or flesh coloured, with few marginal, erect setae. *Setae* dark brown, septate, tapering towards the apex. *Conidiophores* reduced to the conidiogenous cell. *Conidiogenous cells* monopialidic, hyaline, proliferating percurrently at the apex. *Conidia* navicular or fusiform with pointed ends, slightly curved, 1-celled, hyaline, smooth-walled. *Appressoria* formed after conidial germination, dark brown, round to ovate with smooth margins. *Sexual morph unknown* (Adapted from Cannon *et al.* 2012)

Type species: Lectera colletotrichoides (Chilton) P.F. Cannon.

Lectera colletotrichoides (Chilton) P.F. Cannon, MycoKeys 3: 28. 2012. Fig. 30 (A–E).

Basionym: Volutella colletotrichoides Chilton, Mycologia 46: 801. 1954.

Synonym: Volutella colletotrichoides var. *setosa* Chilton, Mycologia 46: 801. 1954

Description and illustrations: Chilton (1954) and Cannon et al. (2012).

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 14–15 mm diam, flat, slightly granulose, encrusted on the agar, surface and reverse orange.

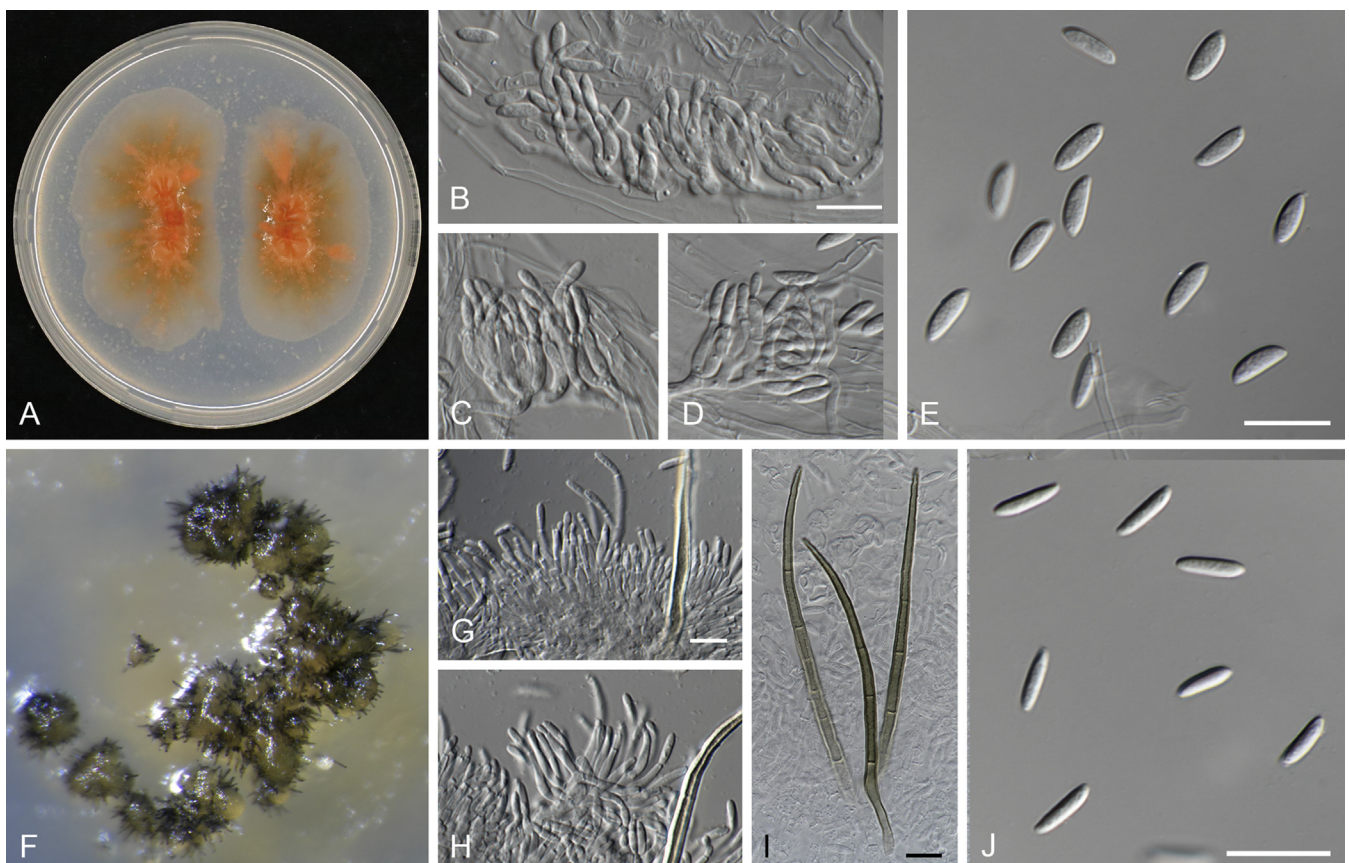


Fig. 30. *Lectera* species. A–E. *Lectera colletotrichoides* (IMI 332702). F–J. *Lectera longa* (ex-type IMI 181698). A. Colony on PDA after 14 d at 25 °C. B–D. Conidiogenous cells. E. Conidia. F. Sporulating conidiomata on PDA. G, H. Conidiogenous cells. I. Setae. J. Conidia. Scale bars = 10 µm. B (applies to C, D); G (applies to H).

Type details: USA: Iowa, Ames, on stems of *Medicago sativa*, Oct. 1954, J. Chilton [ISC 217496, **lectotype** K(M) 176269, isolectotype of *Volutella colletotrichoides*; ISC 217482, **lectotype** K(M) 176270, isolectotype of *Volutella colletotrichoides* var. *setosa*].

Specimens examined: Egypt, on *Cicer arietinum*, unknown date, M.M. Askar, IMI 333702. Morocco, *Capsicum annuum*, Feb. 1986, S.B. Mathur, IMI 303685.

Notes: The genus was proposed to accommodate the plant pathogen *Lectera colletotrichoides* as the type species, along with *L. longa*. *Lectera colletotrichoides* has been associated with diseases mainly of *Fabaceae*, but also of *Asteraceae*, *Lamiaceae*, *Poaceae*, *Solanaceae* and *Violaceae* (Cannon *et al.* 2012). In addition, it is also commonly isolated from soil and plant litter. Recently, *Lectera capsici*, recovered from leaf spots on *Capsicum annuum* in Malaysia, was described by Crous *et al.* (2017).

The type species was lectotypified by Cannon *et al.* (2012) with a specimen from *Medicago sativa*, but the publication lacked an illustration clarifying the morphological features of the organism. In order to permit morphological comparison of this species, we examined and illustrated IMI 303685 and IMI 333702 (Fig. 30 A–E). Based on our observations on PDA, conidiomata and setae were absent. The conidiogenous cells were cylindrical or slightly tapering, hyaline, smooth-walled, growing directly on the vegetative hyphae or on short stipes bearing 2–3 phialides, 6.4–12 µm long, proliferating percurrently with conspicuous periclinal thickening and sometimes a minute collarette. The conidia were navicular, with acute ends, inequilateral, with inner plane flat and outer plane convex, 1-celled, hyaline, smooth-walled, 5.1–7.5 × 2.1–2.7 µm.

Lectera humicola Giraldo López & Crous, **sp. nov.** MycoBank MB828073. Fig. 31.

Etymology: Refers to the substratum from which this fungus was isolated, soil.

Conidiomata sporodochial subglobose, slimy, bright orange, solitary or gregarious, formed abundantly on the surface of PDA. **Setae** dark brown, scarcely produced, 2–3-septate, flexuous, tapering to acutely rounded apices, thick- and smooth-walled, 56–57 µm long, 3.5 µm wide at the base. **Phialides** subcylindrical to subulate, hyaline, smooth-walled, proliferating percurrently at the apex, 5.1–16.3 µm long, 2.2–2.9 µm wide at the base, with conspicuous periclinal thickening at the conidiogenous locus. **Conidia** ellipsoidal-fusiform to navicular, acute at the ends, inequilateral, with inner plane flat, and outer plane convex, slightly curved, 1-celled, hyaline, olive brown in mass, thick- and smooth-walled, 5.6–8 × 2–2.7 µm.

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 20–22 mm diam, flat, dry, encrusted on the agar, fimbriate on the margin, surface and reverse orange. On OA reaching 53–54 mm diam, in 14d, flat, granulose, entire margin, surface and reverse dark mouse grey.

Specimen examined: Brazil, from soil, 18 Feb. 1982, J. Diehl & E. Reis 46/81 (**holotype** CBS H-23651, culture ex-type IMI 265740).

Notes: *Lectera humicola* was previously treated as *L. colletotrichoides* (Cannon *et al.* 2012), but it is genetically different from the strains isolated from *Cicer arietinum* (IMI 333702) and *Capsicum annuum* (IMI 303685) (Fig. 1). In

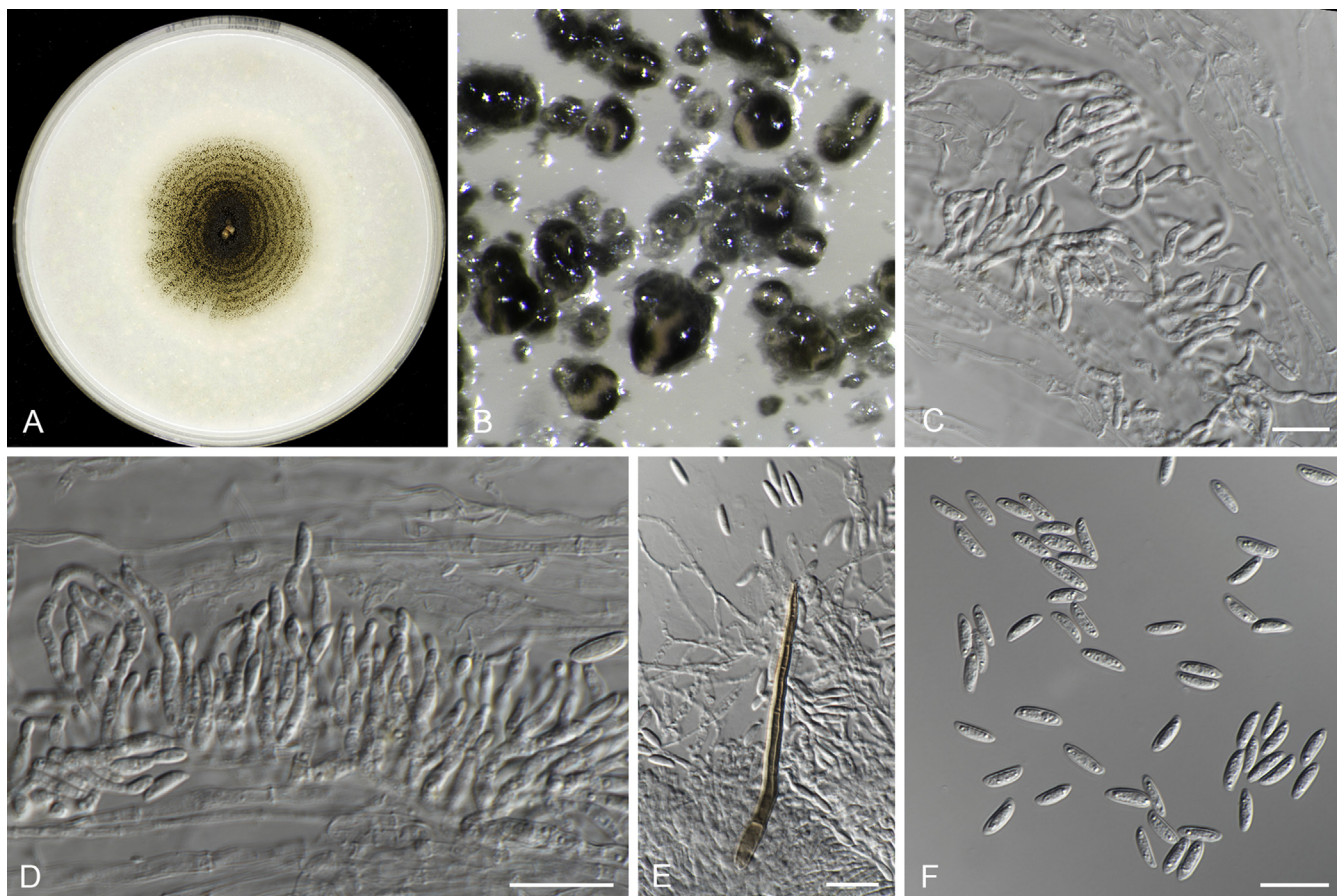


Fig. 31. *Lectera humicola* (ex-type IMI 265740). A. Colony on OA after 14 d at 25 °C. B. Sporulating conidiomata on PDA. C, D. Conidiogenous cells. E. Seta F. Conidia. Scale bars = 10 µm.

addition, it differs morphologically by having relatively long conidiogenous cells without stipe and brown conidia in mass.

Lectera longa P.F. Cannon, MycoKeys 3: 30. 2012. Fig. 30 (F–J).

Description: Cannon *et al.* (2012).

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 8–9 mm diam, flat, smooth, encrusted on the agar, fimbriate margin, surface and reverse peach.

Specimen examined: **Australia**, Western Australia, Nedlands, from *Triticum* sp., 25 Jan 1974, K. Sivasithamparam 530 [holotype of *Lectera longa* IMI 181698 (dried specimen), culture ex-type IMI 181698].

Notes: No conidiomata, setae or conidiogenous cells were shown in the original description (Cannon *et al.* 2012), and therefore we provided a complete illustration of this species in culture (Fig. 30 F–J). After 14 d on PDA the sporodochia were subglobose, cerebriform, bright orange, solitary or gregarious, surrounded by abundant setae. Setae dark brown, 3–6-septate, flexuous, tapering to acutely rounded at the apices, thick- and smooth-walled 77–111 µm long, 3.9–6 µm wide at the base. Conidiogenous cells cylindrical, hyaline, smooth-walled, up to 15 µm long, with conspicuous periclinal thickening at the conidiogenous locus. Conidia cylindrical with acute ends or navicular, 1-celled, hyaline, smooth-walled, 6.7–8.7 × 1.8–2.8 µm.

Lectera longa is closely related to *L. phaseoli* but differs in its longer conidia and setae.

Lectera phaseoli Giraldo López & Crous, sp. nov. MycoBank MB828074. Fig. 32.

Etymology: Refers to *Phaseolus*, the host genus from which this fungus was isolated.

Conidiomata sporodochial, subglobose, bright orange, solitary or gregarious, formed abundantly on the surface of PDA, surrounded by abundant setae. Setae dark brown, 2–4-septate, flexuous, tapering to acutely rounded at the apices, thick- and smooth-walled, intermingled among the conidiogenous cells, 36–38 µm long, 3–5 µm wide at the base. Phialides subcylindrical to doliiform, hyaline, smooth-walled, often borne on short cylindrical subtending cells, proliferating percurrently at apex, 5.2–8.5 µm long, 2–3 µm wide at the base, with conspicuous periclinal thickening at the conidiogenous locus. Conidia ellipsoidal-fusiform to navicular, acute at the ends, inequilateral, with inner plane flat, and outer plane convex, slightly curved, 1-celled, hyaline, becoming olivaceous in mass, thick- and smooth-walled, 5–6.5 × 1.8–2.7 µm.

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 20–26 mm diam, flat, moist, slightly granulose, encrusted on the agar, fimbriate margin, surface and reverse orange. On OA reaching 43–44 mm diam, flat, smooth, moist, entire margin, surface and reverse olivaceous black.

Specimen examined: **Ethiopia**, on seed of *Phaseolus vulgaris*, 1995, H. Wolf-fuechel (holotype CBS H-23652, culture ex-type IMI 366179).

Notes: *Lectera phaseoli* was formerly identified as *L. colletotrichoides* (Cannon *et al.* 2012), however differs morphologically in the production of abundant sporodochia and setae *in vitro*, and by producing shorter phialides and conidia.

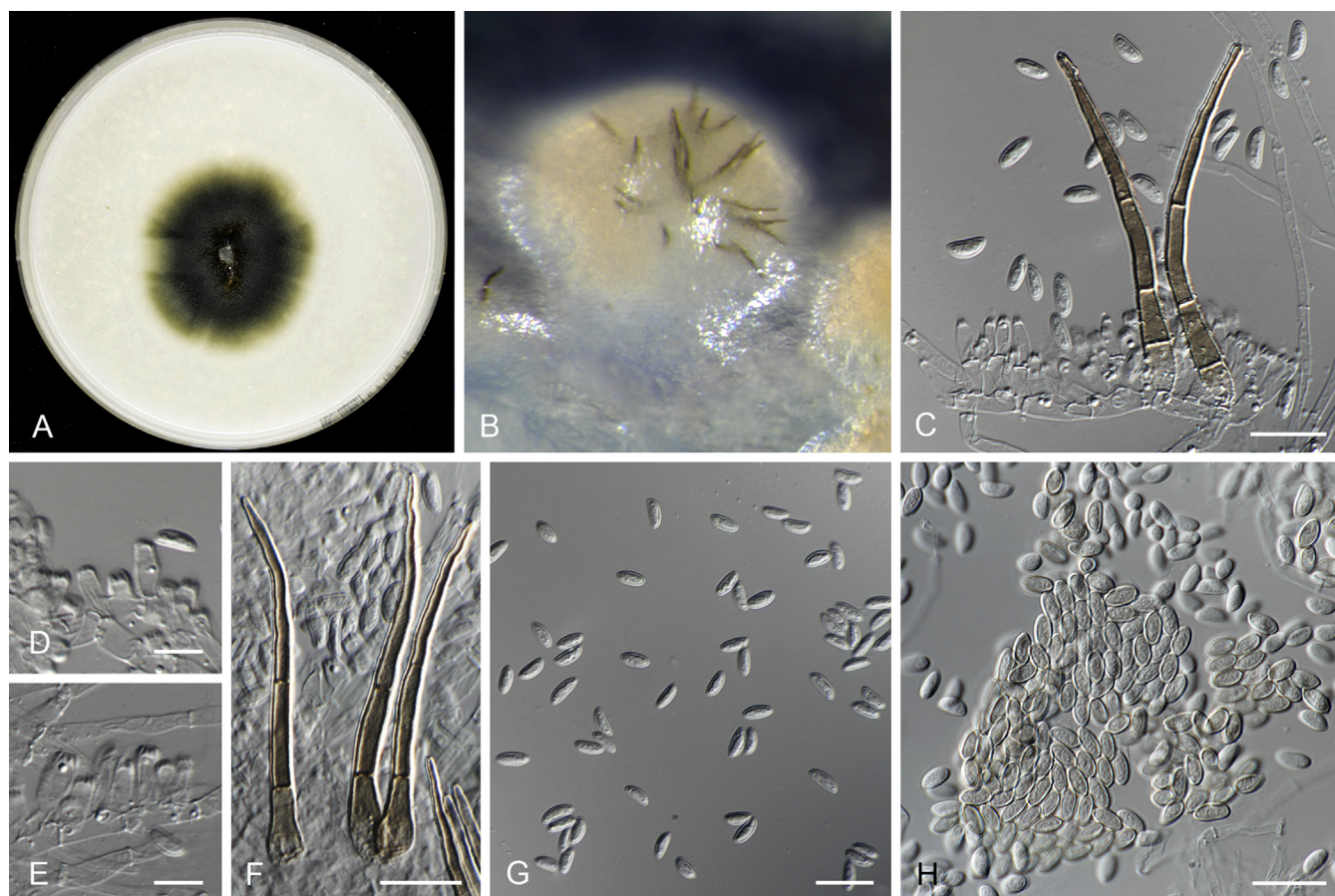


Fig. 32. *Lectera phaseoli* (ex-type IMI 366179). A. Colony on OA after 14 d at 25 °C. B. Sporulating conidiomata on PDA. C–E. Conidiogenous cells. F. Setae. G, H. Conidia. Scale bars = 10 µm.

Clade XI

Verticillium Nees, Syst. Pilze Schwämme 57. 1816.

Mycelium consisting of branched, septate, hyaline, thick-walled hyphae. *Conidiophores* arising from submerged hyphae or aerial mycelium, erect, mostly verticillate, septate, hyaline to subhyaline, sometimes turning brown at the base. *Conidiogenous cells* enteroblastic, monopialidic, inserted in a mesotonous to acrotonous position, terminal, lateral, flask-shaped or aculeate, hyaline, with inconspicuous collarettes. *Conidia* ellipsoidal or cylindrical with rounded ends, 1-celled, rarely 2-celled, hyaline, sometimes turning brown with age, smooth-walled, produced in slimy heads. *Resting structures* including pigmented resting mycelium, chlamydospores in short chains, and/or microsclerotia. *Sexual morph* unknown.

Type species: *Verticillium dahliae* Kleb.

Verticillium alfalfae Inderb. *et al.*, PloS ONE 6: 7. 2011.

Description and illustration Inderbitzin *et al.* (2011a).

Materials examined: **Italy**, from *Catalpa bignonioides*, unknown date and collector, CBS 241.82. **UK**, from *Catalpa bignonioides*, unknown date and collector, CBS 453.51. **USA**, from *Medicago sativa*, unknown date and collector (**holotype** UC 1953895, culture ex-type CBS 130603 = NRRL 54790 = PD489); Pennsylvania, *idem.*, CBS 127169 = ATCC MYA-4576 = FGSC 10136.

Notes: The isolates placed in the *V. alfalfae* clade were previously identified as *V. albo-atrum*, which is commonly confused with *V. alfalfae* or *V. nonalfalfae*. All of them produce resting mycelium in culture. However, *V. albo-atrum* differs by producing microsclerotia, and more rarely 2-celled, brown-pigmented conidia, and microcyclic conidiation. Microsclerotia are only observed on water agar (WA) or prune lactose yeast agar (PLYA) and not in commonly used media such as PDA (Inderbitzin *et al.* 2011a).

At present, *Verticillium alfalfae* is only known as a causal agent of disease in *Medicago sativa* in Canada, China, Japan and the USA (Inderbitzin *et al.* 2011a, Xu *et al.* 2016). According

to our results it can be also found on *Catalpa bignonioides* (*Bignoniaceae*) in Italy and the UK.

Verticillium dahliae Kleb., Mycol. Centbl. 3: 66. 1913. Fig. 33.

Synonyms: *Verticillium albo-atrum* var. *dahliae* (Kleb.) R. Nelson, Tech. Bull. Michigan Agric. Exp. Sta. 221. 1950.

Verticillium albo-atrum f. *dahliae* (Kleb.) Shmotina, Nauch. Dokl. Vyssh. Shkoly, Biol. Nauki 8: 64. 1971.

For additional synonyms see Index Fungorum and MycoBank.

Description and illustration: Inderbitzin *et al.* (2011a).

Materials examined: **Argentina**, from *Helianthus annuus*, unknown date and collector, CBS 110223, CBS 110224, CBS 110225. **Canada**, Quebec, from *Solanum lycopersicon*, *idem.*, CBS 381.66. **Germany**, from *Trifolium pratense*, *idem.*, CBS 110274. **Italy**, from *Xanthium italicum*, *idem.*, CBS 383.49. **Netherlands**, from *Solanum tuberosum*, *idem.*, CBS 384.49; from *Rosa rugosa*, *idem.*, CBS 385.49; from *S. melongena*, *idem.*, CBS 386.49; from *Antirrhinum majus*, *idem.*, CBS 388.49; from *Phlox* sp., *idem.*, CBS 802.97; from *Ribes rubrum*, *idem.*, CBS 806.97; from *Fragaria* sp., *idem.*, CBS 807.97; from *Rosa* sp., *idem.*, CBS 809.97; from *Forsythia* sp., *idem.*, CBS 814.97; Lelystad, from soil, *idem.*, CBS 812.97; Drente, from root of *Solanum tuberosum*, *idem.*, CBS 717.96; Naaldwijk, from *S. lycopersicon*, *idem.*, CBS 425.52; Oost-Flevoland, from root of *Vicia faba*, *idem.*, CBS 718.96; Wageningen, from *S. lycopersicon*, *idem.*, CBS 177.66, CBS 178.66, CBS 179.66, from soil, *idem.*, CBS 800.97, CBS 801.97. **New Zealand**, Motueka, from *Nicotiana tabacum*, *idem.*, CBS 127.79B. **Russia**, from unknown substratum, date and collector, CBS 222.72A, CBS 222.72C. **UK**, from *Humulus lupulus*, unknown date and collector, CBS 380.49. **Unknown** origin, date and collector, from *Rubus idaeus*, CBS 204.26, CBS 205.26; *idem.*, from *Humulus lupulus*, CBS 389.49; *idem.*, from *Fragaria* sp., CBS 390.49; *idem.*, from *Solanum tuberosum*, CBS 391.49; *idem.*, from *Rubus idaeus*, CBS 392.49; *idem.*, from stem of *R. fruticosus*, CBS 810.97; *idem.*, from stem of *Acer* sp., CBS 811.97. **USA**, California, Salinas, from *Capsicum annuum*, unknown date, K.V. Subbarao, CBS 128315; Watsonville, from *Lactuca sativa*, unknown date and collector (**epitype** UC 1953893, designated by Inderbitzin *et al.* 2011a, a dried culture of PD322, culture ex-epitype CBS 130341 = NRRL 54785 = PD322), *idem.*, CBS 127170; Hawaii, from *Caerola frutescens* var. *sericea*, unknown date, WH. Ko, CBS 111590.

Notes: *Verticillium* was introduced by Nees (1816) as a monotypic genus based on *V. tenerum*. Numerous synonyms were later proposed for this species including *Sporotrichum luteoalbum* (Link 1809) and *Acrostalagmus cinnabarinus* (Corda 1838).

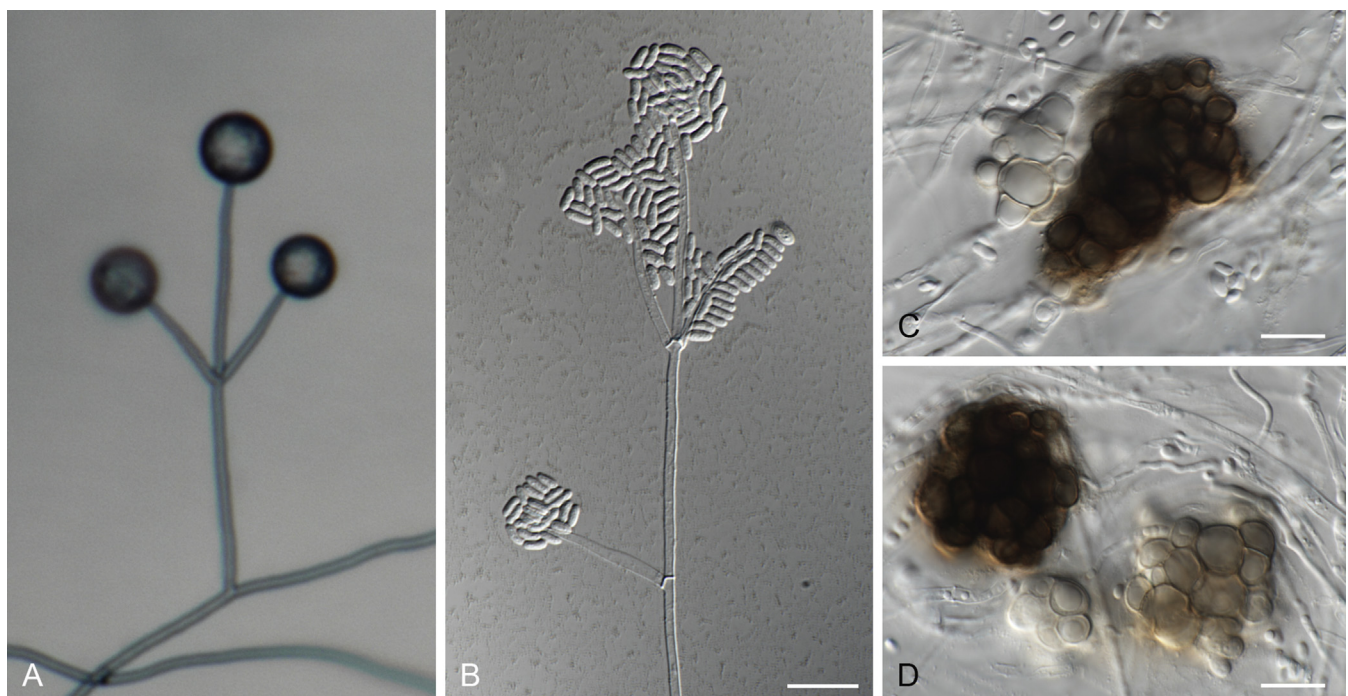


Fig. 33. *Verticillium dahliae* (ex-epitype CBS 130341). A. Conidiophore. B. Phialides and conidia. C, D. Microsclerotia. Scale bars = 10 μ m.

Additional species were subsequently added to the genus, including the important plant pathogens *V. albo-atrum* (Reinke & Berthold 1879) and *V. dahliae* (Klebahn 1913). Molecular studies later demonstrated that the last two species were not congeneric with *V. tenerum*, even though they belonged to the same family (Zare *et al.* 2004). To avoid undesirable name changes for the important plant pathogenic species, Gams *et al.* (2005) proposed to conserve the generic name *Verticillium* with a conserved type *V. dahliae*. *Verticillium tenerum* was subsequently accommodated in *Acrostalagmus* as *A. luteoalbus*.

Numerous species previously assigned to *Verticillium* have been shown to be phylogenetically unrelated, and spread out among different families within the *Hypocreales*, including *Clavicipitaceae*, *Cordycipitaceae* and *Ophiocordycipitaceae*. *Verticillium* s. str. is now restricted to a monophyletic clade in the *Plectosphaerellaceae*, embracing 10 species, viz., *V. albo-atrum*, *V. alfalfae*, *V. dahliae*, *V. isaacii*, *V. klebahnii*, *V. longisporum*, *V. nonalfalfae*, *V. nubilum*, *V. tricornis* and *V. zaregamsianum* (Zare *et al.* 2007, Inderbitzin *et al.* 2011a). This clade includes soil-borne and root-inhabiting fungi, some of them plant pathogens producing vascular wilt in various agricultural crops worldwide (Domsch *et al.* 2007). The non-Plectosphaerellaceous species previously described in *Verticillium* have been reassigned to *Lecanicillium* (currently *Akanthomyces*) and *Simplicillium* (both *Cordycipitaceae*) for insect and fungal pathogens (Gams & Zare 2001, Zare & Gams 2001a, b, 2008); *Haptocillium* (now *Drechmeria*, *Ophiocordycipitaceae*), *Pochonia* and *Rotiferophthora* (*Clavicipitaceae* s. str.) for nematode parasites (Zare & Gams 2001b, Zare *et al.* 2001); and more recently *Ovicillium* (*Bionectriaceae*), *Leptobacillium* (*Cordycipitaceae*), *Chlamydocillium* and *Chlorocillium* (*incertae sedis*) (Zare & Gams 2016) for species with diverse ecologies.

All the specimens examined here were morphologically identified as *V. dahliae*, except CBS 380.49 and CBS 127.79B, which were formerly identified as *V. albo-atrum* and *V. tricornis*, respectively.

Verticillium isaacii Inderb. *et al.*, PLoS ONE 6: 9. 2011.

Description and illustrations: Inderbitzin *et al.* (2011a).

Materials examined: **Israel**, Kerem-Shalom, from *Solanum* sp., 1994–1996, N. Korolev, CBS 100843; Nir-Itzhak, from *Brassica* sp., CBS 101220; Re'im, from soil in potato field, CBS 100839; *idem.*, CBS 100840. **Netherlands**, Groningen, from *Lactuca sativa*, unknown date and collector, CBS 238.75; Wageningen, CBS 237.75; from stem of *Limonium* sp., *idem.*, CBS 804.97, CBS 813.97; from *Chrysanthemum* sp., *idem.*, CBS 805.97. **USA**, California, *idem.*, from *Lactuca sativa* (**holotype** UC 1953896, culture ex-type CBS 130343 = NRRL 54792).

Notes: *Verticillium isaacii* was described by Inderbitzin *et al.* (2011a) from *Lactuca sativa* in the USA. It is phylogenetically related to *V. tricornis*, and *V. klebahnii*. All three species are morphologically indistinguishable, producing resting mycelium, abundant chlamydospores, microsclerotia and yellow pigmented hyphae. However, they differ in pathogenicity. *Verticillium klebahnii* and *V. tricornis* are demonstrated pathogens of lettuce and tomato, respectively. In contrast, *V. isaacii* is known from many hosts, and is non-pathogenic (Isaac 1953, Vallad *et al.* 2006, Qin *et al.* 2008).

Inderbitzin *et al.* (2011a) reported *Verticillium isaacii* on *Cynara scolymus*, *Lactuca sativa*, *Solanum lycopersicum* var. *lycopersicum*, *S. physalifolium*, *Spinacia oleracea* and soil from Canada, UK and the USA. According to our results this species can be also found on *Brassica*, *Chrysanthemum* and *Limonium*. New distribution data includes the Netherlands and Israel.

This clade includes nine isolates formerly identified as *V. albo-atrum*, which are molecularly reidentified here as *V. isaacii*. In Fig. 1 the ex-type strain of *V. klebahnii* CBS 130344 nestled together with the *V. isaacii* isolates, including the ex-type CBS 130343; however, it fell in a separate clade in Fig. 2.

Verticillium longisporum (C. Stark) Karapapa *et al.*, Mycol. Res. 101: 1281. 1997. Fig. 34.

Basionym: *Verticillium dahliae* var. *longisporum* C. Stark, Gartenbauwissenschaft 26: 508. 1961.

Description and illustration: Inderbitzin *et al.* (2011a).

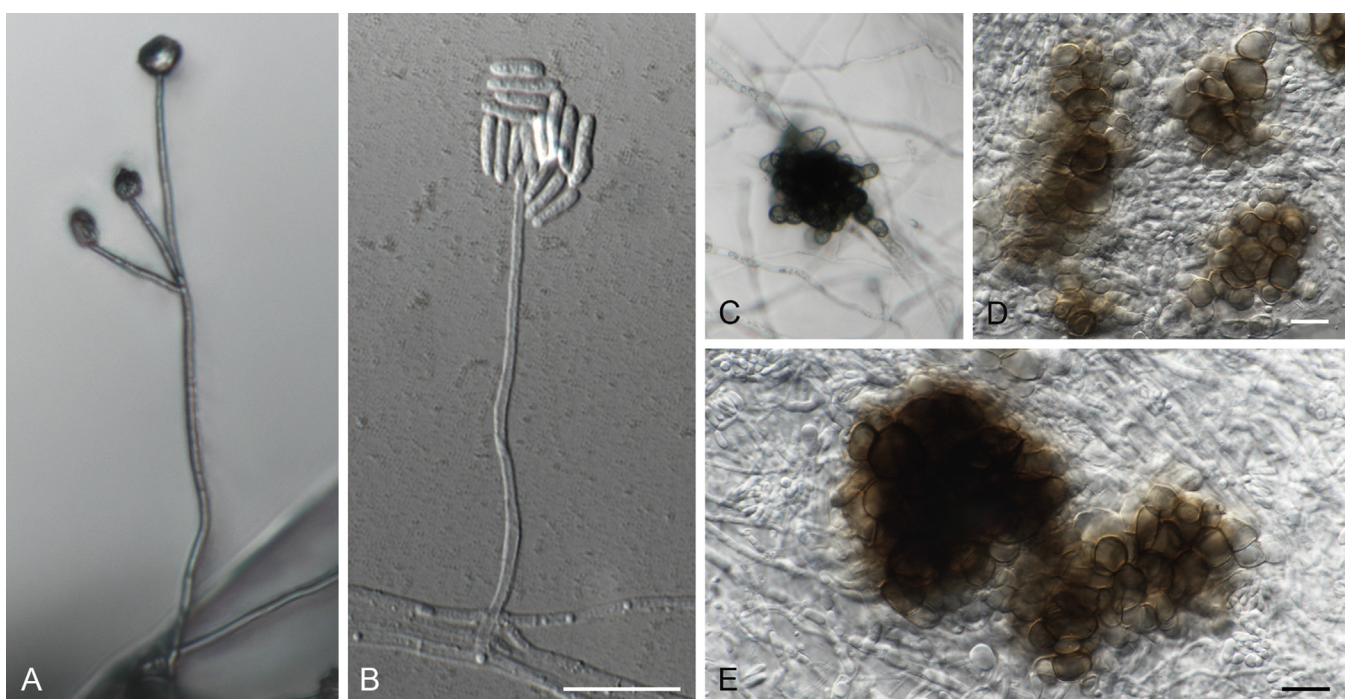


Fig. 34. *Verticillium longisporum* (ex-type CBS 124.64). **A.** Conidiophore. **B.** Phialide and conidia. **C.** Microsclerotia directly on PCA. **D, E.** Microsclerotia. Scale bars = 10 μ m.

Examined materials: **Germany**, Niedersachsen, Altes Land, from root of *Ammoracia rusticana*, unknown date, C. Stark (**holotype** CBS H-19247, culture ex-type CBS 124.64 = PD687 = NRRL 54793); from *Brassica napus*, unknown date and collector, CBS 110232, CBS 110233. **Sweden**, from stem of *Brassica rapa*, unknown date, Dep. Microbial Ecol. Lund., CBS 649.85; from *Brassica napus*, unknown date and collector, CBS 110218, CBS 110219, CBS 110220, CBS 110221, CBS 110226, CBS 110227, CBS 110228, CBS 110229, CBS 110230, CBS 110231, CBS 110272, CBS 110273, CBS 110275, CBS 110276, CBS 110277. **USA**, California, Salinas, from *Brassica oleracea* var. *botrytis*, unknown date, S.T. Koike, CBS 128317 = PD348; Illinois, East Saint Louis, from *Ammoracia rusticana*, unknown date, D.M. Eastburn, CBS 128316 = PD356.

Notes: *Verticillium longisporum* is the causal agent of the Verticillium wilt of oil seed rape. This wilt is an important disease in crucifer crops (*Brassicaceae*) in Europe. *Verticillium longisporum* is known to be a diploid hybrid species, with relatively long conidia (compared with the other species from the genus) and almost double the quantity of nuclear DNA (Inderbitzin *et al.* 2011a, b). This polyphyletic species originated at least three different times, involving four different parental lineages and three parental species, i.e., *V. dahliae*, Species A1 and Species D1. To date, *V. dahliae* is the only named parent of *V. longisporum*, while Species A1 and D1 have never been collected (Inderbitzin *et al.* 2011a, b).

In this study, we have included 20 isolates of *V. longisporum*, which were indistinguishable from the parental species *V. dahliae* based on their LSU and ITS sequences. Although, the *TEF1- α* showed a good resolution to resolve species boundaries, these isolates have different alleles for that locus, making the sequences unsuitable for multilocus sequence analysis. The same isolates possessed a unique allele for *RPB2*, but its low rate of amplification prevented obtaining an amplicon from some of them.

According to Inderbitzin *et al.* (2011a) the ex-type culture of *Verticillium longisporum* CBS 124.64 (PD687) probably lost the ability to form microsclerotia in culture. However, the examination of this strain on PDA and PCA, showed that these structures were produced after 10 d of incubation at room temperature (Fig. 34). They were similar to those produced by CBS 128316 (PD356), another isolate studied by Inderbitzin *et al.* (2011a).

Verticillium nonalfalfae Inderb. *et al.*, PLoS ONE 6: 12. 2011.

Description and illustration: Inderbitzin *et al.* (2011a).

Materials examined: **Belgium**, unknown substratum and date, M. Cavellier, CBS 451.88; Poperinge, from *Humulus lupulus*, unknown date, De Korte, CBS 395.91 = IPO 1435. **Canada**, growing on *Verticillium albo-atrum*, unknown date and collector, CBS 382.66 = ATCC 16534 = IMI 118378. **Japan**, Hokkaido, from *Solanum tuberosum*, *idem.* (**holotype** UC 1953898, culture ex-type CBS 130339 = NRRL 54791 = PD592). **Netherlands**, Loenen, from *Lycopersicon esculentum*, *idem.*, CBS 385.91; Naaldwijk, *idem.*, CBS 321.91; *idem.*, CBS 322.91. **Portugal**, from *Citrus sinensis*, *idem.*, CBS 113707 = UPSC 2001. **Slovenia**, Savinja valley, from *Humulus lupulus*, unknown date, S. Radisek, CBS 121305; *idem.*, CBS 121306. **UK**, from *Humulus lupulus*, unknown date and collector, CBS 381.49; from *Fragaria* sp., *idem.*, CBS 382.49; from *Antirrhinum* sp., *idem.*, CBS 452.51; from *Solanum tuberosum*, *idem.*, CBS 454.51 = IHEM 3916.

Notes: As mentioned before, isolates of *V. nonalfalfae* and *V. alfalfae* are commonly misidentified as *V. albo-atrum*. This clade includes 13 isolates which were deposited in the CBS collection as *V. albo-atrum*, but are molecularly reidentified here as *V. nonalfalfae*. Similarly, several ITS sequences from *V. nonalfalfae* available in GenBank are wrongly labeled as *V. albo-atrum*.

Verticillium nonalfalfae and *V. alfalfae* are morphologically indistinguishable, but are different in DNA sequences and pathogenicity (Inderbitzin *et al.* 2011a). *Verticillium nonalfalfae*

affects different kinds of hosts, including *Solanum tuberosum* and *Humulus lupulus*, while *V. alfalfae* causes disease mainly on *Medicago sativa* (Alfalfa or Lucerne). Within Europe, *V. nonalfalfae* has been reported from Austria, Germany, Slovenia and the UK (Inderbitzin *et al.* 2011a, Jelen *et al.* 2016, Maschek & Halmschlage 2018). We have also found it in Belgium, the Netherlands and Portugal growing on *Antirrhinum* sp., *Citrus sinensis*, *Fragaria* sp. and *Solanum lycopersicum*.

Verticillium nonalfalfae is considered to be a potential biocontrol agent for the invasive tree species *Ailanthus altissima* (tree-of-heaven) in the eastern USA, including Ohio, Pennsylvania and Virginia (Kasson *et al.* 2015). Similar use has been considered in Austria (Maschek & Halmschlage 2018).

Verticillium zaregamsianum Inderb. *et al.*, PLoS ONE 6: 15. 2011.

Description and illustrations: Inderbitzin *et al.* (2011a) and Grum-Grzhimaylo *et al.* (2016).

Materials examined: **Israel**, Kerem-Shalom, from *Solanum* sp., 1994–1996, N. Korolev, CBS 100838, CBS 100841, CBS 100842; Sde-Boker, *idem.*, CBS 100837. **Japan**, Chiba, *idem.*, from *Lactuca sativa* (**holotype** UC 1953899, culture ex-type CBS 130342 = PD73 6 = NRRL 54795).

Notes: *Verticillium zaregamsianum* was recently described by Inderbitzin *et al.* (2011a) to accommodate isolates previously treated as *V. tricorpus*, which were pathogens of lettuce (*Lactuca sativa*) in Japan. According to our results and those of Grum-Grzhimaylo *et al.* (2016) this species can be also found in potato and in alkalophilic soils. *Verticillium zaregamsianum* can be morphologically distinguished from its relatives by the production of both microsclerotia and yellow-pigmented hyphae.

Clade XII

Acrostalagmus Corda, Icones fungorum hucusque cognitorum 2: 15. 1838.

Mycelium consisting of branched, septate, (sub)hyaline, thick-walled hyphae. *Conidiophores* mononematous or synnematos, arising from submerged hyphae, erect, branched, distinctly bright orange to reddish pigmented throughout. *Conidiogenous cells* enteroblastic, monophialidic, in pairs or whorls, terminal, lateral, flask-shaped, subulate or cylindrical, (sub)hyaline to pale orange, with a distinct periclinal thickening at the conidiogenous locus. *Conidia* oval, ellipsoidal to oblong-ellipsoidal, 1-celled, bright orange to reddish, smooth-walled, arranged in slimy heads. *Sexual morph* unknown.

Type species: *Acrostalagmus luteoalbus* (Link) Zare, W. Gams & Schroers.

Acrostalagmus luteoalbus (Link : Fr.) Zare *et al.*, Mycol. Res. 108: 581. 2004. Fig. 35.

Basionym: *Sporotrichum luteo-album* Link: Fr., Mag. Ges. Naturf. Freunde Berlin 3: 13. 1809; Fries, Syst. mycol. 3: 424. 1832.

Synonym: *Verticillium luteoalbum* (Link: Fr.) Subram., Hyphomycetes: 649. 1971.

Additional synonyms in Zare *et al.* (2004).

Mycelium consisting of branched, septate, (sub)hyaline, thick- and smooth-walled hyphae, 2–3 μ m wide. *Conidiophores* arising from submerged hyphae, usually densely crowded, erect, more or less straight, with main axis repeatedly branched, bearing up

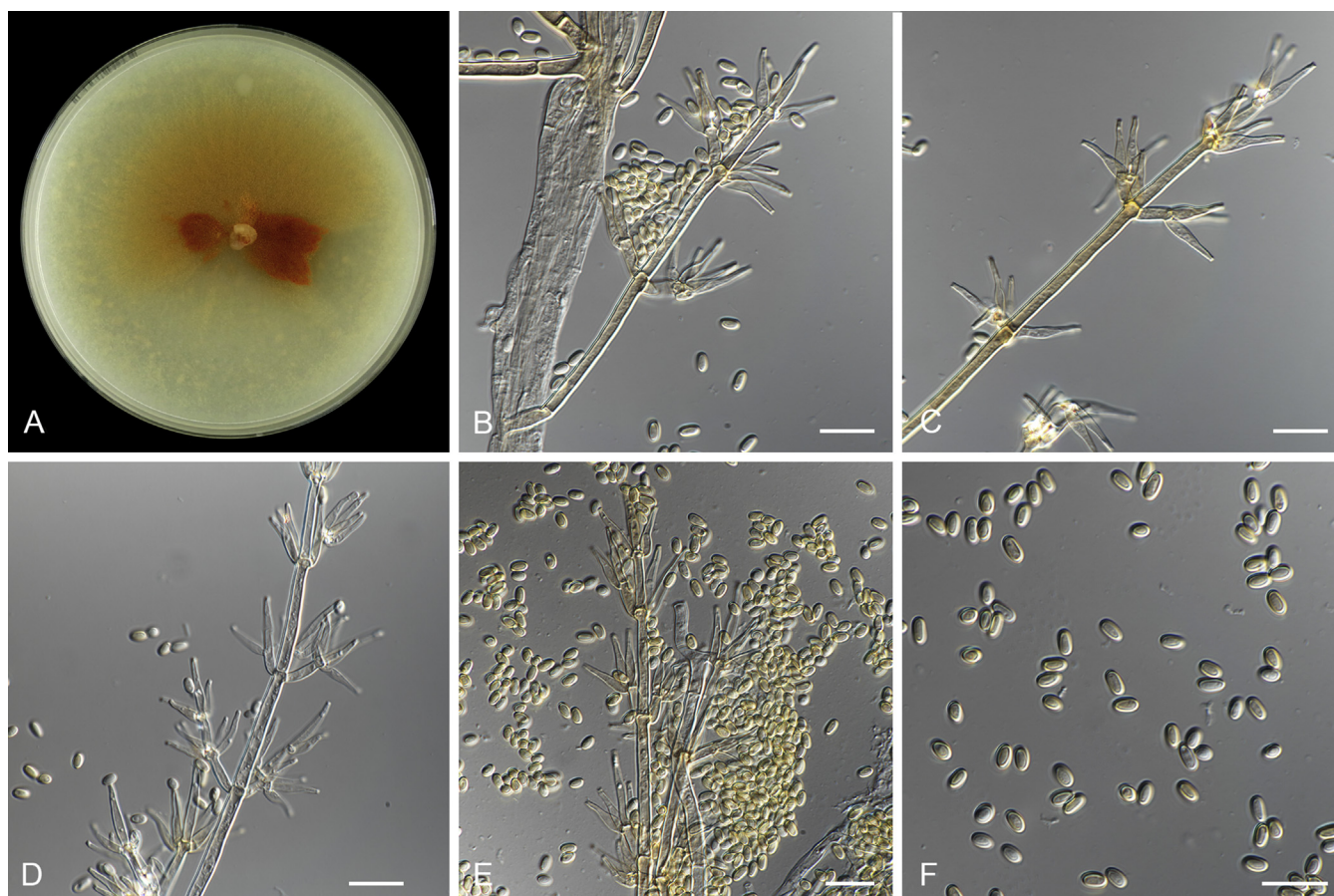


Fig. 35. *Acrostalagmus luteoalbus* (CBS 121214). A. Colony on OA after 14 d at 25 °C. B–D. Conidiophores. E. Conidiogenous cells. F. Conidia. Scale bars = 10 µm.

to 5 nodes of phialides, usually ending in a particularly long phialide, around which three to five shorter phialides are grouped forming a verticil; up to 400 µm long, 4–5 µm wide at the base, distinctly bright orange to reddish throughout, with cell walls usually thicker than those of the vegetative hyphae. *Phialides* arising in whorls of 2–5(–7) along the main stipe and its branches, terminal, lateral, flask-shaped, tapering strongly near the middle into a narrow neck, (sub)hyaline to light orange, thick- and smooth-walled, 10–14 µm long, 2–3.1 µm wide at the base, with an inconspicuous collarete and distinct periclinal thickening at the conidiogenous locus. *Conidia* oval, 1-celled, bright orange to reddish brown, smooth- and thick-walled, 3–4 × 1.8–2.3 µm, arranged in slimy heads (adapted from Domsch *et al.* 2007).

Culture characteristics: After 14 d at ca. 20 °C: On PDA, filling the plate; flat, floccose, dull orange to orange-brown due to the pigmented conidiophores and conidia. On OA, reaching 74–75 mm diam, flat, hairy at centre, granulose at periphery, orange with sienna shades.

Type details: **Unknown** location, substratum, date and collector, herbarium B (**holotype** of *Sporotrichum luteo-album*, slide 2423). According to Zare *et al.* (2004) and Gams (2017).

Specimens examined: **Brazil**, Minas Gerais, Viçosa, from *Musa sapientum*, 17 Nov. 2006, O.L. Pereira, CBS 121213 = IRAN 1110C = OLP 306; 25 Nov. 2006, *idem.*, CBS 121214 = IRAN 1111C = OLP 307; 27 Nov. 2006, *idem.*, CBS 121215 = IRAN 1112C = OLP 308. **Canada**, Ontario, York Co., Toronto, High Park, from decaying leaf, unknown date and collector, CBS 565.80; Quebec, Gatineau Park, from decayed wood, 31 Oct. 1960, G.L. Hennebert, CBS 325.61 = DAOMC 71555 = MUCL 1601. **Germany**, from straw-meal-amended field soil, unknown date and collector, CBS 194.87; Geisenheim, from wall treated with fungicides, *idem.*, CBS 222.60. **Netherlands**, decaying timber of boat, *idem.*, CBS 388.65 = IAM 14705. **Russia**, Astrakhan, growing on *Colletotrichum*

lagenarium, *idem.*, CBS 577.78B = VKM MF-55; Kulunda steppe, Altai, Bezi-myannoe lake, from alkaline soil, Aug. 2002, D.Y. Sorokin, CBS 137628 = V208; Glauberovoe lake, *idem.*, CBS 137629 = V209. **UK**, from bark of *Fagus sylvatica*, unknown date, W.R. Day, CBS 331.52; unknown substrate, 1916, G.H. Pethybridge, CBS 112.16. **Unknown** origin, substrate, date and collector, CBS 236.55.

Notes: In 1809, Link introduced the species *Sporotrichum luteoalbum*, which was later considered by Subramanian (1971) to be a synonym of the type species of *Verticillium*, *V. tenerum*; therefore the combination *Verticillium luteoalbum* was made. For a long time, this species was treated as the asexual morph of *Nectria inventa* (Pethybridge 1919). Zare *et al.* (2004), however, demonstrated that this asexual-sexual connection was erroneous, and the re-examination of conserved material of the latter fungus suggested its probable identity with *Stephanonectria keithii* (*Bionectriaceae*, *Hypocreales*). Separately, Corda (1838) had established the genus *Acrostalagmus* based on *A. cinnabarinus* as the type species, and this species turned out to be morphologically identical with *V. luteoalbum* (Hughes 1958, Subramanian 1971). The combination *A. luteoalbum* was therefore proposed.

Fifty-four records are listed in Index Fungorum and Myco-Bank under the name *Acrostalagmus*, including records for 29 accepted species, six forms and eight varieties. Most of these were recently reviewed by Gams (2017) and were considered as probable synonyms of *A. luteoalbum*, including *A. lateritius*, *A. ochraceus*, *A. parasitans* and *A. persistens*. *Acrostalagmus albus*, *A. albus* f. *minor*, *A. aphidum*, *A. cephalosporioides*, *A. cylindrosporus*, *A. niveus*, *A. nodosus*, *A. penicillioides*, and *A. spicarioides* were treated as *nomina dubia*. *Acrostalagmus caulophagus* and *A. nigripes* were considered probable synonyms of *Verticillium albo-atrum*; *A. albus* var. *varius* and

A. coccidicola were possibly *Gibellulopsis nigrescens* and *Leptobacillium leptobactrum*, respectively. Several other species were synonymized with other genera i.e., *Acrostalagmus fragrans* with *Syzygites megalocarpus*, *A. galeoides* with *Calcarisporium arbuscula*, *A. herbarum* with *Verticillium distans* and *A. olivaceus* with *Stachylidium bicolor*, while *A. murinus* and *A. tetracladus* were included in *Phaeostalagmus* and the *Lecanicillium fungicola* species complex, correspondingly. *Acrostalagmus characeus*, *A. fulvus* and *A. roseus* were not included in Gams (2017) and are labelled in Index Fungorum and MycoBank as members of the *Hypocreaceae*.

According to Gams (2017) the holotype of *Sporotrichum luteoalbum* is deposited in B herbarium as the slide "2423". Although we have not examined this slide, we have examined 14 isolates that match the morphological features described for this species. However, more isolates should be collected in order to propose an epitype for this species.

Acrostalagmus luteoalbus is a cosmopolitan fungus reported from various soil types, including alkaline soils, in Europe, Russia, Turkey, Sri Lanka, Nepal, Japan, Australia, Hawaii, Canada and the USA. Additionally, it can be isolated from a great variety of types of plant debris, as well as dung. It is known as a mycoparasite on *Alternaria brassicae*, *Cronartium comandrae*, *Daldinia concentrica* and *Flammulina velutipes* (Zare et al. 2004, Domsch et al. 2007, Seifert et al. 2011, Zhang & Tang 2015, Grum-Grzhimaylo et al. 2016).

Acrostalagmus annulatus (Berk. & Broome) Seifert, Stud. Mycol. 68: 186. 2011. Fig. 36.

Basionym: *Stilbum annulatum* Berk. & Broome, Grevillea 3: 63. 1874.

Synonym: *Stilbella annulata* (Berk. & Broome) Seifert, Stud. Mycol. 27: 58. 1985.

Additional synonyms in Seifert (1985).

Synnemata scattered, gregarious or caespitose, cylindrical-capitate, clavate or cylindrical, straight or slightly bent, unbranched or branched, often proliferating percurrently, smooth or villose at the base, with stipes white to pale orange brown, and capitula orange-brown, 250–2 000 µm tall, (25–)50–200(–500) µm wide. *Hyphae of stipe* smooth-walled, sometimes with scattered verrucose hyphae, 1.5–2.5(–3) µm wide. *Marginal hyphae* lobed, abundant, concentrated in and near the capitulum, thick- and smooth-walled, with individual lobes up to 2 µm wide. *Conidiophore* branching once or twice monochasial, 1.5–2 µm wide, metulae 11–20 × 1.5–3 µm. *Phialides* solitary or rarely in whorls of 3, terminal, lateral, cylindrical or subulate, straight or sinuous, orange in mass, thick- and smooth-walled, (8.5–) 15–30(–35) µm long, 1.5–2 µm wide at the base, with a conspicuous flared collarete and periclinal thickening at the conidiogenous locus. *Conidial mass* globose, hemispherical, initially yellow, becoming orange, then dark red to red-brown when mature, *Conidia* ellipsoidal to oblong-ellipsoidal, 1-celled, light orange, smooth- and thick-walled, 4.3–6.3 × 2.2–3 µm, arranged in slimy heads. Adapted from Seifert (1985).

Culture characteristics: After 14 d at ca. 25 °C: On PDA reaching 22–30 mm diam, flat, floccose to hairy, dirty white to saffron or

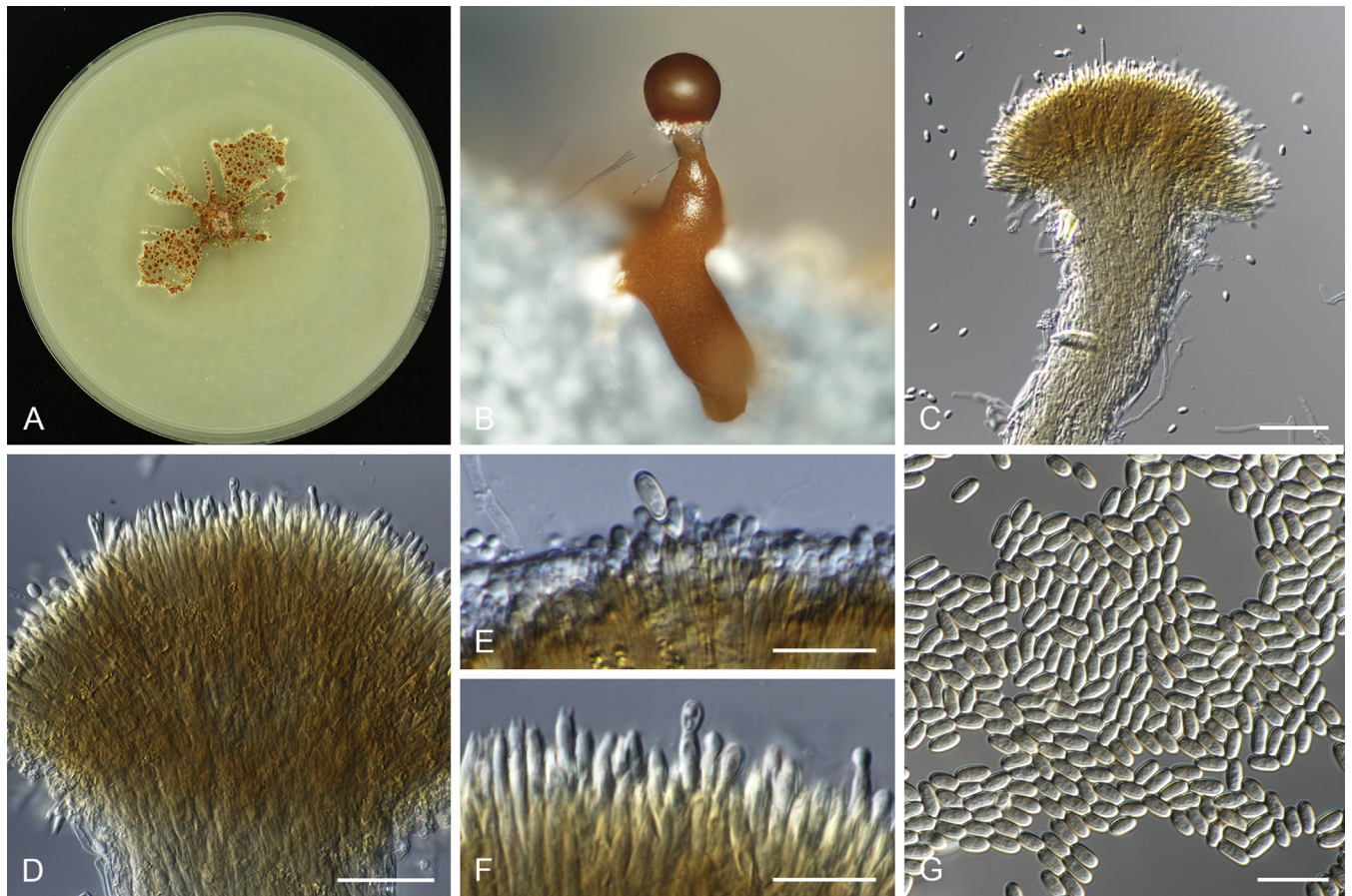


Fig. 36. *Acrostalagmus annulatus* (CBS 185.70). A. Colony on OA after 20 d at 25 °C. B, C. Synnemata. D. Apical portion of a synnema. E, F. Conidiogenous cells. G. Conidia. Scale bars: C, D = 25 µm; E–G = 10 µm.

orange. On OA reaching 22–23 mm diam, flat, granulose, white to amber, with drops of orange exudate.

Type details: **Unknown** location, on *Brassica* sp., Herbarium K (**holotype** of *Stilbum annulatum*: no. 6045, Car. Inf., herb. Berk., 1879). According to Seifert (1985).

Specimens examined: **Brazil**, Pará, near Belém, from soil and roots, unknown date, L. Pfenning, DAOMC 212126. **Mexico**, from *Glycine max*, Jan. 1970, J. Dunleavy, CBS 185.70 = JCM 9305. **Japan**, Okinawa Prefecture, Ishigaki island, mount. Omoto, from dead stem, 2 Jun. 1984, G. Okada, CBS 545.84 = CM 9306 = OFC 1487. **Sierra Leone**, Njala, from leaf of *Ananas comosus*, unknown date, K.A. Seifert, CBS 121.84 = IMI 056086. **Venezuela**, Amazonas, Cerro de la Neblina, base of Pico Phelps, from wood, *idem.*, G.J. Samuels, CBS 450.85 = GJS 1253.

Notes: *Acrostalagmus annulatus* is reported as saprophytic on wood, bark, leaves and herbaceous stems, and it is occasionally isolated from soil. It has a cosmopolitan distribution, being specially isolated from the tropics and subtropics (Seifert 1985).

This species was treated and illustrated by Seifert (1985) as *Stilbella annulata*, but transferred to *Acrostalagmus* by Réblová *et al.* (2011), based on a phylogeny inferred from SSU and *RPB2* sequences. The synnematous construction of the conidiophores is distinct from the mononematous structures seen in the generic type, *Acrostalagmus luteoalbus*; however, the orange pigmentation in the conidiophores and conidia produced by the two species is a shared character that reflects their strong phylogenetic relationship (98 % BS).

In this study, we have included four isolates deposited in the CBS collection as *Stilbella annulata*; some of them (CBS 185.70 and CBS 545.84) revised by Seifert (1985). All of them were

nestled in the same clade as the strain DAOMC 212126 from soil and roots sampled in Brazil, which was included in the study of Réblová *et al.* (2011).

Sodiomyces A.A. Grum-Grzhim. *et al.*, Persoonia 31: 154. 2013.

Ascomata cleistothecial, superficial, globose, dark-brown. **Peridium** multi-layered, pseudoparenchymatous, surface with *textura angularis*. **Asci** unitunicate, saccate, thin-walled, without apical apparatus, scattered irregularly in the ascoma. **Ascospores** released by dissolution of the ascus wall before maturity, accumulating within the ascocarp, released in a slimy mass, liberated by pressure within the ascocarp. **Ascospores** ellipsoidal or ovoid, 2-celled, not constricted at the septum, pale brown, thick- and smooth-walled. **Asexual morph.** **Conidiophores** simple, weakly branched or penicillate, hyaline, smooth, thin-walled. **Conidiogenous** cells enteroblastic, monophialidic, cylindrical or subulate, hyaline, thin-walled. **Conidia** subglobose, cylindrical to oval or allantoid, 1-celled, hyaline, smooth-walled, arranged in slimy heads.

Types species: *Sodiomyces alkalinus* (Bilanenko & M. Ivanova) A.A. Grum-Grzhim. *et al.*

Sodiomyces alcalophilus (G. Okada) Giraldo López & Crous, **comb. nov.** MycoBank MB828075. Fig. 37.

Basionym: *Acremonium alcalophilum* G. Okada, Trans. Mycol. Soc. Japan 34: 173. 1993.

Description and illustrations: Okada *et al.* (1993).

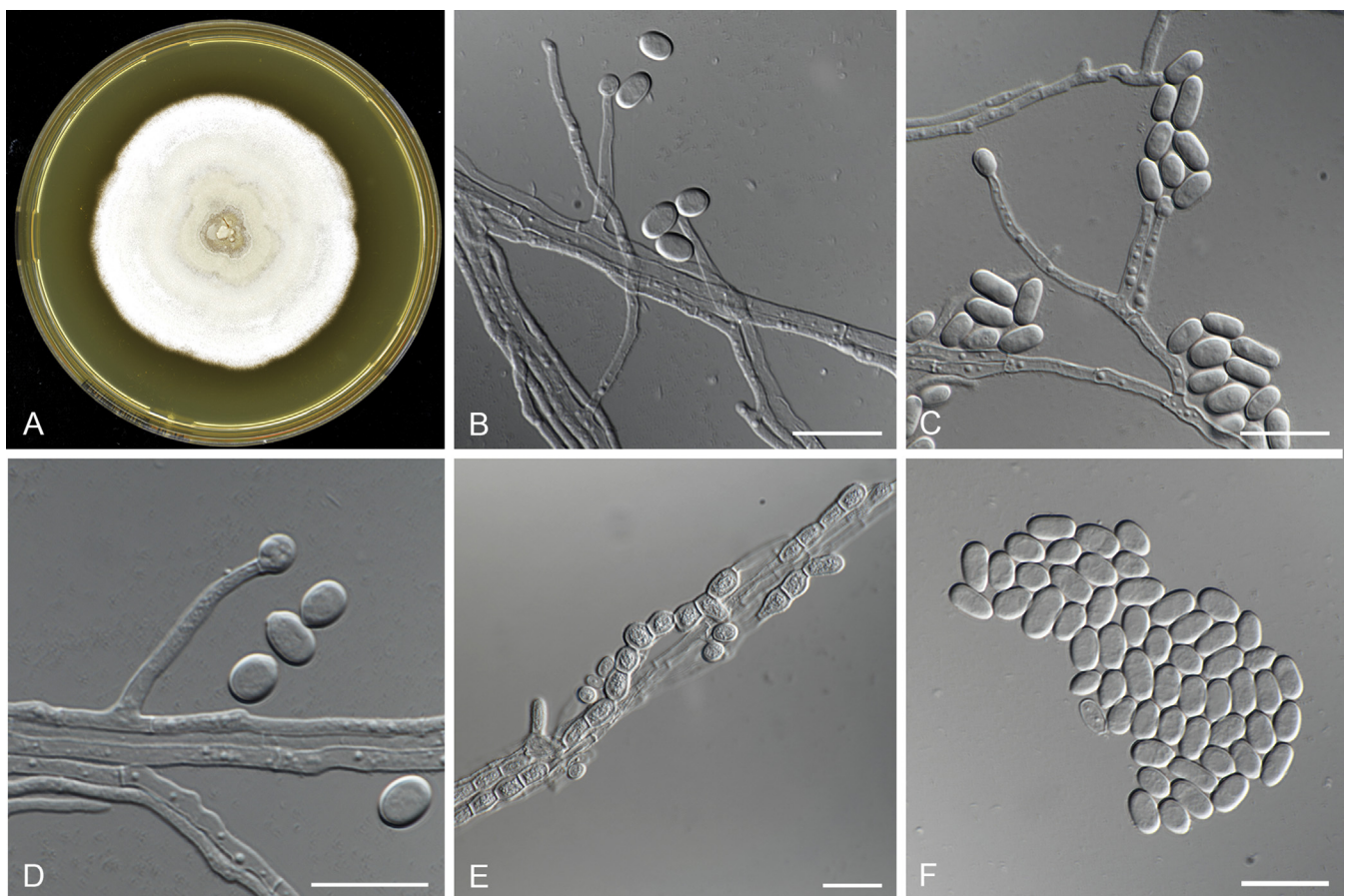


Fig. 37. *Sodiomyces alcalophilus* (ex-isotype CBS 114.92). **A.** Colony on MEA+KOH after 14 d at 25 °C. **B–D.** Conidiogenous cells. **E.** Chlamydospore-like hyphae. **F.** Conidia. Scale bars = 10 µm.

Specimen examined: Japan, Kanagawa Pref., Tsukui-gun, near Tsukui Lake, from sludge of pig faeces compost, 9 Dec. 1984, A. Yoneda (**holotype** TNS-F-176428, isotype CBS H-5163, ex-isotype culture CBS 114.92 = JCM 7366).

Notes: *Acremonium alcalophilum* was described by Okada *et al.* (1993) and isolated from sludge of pig manure compost, collected near the Tsukui Lake in Japan. The fungus was physiologically characterised by its alkaliphilic (optimal growth at pH 9.0–9.2) and cellulolytic properties, and morphologically by its pleomorphic conidiogenesis, featuring mainly phialidic structures, but also sympodial, arthric, blastic and retrogressive modes. This pleomorphism in conidial ontogeny was specially produced on alkaline glucose agar (Okada *et al.* 1993). Recently the genome of the ex-type strain of *Acremonium alcalophilum* has been sequenced, revealing a large number of genes encoding biomass-degrading enzymes, specially lipases, which have an important application in the production of biofuels and detergents, as well as in food processing, textile industries and other processes requiring an alkaline environment (Grigoriev *et al.* 2012, Nordberg *et al.* 2014).

Based in our phylogeny, the ex-type strain of *Acremonium alcalophilum* is nested with full support (100 % BS) in the same clade as the known *Sodiomyces* species, and therefore the new combination *Sodiomyces alcalophilus* is introduced here. This result is supported by the previous phylogeny showed in Grum-Grzhimaylo *et al.* (2013). Species of this genus are known to be alkaliphilic, a physiological feature also reported in *S. alcalophilus* (Okada *et al.* 1993). *Sodiomyces alcalophilus* can be morphologically distinguished from the other species of the genus by the absence of the sexual morph in culture.

The older genus *Zodiomyces*, based on *Z. vorticellarius* (*Laboulbeniales*, *Laboulbeniomyces*, *Ascomycota*) was proposed by Thaxter (1891) for a fungus growing on the beetle *Cymbiodyta lacustris* (*Coleoptera*). The generic name comes from the Greek *zodio*, meaning a small animal, while *Sodiomyces* is based on English soda. Since they have a different etymology both names should not be confused.

Sodiomyces alkalinus Grum-Grzhim., Debets & Bilanenko, **sp. nov.** MycoBank MB828148.

Synonyms: *Heleococcum alkalinum* Bilanenko & M. Ivanova, Mycotaxon 91: 501 (2005), Nom. inval., Art. 40.7 (Melbourne). *Sodiomyces alkalinus* (Bilanenko & M. Ivanova) AA. Grum-Grzhim. *et al.*, Persoonia 31: 157. 2013. Nom. inval., Art. 40.7 (Melbourne).

Description and illustrations: Bilanenko *et al.* (2005) and Grum-Grzhimaylo *et al.* (2013, 2016).

Specimen examined: Mongolia, Choibalsan area, the soda soil (pH 10.7) on the edge of Shar-Burdiyn lake, 1999, D. Sorokin (**holotype** designated here CBS 110278 culture permanently preserved in a metabolically inactive state) culture ex-type CBS 110278 = F11 = VKM F-3762.

Notes: The genus *Sodiomyces* was proposed by Grum-Grzhimaylo *et al.* (2013) to accommodate the alkaliphilic species *Heleococcum alkalinum*, which was demonstrated to be not congeneric with the type species *H. aurantiacum* (*Bionectriaceae*, *Hypocreales*). The name *Sodiomyces alkalinus* was, however, invalid, as the basionym was not validly published. It is validated above. Recently two more species have been added to the genus from soda soils, *Sodiomyces magadii* and *S. tronii*. The three species form cleistothecial ascomata in culture, but can be morphologically distinguished by asexual state morphology. While *Sodiomyces magadii*

lacks asexual sporulation, *S. alkalinus* produces an acronium-like state and *S. tronii* produces a gliocladium-like state (Grum-Grzhimaylo *et al.* 2013, 2016).

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