

Generic concepts in *Nectriaceae*

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Abstract: The ascomycete family *Nectriaceae* (*Hypocreales*) includes numerous important plant and human pathogens, as well as several species used extensively in industrial and commercial applications as biodegraders and biocontrol agents. Members of the family are unified by phenotypic characters such as uniloculate ascospores that are yellow, orange-red to purple, and with phialidic asexual morphs. The generic concepts in *Nectriaceae* are poorly defined, since DNA sequence data have not been available for many of these genera. To address this issue we performed a multi-gene phylogenetic analysis using partial sequences for the 28S large subunit (LSU) nrDNA, the internal transcribed spacer region and intervening 5.8S nrRNA gene (ITS), the large subunit of the ATP citrate lyase (*acl1*), the RNA polymerase II largest subunit (*rpb1*), RNA polymerase II second largest subunit (*rpb2*), α -actin (*act*), β -tubulin (*tub2*), calmodulin (*cmdA*), histone H3 (*his3*), and translation elongation factor 1- α (*tef1*) gene regions for available type and authentic strains representing known genera in *Nectriaceae*, including several genera for which no sequence data were previously available. Supported by morphological observations, the data resolved 47 genera in the *Nectriaceae*. We re-evaluated the status of several genera, which resulted in the introduction of six new genera to accommodate species that were initially classified based solely on morphological characters. Several generic names are proposed for synonymy based on the abolishment of dual nomenclature. Additionally, a new family is introduced for two genera that were previously accommodated in the *Nectriaceae*.

Key words: Generic concepts, *Nectriaceae*, Phylogeny, Taxonomy.

Taxonomic novelties: **New family:** *Tilachlidiaceae* L. Lombard & Crous; **New genera:** *Aquanectria* L. Lombard & Crous, *Bisifusarium* L. Lombard, Crous & W. Gams, *Coccinonectria* L. Lombard & Crous, *Paracremonium* L. Lombard & Crous, *Rectifusarium* L. Lombard, Crous & W. Gams, *Xenoacremonium* L. Lombard & Crous; **New species:** *Mariannaea humicola* L. Lombard & Crous, *Neocosmospora rubicola* L. Lombard & Crous, *Paracremonium inflatum* L. Lombard & Crous, *P. contagium* L. Lombard & Crous, *Pseudonectria foliicola* L. Lombard & Crous, *Rectifusarium robinianum* L. Lombard & Crous, *Xenoacremonium falcatus* L. Lombard & Crous, *Xenogliocladiopsis cypellocarpa* L. Lombard & Crous; **New combinations:** *Aquanectria penicillioides* (Ingold) L. Lombard & Crous, *A. submerse* (H.J. Huds.) L. Lombard & Crous, *Bisifusarium biseptatum* (Schroers, Summerbell & O'Donnell) L. Lombard & Crous, *B. delphinoides* (Schroers, Summerbell, O'Donnell & Lampr.) L. Lombard & Crous, *B. dimerum* (Penz.) L. Lombard & Crous, *B. domesticum* (Fr.) L. Lombard & Crous, *B. lunatum* (Ellis & Everh.) L. Lombard & Crous, *B. nectrioides* (Wollenw.) L. Lombard & Crous, *B. penzigii* (Schroers, Summerbell & O'Donnell) L. Lombard & Crous, *Calonectria candelabra* (Viégas) Rossman, L. Lombard & Crous, *C. cylindrospora* (Ellis & Everh.) Rossman, L. Lombard & Crous, *Clonostachys apocyni* (Peck) Rossman, L. Lombard & Crous, *C. aurantia* (Penz. & Sacc.) Rossman, L. Lombard & Crous, *C. blumenaviae* (Rehm) Rossman, L. Lombard & Crous, *C. gibberosa* (Schroers) Rossman, L. Lombard & Crous, *C. manihotis* (Rick) Rossman, L. Lombard & Crous, *C. parva* (Schroers) Rossman, L. Lombard & Crous, *C. tonduzii* (Speg.) Rossman, L. Lombard & Crous, *C. tomatata* (Höhn.) Rossman, L. Lombard & Crous, *Coccinonectria pachysandricola* (B.O. Dodge) L. Lombard & Crous, *C. rusci* (Lechat, Gardienet & J. Fourn.) L. Lombard & Crous, *Hydropisphaera fusigera* (Berk. & Broome) Rossman, L. Lombard & Crous, *Ilyonectria destructans* (Zinssm.) Rossman, L. Lombard & Crous, *I. macroconidialis* (Brayford & Samuels) Rossman, L. Lombard & Crous, *Mariannaea catenulatae* (Samuels) L. Lombard & Crous, *Nectriopsis rexiana* (Sacc.) Rossman, L. Lombard & Crous, *Neocosmospora ambrosia* (Gadd & Loos) L. Lombard & Crous, *N. falciformis* (Carrión) L. Lombard & Crous, *N. illudens* (Berk.) L. Lombard & Crous, *N. ipomoeae* (Halst.) L. Lombard & Crous, *N. monilifera* (Berk. & Broome) L. Lombard & Crous, *N. phaseoli* (Burkh.) L. Lombard & Crous, *N. plagianthi* (Dingley) L. Lombard & Crous, *N. ramosa* (Bat. & H. Maia) L. Lombard & Crous, *N. solani* (Mart.) L. Lombard & Crous, *N. termitum* (Höhn.) L. Lombard & Crous, *N. tucumaniae* (T. Aoki, O'Donnell, Yos. Homma & Lattanzi) L. Lombard & Crous, *N. virguliformis* (O'Donnell & T. Aoki) L. Lombard & Crous, *Neonectria candida* (Ehrenb.) Rossman, L. Lombard & Crous, *Penicillifer diparietisporus* (J.H. Miller, Giddens & A.A. Foster) Rossman, L. Lombard & Crous, *Rectifusarium ventricosum* (Appel & Wollenw.) L. Lombard & Crous, *Sarcopodium flavolanatum* (Berk. & Broome) L. Lombard & Crous, *S. mammiforme* (Chardón) L. Lombard & Crous, *S. oblongisporum* (Y. Nong & W.Y. Zhuang) L. Lombard & Crous, *S. rariipilum* (Penz. & Sacc.) L. Lombard & Crous, *Sphaerostilbella penicillioides* (Corda) Rossman, L. Lombard & Crous, *S. aurifila* (W.R. Gerard) Rossman, L. Lombard & Crous, *Volutella asiatica* (J. Luo, X.M. Zhang & W.Y. Zhuang) L. Lombard & Crous, *Xenoacremonium recifei* (Leão & Lôbo) L. Lombard & Crous; **New name:** *Mariannaea pinicola* L. Lombard & Crous; **Typification:** **Epitypification (basionyms):** *Rectifusarium ventricosum* Appel & Wollenw., *Xenogliocladiopsis eucalyptorum* Crous & W.B. Kendr.

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INTRODUCTION

The order *Hypocreales* (*Hypocreomycetidae*, *Sordariomycetes*, *Pezizomycotina*, *Ascomycota*) includes approximately 2700 fungal species from 240 genera, which are divided over eight families (Kirk *et al.* 2008, Crous *et al.* 2014), with some genera still classified as *incertae sedis* (Lumbsch & Huhndorf 2007). Members of this order are globally found in various environments

and are of great importance to agriculture and medicine. They have been extensively exploited in industrial and commercial applications (Rossman 1996). These fungi are generally characterised by the production of lightly to brightly coloured, ostiole, perithecial ascospores, containing unitunicate asci with hyaline ascospores; asexual morphs, the form most frequently encountered in nature, are moniliaceous and phialidic (Rogerson 1970, Samuels & Seifert 1987, Rossman 1996, 2000, Rossman

et al. 1999). The taxonomic importance of these asexual morphs has only been recognised relatively recently (Rossman 2000, Seifert & Samuels 2000). The morphology of asexual forms is often crucial for the morphological identification of these fungi.

The family *Nectriaceae* is characterised by uniloculate ascomata that are white, yellow, orange-red or purple. These ascomata change colour in KOH, and are not immersed in a well-developed stroma. They are associated with phialidic asexual morphs producing amerosporous to phragmosporous conidia (Rossman *et al.* 1999, Rossman 2000). This family includes around 55 genera that were originally based on asexual or sexual morphs. The genera include approximately 900 species (www.mycobank.org; www.indexfungorum.org). The majority of these species are soil-borne saprobes or weak to virulent, facultative or obligate plant pathogens, while some are facultatively fungicolous or insecticolous (Rossman *et al.* 1999, Rossman 2000, Chaverri *et al.* 2011, Gräfenhan *et al.* 2011, Schroers *et al.* 2011). Several species have also been reported as important opportunistic pathogens of humans (Chang *et al.* 2006, de Hoog *et al.* 2011, Guarro 2013) while others produce mycotoxins of medical concern (Rossman 1996).

Prior to the advent of DNA sequencing studies, most sexual morph genera recognised in the *Nectriaceae* were placed in *Nectria sensu lato* (Rehner & Samuels 1995, Rossman *et al.* 1999). The genus *Nectria s. str.*, however, is restricted to the type species *N. cinnabarina* with tubercularia-like asexual morphs (Rossman 2000, Hirooka *et al.* 2012). Recently, several studies have treated taxonomic concepts within *Nectriaceae* based on multi-gene phylogenetic inference (Lombard *et al.* 2010a, b, 2012, 2014a, b, Lombard & Crous 2012, Chaverri *et al.* 2011, Gräfenhan *et al.* 2011, Schroers *et al.* 2011, Hirooka *et al.* 2012). In these studies, well-known and important plant and human pathogenic genera have been segregated into several new genera, with some older generic names resurrected (Chaverri *et al.* 2011, Gräfenhan *et al.* 2011, Schroers *et al.* 2011, Hirooka *et al.* 2011, 2012). This has resulted in debates (Geiser *et al.* 2013, O'Donnell *et al.* 2013, Aoki *et al.* 2014) about the prospects for continued use of certain well-known generic names, such as *Fusarium*, for species of agricultural and medical importance. Several genera traditionally classified in the *Nectriaceae* have been excluded from these studies. In the present study, the phylogenetic relationships of most of the genera known from culture and traditionally classified as *Nectriaceae* are evaluated based on DNA sequences of 10 loci. The goal is to provide a phylogenetic backbone for the family *Nectriaceae*. Nomenclatural changes due to the implementation of the new International Code of Nomenclature for algae, fungi and plants (ICN; McNeill *et al.* 2012), are also considered in this study. The taxonomy of some genera is re-evaluated.

MATERIALS AND METHODS

Isolates

Fungal strains were obtained from the culture collection of the CBS-KNAW Fungal Biodiversity Centre (CBS), Utrecht, The Netherlands and the working collection of Pedro W. Crous housed at the CBS (Table 1).

DNA isolation, amplification and analyses

Total genomic DNA was extracted from 7-d-old single-conidial cultures growing on 2 % (w/v) malt extract agar (MEA) using the method of Damm *et al.* (2008). Partial gene sequences were determined for the 28S large subunit (LSU) nrDNA, the internal transcribed spacer region and intervening 5.8S nrDNA gene (ITS), the large subunit of the ATP citrate lyase (*acl1*), the RNA polymerase II largest subunit (*rpb1*), RNA polymerase II second largest subunit (*rpb2*), β -tubulin (*tub2*), histone H3 (*his3*), translation elongation factor 1- α (*tef1*), calmodulin (*cmdA*) and α -actin (*act*) using the primers and PCR protocols listed in Table 2. Integrity of the sequences was ensured by sequencing the amplicons in both directions using the same primer pairs as were used for amplification. A consensus sequence for each locus was assembled in MEGA v. 6 (Tamura *et al.* 2013) and additional sequences were obtained from GenBank (Table 1). Subsequent alignments for each locus were generated in MAFFT v. 7 (Katoh & Standley 2013) and manually corrected where necessary. Phylogenetic congruency of the 10 loci was tested using a 70 % reciprocal bootstrap criterion (Mason-Gamer & Kellogg 1996).

Phylogenetic analyses were based on Bayesian inference (BI) and Maximum Likelihood (ML). For both analyses, the evolutionary model for each partition was determined using MrModeltest (Nylander 2004) and incorporated into the analyses. For the BI analysis, the software package BEAST v. 8.0 (Drummond *et al.* 2012) was used. The phylogenetic relationships were estimated by performing six independent repetitions of 100 M generations each, with sampling at every 1000th generation. The Yule speciation algorithm with GTR substitution model and a lognormal uncorrelated relaxed clock were selected for the data. LogCombiner v. 8.0 (from the BEAST package) was used to combine the outputs of six independent runs. The resulting trees were summarised using Tree Annotator v. 1.8.0 (from the BEAST package) using the maximum clade credibility option. FigTree v. 1.4 was used to visualise the final tree.

The ML analysis was performed using RAxML v. 8.0.9 (randomised accelerated (sic) maximum likelihood for high performance computing; Stamatakis 2014) through the CIPRES website (<http://www.phylo.org>) to obtain a second measure of branch support. The robustness of the analysis was evaluated by bootstrap support (BS) with the number of bootstrap replicates automatically determined by the software. All novel sequences generated in this study were deposited in GenBank (Table 1) and the alignment(s) and tree(s) in TreeBASE.

Morphology

For morphological characterisation, single-conidial isolates were grown on synthetic nutrient-poor agar (SNA, Nirenberg 1981) with sterile toothpicks, filter paper or carnation leaves placed on the surface of the agar. Alternatively, isolates were also plated onto potato dextrose agar (2 % w/v, PDA), oatmeal agar (OA) and malt extract agar (2 % w/v, MEA) (recipes in Crous *et al.* 2009) to induce sporulation when this failed on SNA. Plates were incubated at room temperature (22–25 °C) under ambient light conditions. Some isolates were incubated at 12 h / 12 h fluorescent light and darkness at 25 °C. Gross morphological characters of the asexual morphs were examined after 7–10 d by mounting fungal structures in clear lactic acid and

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

Species	Isolate nr. ¹	Substrate	Collector/ Depositor	Locality	GenBank Accession No. ²									
					<i>acl1</i>	<i>act</i>	<i>cmdA</i>	<i>his3</i>	ITS	LSU	<i>rpb1</i>	<i>rpb2</i>	<i>tef1</i>	<i>tub2</i>
" <i>Acremonium</i> cf. <i>curvulum</i> "	CBS 100551	<i>Olea europaea</i>	S. Frisullo	Italy	<i>KM231057</i>	<i>KM231223</i>	<i>KM231400</i>	<i>KM231552</i>	<i>KM231818</i>	HQ232031	<i>KM232244</i>	<i>KM232385</i>	<i>KM231949</i>	<i>KM232088</i>
<i>Albonectria rigidiuscula</i>	CBS 315.73; ATCC 24367; IMI 137397	<i>Theobroma cacao</i>	P.S. Liu	Malaysia	<i>KM231012</i>	<i>KM231206</i>	<i>KM231383</i>	<i>KM231534</i>	<i>KM231809</i>	<i>KM231677</i>	<i>KM232229</i>	<i>KM232378</i>	<i>KM231938</i>	<i>KM232071</i>
	CBS 122570; GJS 01-170	Bark	G.J. Samuels	Cameroon	HQ897896	<i>KM231205</i>	<i>KM231382</i>	<i>KM231533</i>	HQ897815	<i>KM231676</i>	<i>KM232228</i>	HQ897760	<i>KM231937</i>	<i>KM232070</i>
<i>Allantonectria miltina</i>	CBS 474.69; MUCL 14535	<i>Agave americana</i>	H.A. van der Aa	Spain	<i>KM231080</i>	<i>KM231246</i>	<i>KM231430</i>	<i>KM231592</i>	<i>KM231835</i>	<i>KM231716</i>	<i>KM232269</i>	<i>KM232408</i>	<i>KM231973</i>	–
	CBS 121121; AR 4391	<i>Agave americana</i>	G. Cacialli	Italy	<i>KM231081</i>	HM484514	<i>KM231431</i>	<i>KM231593</i>	HM484547	HM484572	HM484587	<i>KM232409</i>	HM484524	HM484609
	CBS 125499; TG 2008-02	<i>Yucca elata</i>	T. Gräfenhan	USA	–	<i>KM231247</i>	<i>KM231432</i>	–	<i>KM231836</i>	<i>KM231717</i>	<i>KM232270</i>	HQ897730	<i>KM231974</i>	<i>KM232107</i>
<i>Aquanectria penicillioides</i>	CBS 257.54; ATCC 16261	<i>Acer</i> sp.	F.V. Ranzoni	USA	<i>KM230954</i>	<i>KM231110</i>	<i>KM231275</i>	–	<i>KM231743</i>	<i>KM231613</i>	<i>KM232135</i>	<i>KM232299</i>	<i>KM231865</i>	<i>KM232000</i>
<i>A. submersus</i>	CBS 394.62 ^T	Unknown	H.J. Hudson	UK	HQ897845	<i>KM231109</i>	–	<i>KM231458</i>	HQ897796	<i>KM231612</i>	<i>KM232134</i>	HQ897728	–	<i>KM231999</i>
<i>Atractium crassum</i>	CBS 180.31 ^T ; NRRL 20894	Water tap	H.W. Wollenweber	Germany	HQ897859	<i>KM231183</i>	<i>KM231356</i>	<i>KM231508</i>	<i>KM231790</i>	U88110	<i>KM232205</i>	HQ897722	<i>KM231919</i>	<i>KM232049</i>
<i>A. stilbaster</i>	CBS 410.67 ^T	Decaying bark	W. Gams	Germany	<i>KM230990</i>	<i>KM231184</i>	<i>KM231357</i>	<i>KM231509</i>	<i>KM231791</i>	<i>KM231654</i>	<i>KM232206</i>	–	<i>KM231920</i>	<i>KM232050</i>
	CBS 783.85; KAS 385a	Stump	K.A. Seifert & G. Andersson	Sweden	<i>KM230991</i>	<i>KM231185</i>	<i>KM231358</i>	<i>KM231510</i>	<i>KM231792</i>	<i>KM231655</i>	<i>KM232207</i>	–	<i>KM231921</i>	<i>KM232051</i>
<i>Bisifusarium delphinooides</i>	CBS 120718 ^T ; CPC 13041	<i>Hoodia gordonii</i>	S.C. Lamprecht	South Africa	<i>KM230994</i>	<i>KM231188</i>	<i>KM231363</i>	<i>KM231515</i>	EU926229	<i>KM231660</i>	<i>KM232210</i>	–	EU926296	<i>KM232056</i>
<i>B. dimerum</i>	CBS 108944 ^T ; NRRL 36140	<i>Homo sapiens</i>	H. Ph. Endtz	The Netherlands	<i>KM230996</i>	<i>KM231190</i>	<i>KM231365</i>	<i>KM231517</i>	JQ434586	JQ434514	<i>KM232212</i>	<i>KM232363</i>	EU926334	EU926400
<i>B. domesticum</i>	CBS 116517; NRRL 29976	Cheese	K. O'Donnell	Switzerland	<i>KM230997</i>	<i>KM231191</i>	<i>KM231366</i>	<i>KM231518</i>	EU926219	JQ434512	<i>KM232213</i>	HQ897694	EU926286	JQ434531
<i>B. lunatum</i>	CBS 632.76 ^T ; BBA 63199; NRRL 20690	<i>Gymnocalcium damsii</i>	I. Rummland	Germany	HQ897902	<i>KM231192</i>	<i>KM231367</i>	<i>KM231519</i>	HQ897819	<i>KM231662</i>	<i>KM232214</i>	HQ897766	EU926291	<i>KM232057</i>
<i>B. nectrioides</i>	CBS 176.31 ^T ; NRRL 20689	Soil	H.W. Wollenweber	Honduras	<i>KM230993</i>	<i>KM231187</i>	<i>KM231362</i>	<i>KM231514</i>	EU926245	<i>KM231659</i>	<i>KM232209</i>	HQ897721	EU926312	<i>KM232055</i>
<i>B. penzigii</i>	CBS 317.34 ^T ; NRRL 22109	<i>Fagus sylvatica</i>	J. Ehrlich	UK	<i>KM230995</i>	<i>KM231189</i>	<i>KM231364</i>	<i>KM231516</i>	<i>KM231795</i>	<i>KM231661</i>	<i>KM232211</i>	<i>KM232362</i>	EU926324	EU926390
<i>Calonectria brassicae</i>	CBS 111869; CPC 2409; PC 551197	<i>Argyrea</i> sp.			<i>KM230965</i>	GQ280454	GQ267382	DQ190720	GQ280576	GQ280698	<i>KM232181</i>	<i>KM232308</i>	FJ918567	AF232857
<i>C. ilicicola</i>	CBS 190.50 ^T ; CPC 2482; IMI 299389	<i>Solanum tuberosum</i>	K.B. Boedjin & J. Reitsma	Java	<i>KM230964</i>	GQ280483	AY725764	AY725676	GQ280605	GQ280727	<i>KM232180</i>	<i>KM232307</i>	AY725726	AY725631

(continued on next page)

Table 1. (Continued)

Species	Isolate nr. ¹	Substrate	Collector/ Depositor	Locality	GenBank Accession No. ²									
					<i>act1</i>	<i>act</i>	<i>cmdA</i>	<i>his3</i>	ITS	LSU	<i>rpb1</i>	<i>rpb2</i>	<i>tef1</i>	<i>tub2</i>
<i>C. naviculata</i>	CBS 101121 ^T ; CMW 30974	Leaf litter	R.F. Castañeda	Brazil	KM230966	GQ280478	GQ267399	GQ267252	GQ280600	GQ280722	KM232182	KM232309	GQ267317	GQ267211
<i>Calostilbe striispora</i>	CBS 133491		C. Lechat	French Guiana	–	KM231182	KM231355	–	KM231789	KM231653	KM232204	KM232361	KM231918	KM232048
" <i>C. striispora</i> "	CBS 122.39	<i>Erythrina glauca</i>	R.E.D. Baker	Trinidad and Tobago	KM231102	–	–	–	KM231855	KM231735	KM232290	KM232431	KM231991	KM232125
<i>Campylocarpon fasciculare</i>	CBS 112613 ^T ; CPC 3970	<i>Vitis</i> sp.	F. Halleen	South Africa	KM231026	HM352881	KM231297	JF735502	AY677301	HM364313	HM364331	KM232322	JF735691	AY677221
<i>C. pseudofasciculare</i>	CBS 112679 ^T ; CPC 5472	<i>Vitis vinifera</i>	F. Halleen	South Africa	KM231027	HM352882	KM231298	JF735503	AY677306	HM364314	HM364332	KM232323	JF735692	AY677214
<i>Chaetopsina acutispora</i>	CBS 667.92 ^T	Forest litter	A. Rambeli	Africa	KM230976	KM231164	KM231337	KM231494	KM231771	KM231636	KM232187	–	KM231901	KM232029
<i>C. chaetopsinae-penicillatae</i>	CBS 608.92 ^T ; GJS 77-21; ATCC 56205	<i>Beilschmiedia tawa</i>	G.J. Samuels	New Zealand	HQ897847	–	–	–	HQ897798	KM231638	–	HQ897709	KM231903	KM232031
<i>C. fulva</i>	CBS 142.56 ^T ; IMI 062199	<i>Cedrus deodara</i>	A. Rambeli	Italy	KM230977	KM231165	KM231338	KM231495	KM231772	KM231637	KM232188	–	KM231902	KM232030
<i>Cilicium brevipes</i>	CBS 691.83	<i>Fagus sylvatica</i>	G.S. de Hoog	The Netherlands	–	KM231266	KM231451	–	KM231856	KM231736	KM232291	KM232432	KM231992	KM232126
<i>C. hyalinum</i>	CBS 106.13 ^T	Soil	W. Daszewska	Switzerland	KM231103	KM231267	–	KM231606	KM231857	KM231737	KM232292	KM232433	KM231993	–
<i>Coccinectria pachysandricola</i>	CBS 501.63; BBA 808; CCT 4699	<i>Pachysandra terminalis</i>	R. Schneider	Germany	KM230979	KM231167	KM231340	KM231497	KM231774	KM231640	KM232190	KM232350	KM231905	KM232033
	CBS 476.92; PD 92/1036	<i>Pachysandra terminalis</i>		The Netherlands	KM230980	KM231168	–	KM231498	KM231775	KM231641	KM232191	–	KM231906	KM232034
	CBS 128674; AR 4592	<i>Pachysandra terminalis</i>	P. Brown	USA	KM230981	JF832512	KM231341	KM231499	JF832658	JF832715	JF832791	KM232351	JF832544	JF832909
<i>C. rusci</i>	CBS 126108 ^T	<i>Ruscus aculeatus</i>	C. Lechat	France	KM230978	KM231166	KM231339	KM231496	KM231773	KM231639	KM232189	KM232349	KM231904	KM232032
<i>Corallomycetella elegans</i>	CBS 275.60	<i>Musa sapientum</i>		Zaire	–	KM231237	–	KM231567	KM231828	KM231710	–	KM232393	KM231963	KM232100
<i>C. repens</i>	CBS 358.49	<i>Carica papaya</i>	K.B. Boedijn & J. Reitsma	Java	KM231063	KC479740	–	KM231565	KC479756	KM231708	KM232258	KM232391	KM231961	KC479785
	CBS 118.84; IMI 101072	Soil	O.S. Peries	Sri Lanka	KM231064	KC479738	–	KM231566	KC479755	KM231709	KM232259	KM232392	KM231962	KC479784
<i>Corallonectria jatrophae</i>	CBS 913.96 ^T ; GJS 96-18	Unknown tree	G.J. Samuels	Puerto Rico	KM230951	KC479744	KM231273	KM231457	KC479758	KM231611	KM232132	KM232298	KM231863	KC479787
<i>Cosmospora arxii</i>	CBS 748.69 ^T	<i>Hypoxylon</i> sp.	W. Gams	Germany	HQ897725	KM231224	KM231401	KM231553	KM231819	KM231694	KM232245	HQ897862	KM231950	KM232089
<i>C. coccinea</i>	CBS 341.70 ^T	<i>Inonotus nodulosus</i>	W. Gams	Germany	HQ897913	KM231221	KM231398	KM231550	HQ897827	KM231692	KM232242	HQ897777	KM231947	KM232086
<i>C. cymosa</i>	CBS 762.69 ^T	<i>Inonotus radiatus</i>	W. Gams	Germany	HQ897914	KM231222	KM231399	KM231551	HQ897828	KM231693	KM232243	HQ897778	KM231948	KM232087

Table 1. (Continued)

Species	Isolate nr. ¹	Substrate	Collector/ Depositor	Locality	GenBank Accession No. ²									
					<i>acl1</i>	<i>act</i>	<i>cmdA</i>	<i>his3</i>	ITS	LSU	<i>rpb1</i>	<i>rpb2</i>	<i>tef1</i>	<i>tub2</i>
<i>Cosmospora</i> sp.	CBS 101915; GJS 83-159	Lichen	G.J. Samuels	New Zealand	KM231058	KM231225	KM231402	KM231554	KM231820	KM231695	KM232246	KM232386	KM231951	KM232090
<i>Curviciadiella cigneae</i>	CBS 101411; MUCL 40268	Decaying seed	C. Decock	French Guiana	KM230967	KM231120	KM231285	KM231459	KM231744	JQ666075	KM232141	KM232310	KM231866	KM232001
	CBS 109167 ^T ; CPC 1595; MUCL 40269	Leaf litter	C. Decock	French Guiana	KM230969	KM231122	KM231287	KM231461	AF220973	AY793431	KM232142	KM232311	KM231867	KM232002
	CBS 109168; CPC 1594; MUCL 40268	Decaying seed	C. Decock	French Guiana	KM230968	KM231121	KM231286	KM231460	KM231745	JQ666074	KM232143	KM232312	KM231868	KM232003
<i>Cyanonectria buxi</i>	CBS 130.97	<i>Buxus sempervirens</i>	H.-J. Schroers	France	HM626622	KM231210	KM231388	KM231539	KM231811	KM231679	KM232233	HM626690	HQ728150	KM232075
	CBS 125551 ^T ; HJS 1398	<i>Buxus sempervirens</i>	H.-J. Schroers	Slovenia	HM626630	–	–	–	HM626661	HM626673	–	HM626689	HM626648	–
<i>C. cyanostoma</i>	CBS 101734 ^T ; GJS 98-127	<i>Buxus sempervirens</i>	G.J. Samuels & F. Candoussau	France	HQ897895	GQ505961	KM231387	KM231538	FJ474076	HM626671	GQ506017	HQ897759	HM484611	HM484535
<i>Cylindrium aeruginosum</i>	CBS 693.83	<i>Fagus sylvatica</i>	G.S. de Hoog	The Netherlands	–	KM231265	KM231450	–	KM231854	KM231734	–	KM232430	KM231990	KM232124
<i>C. elongatum</i>	CBS 685.83A	<i>Fagus</i> sp.	G.S. de Hoog	The Netherlands	–	KM231264	KM231448	–	KM231852	KM231732	–	KM232428	KM231988	KM232122
	CBS 115974		G. Verkley	The Netherlands	KM231101	–	KM231449	KM231605	KM231853	KM231733	KM232289	KM232429	KM231989	KM232123
<i>Cylindrocarpostylus gregarius</i>	CBS 101072 ^T	<i>Hylurgops palliatus</i>	R. Kirschner	Germany	KM231021	KM231127	KM231292	–	KM231747	JQ666084	KM232144	KM232317	KM231870	KM232005
	CBS 101073	<i>Pinus sylvestris</i>	R. Kirschner	Germany	KM231022	KM231128	KM231293	KM231465	KM231748	JQ666083	–	KM232318	KM231871	KM232006
	CBS 101074	<i>Picea abies</i>	R. Kirschner	Germany	KM231020	KM231126	KM231291	–	KM231746	KM231614	–	KM232316	KM231869	KM232004
<i>Cylindrocladiella camelliae</i>	CPC 234 ^T ; PPRI 3990; IMI 346845	<i>Eucalyptus grandis</i>	P.W. Crous	South Africa	KM230959	KM231115	KM231280	AY793509	AF220952	JN099249	KM232139	KM232304	JN099087	AY793471
<i>C. lageniformis</i>	CBS 340.92 ^T ; PPRI 4449; UFV 115	<i>Eucalyptus</i> sp.	A.C. Alfenas	Brazil	KM230958	KM231114	KM231279	AY793520	AF220959	JN099165	JN989491	KM232303	JN099003	AY793481
<i>C. parva</i>	CBS 114524 ^T ; ATCC 28272; CPC 2370	<i>Telopea speciosissima</i>	H.J. Boesewinkel	New Zealand	KM230960	KM231116	KM231281	AY793526	AF220964	JN099171	KM232140	–	JN099009	AY793486
<i>Cylindrodendrum album</i>	CBS 301.83 ^T ; ATCC 46842; IMI 255534	<i>Fucus distichus</i>	R.C. Summerbell	Canada	KM231046	KM231152	KM231322	KM231484	KM231764	KM231626	KM232162	KM232339	KM231889	KM232021
	CBS 110655	Soil	F.X. Prenafeta-Boldú	The Netherland	KM231047	KM231153	KM231323	KM231485	KM231765	KM231627	KM232340	KM232340	KM231890	KM232022
<i>C. hubeiense</i>	CBS 129.97	<i>Viscum album</i>	W. Gams	France	KM231048	KM231154	KM231324	KM231486	KM231766	KM231628	KM232164	KM232341	KM231891	KM232023
<i>Dactylonectria alcacerensis</i>	CBS 129087 ^T ; CPC 19172	<i>Vitis vinifera</i>	A. Cabral & H. Oliveira	Portugal	KM231054	KM231158	KM231330	JF735630	JF735333	KM231629	KM232176	–	JF735819	AM419111
<i>D. estremocensis</i>	CBS 129085 ^T ; CPC 19170	<i>Vitis vinifera</i>	C. Rego & T. Nascimento	Portugal	KM231052	KM231156	KM231328	JF735617	JF735320	KM231630	KM232174	KM232345	JF735807	JF735448

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Table 1. (Continued)

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					<i>act1</i>	<i>act</i>	<i>cmdA</i>	<i>his3</i>	ITS	LSU	<i>rpb1</i>	<i>rpb2</i>	<i>tef1</i>	<i>tub2</i>
<i>D. macrodidyma</i>	CBS 112615 ^T ; CPC 3976	<i>Vitis vinifera</i>	F. Halleen	South Africa	KM231055	HM352883	KM231331	JF735647	AY677290	HM364315	HM364333	JF268710	JF268750	AY677233
<i>D. novozelandica</i>	CBS 113552 ^T ; CPC 5713	<i>Vitis vinifera</i>	R. Bonfiglioli	New Zealand	KM231053	KM231157	KM231329	JF735633	JF735334	–	KM232175	KM232346	JF735822	AY677237
<i>D. torresensis</i>	CBS 129086 ^T ; CPC 19171	<i>Vitis vinifera</i>	A. Cabral	Portugal	KM231056	KM231159	KM231332	JF735681	JF735362	KM231631	KM232177	KM232347	JF735870	JF735492
<i>Dialonectria epispheeria</i>	CBS 125494; TG 2006-11	Unknown Ascomycete	T. Gräfenhan	Canada	HQ897892	KM231227	KM231404	KM231556	HQ897811	KM231697	KM232248	HQ897756	KM231953	KM232092
<i>D. ullevolea</i>	CBS 125493; TG 2007-56	Unknown Ascomycete	T. Gräfenhan	USA	HQ897918	KM231226	KM231403	KM231555	KM231821	KM231696	KM232247	HQ897782	KM231952	KM232091
<i>Dematiocladium celtidis</i>	CBS 115994 ^T	<i>Celtis tala</i>	N. Allegrucci	Argentina	KM230952	KM231108	KM231274	–	AY793430	AY793438	KM232133	–	KM231864	–
<i>Falcocladium multivesiculatum</i>	CBS 120386 ^T ; PREM 51541; CPC 13207	Leaf litter	S.F. Silveira	Brazil	KM231099	KM231262	–	–	JF831936	JF831932	KM232287	–	–	–
<i>F. sphaeroped-unculatum</i>	CBS 111292 ^T ; CPC 1448	Leaf litter	P.W. Crous	Brazil	–	KM231260	–	–	JF831938	JF831933	KM232285	–	–	–
<i>F. thailandicum</i>	CBS 121717 ^T ; CPC 13489	<i>Eucalyptus camaldulensis</i>	W. Himaman	Thailand	KM231098	KM231261	–	–	JF831939	JF831934	KM232286	–	–	–
<i>Fusarium circinatum</i>	CBS 405.97 ^T ; BBA 69720; DAOM 225113; MRC 7541; NRRL 25331	<i>Pinus radiata</i>	J. Correll	USA	KM231017	KM231215	KM231393	KM231544	U61677	AY249397	JX171510	JX171623	KM231943	KM232080
<i>F. proliferatum</i>	CBS 189.38; IMI 035108; MUCL 1129		B.L. Chona	India	KM231019	KM231217	KM231395	KM231546	KM231816	KM231685	KM232238	KM232384	–	KM232082
	CBS 263.54; ATCC 10052; IMI 058292; NRRL 2374; QM 1224	<i>Avena sativa</i>	T.S. Ramakrishnan	India	KM231018	KM231216	KM231394	KM231545	KM231815	KM231684	KM232237	KM232383	–	KM232081
<i>F. sambucinum</i>	CBS 146.95; BBA 64226	<i>Solanum tuberosum</i>	H.I. Nirenberg	UK	KM231015	KM231213	KM231391	KM231542	KM231813	KM231682	KM232235	KM232381	KM231941	KM232078
<i>F. subglutratum</i>	CBS 189.34 ^T ; BBA 62431; NRRL 13384	Soil	O.A. Reinking	Costa Rica	HQ897916	KM231211	KM231389	KM231540	HQ897830	KM231680	HQ897780	KM232380	–	KM232076
<i>F. venenatum</i>	CBS 458.93 ^T ; BBA 64537; NRRL 26228	Winter wheat	H.I. Nirenberg	Austria	KM231016	KM231214	KM231392	KM231543	KM231814	KM231683	KM232236	KM232382	KM231942	KM232079
<i>F. verrucosa</i>	CBS 102163; GJS 84-426	Bamboo	G.J. Samuels	Venezuela	HQ897920	KM231212	KM231390	KM231541	KM231812	KM231681	KM232234	HQ897784	KM231940	KM232077
<i>Fusicolla aquaeductuum</i>	CBS 837.85; BBA 64559; NRRL 20865	Plug in water tap	H.I. Nirenberg	Germany	HQ897880	–	KM231406	–	KM231823	KM231699	KM232250	HQ897744	KM231955	KM232094

Table 1. (Continued)

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<i>F. matuoi</i>	CBS 581.78; ATCC 18694; NRRL 20427	<i>Albizia julibrissin</i>	T. Matuo	Japan	HQ897858	KM231228	KM231405	KM231557	KM231822	KM231698	KM232249	HQ897720	KM231954	KM232093
<i>F. violacea</i>	CBS 634.76 ^T ; BBA 62461; NRRL 20896	<i>Quadraspidiotus perniciosus</i>	W. Gerlach	Iran	KM231059	KM231229	KM231407	KM231558	KM231824	KM231700	KM232251	HQ897696	KM231956	KM232095
<i>Geejayessia celtidicola</i>	CBS 125502 ^T ; TG 2008-32	<i>Celtis occidentalis</i>	T. Gräfenhan	Canada	HM626625	KM231209	KM231386	KM231537	HM626657	HM626669	KM232232	HM626685	HM626638	KM232074
<i>G. cicatricum</i>	CBS 125549 ^T ; HJS 1372	<i>Buxus sempervirens</i>	H.-J. Schroers	Slovenia	HM626636	KM231208	KM231385	KM231536	KM231810	KM231678	KM232231	HM626679	HM626643	KM232073
<i>G. desmazieri</i>	CBS 125507; TG 2007-87	<i>Buxus sempervirens</i>	T. Gräfenhan	Spain	HM626633	KM231207	KM231384	KM231535	HM626651	HM626663	KM232230	HM626675	HQ728146	KM232072
<i>Gliocephalotrichum bulbilium</i>	CBS 242.62 ^T ; ATCC 22228; IFO 9325; IMI 096357; MUCL 18575; NRRL 2899; QM 9007	Soil	L.J. Wickerham	USA	KM230962	KM231118	KM231283	KF513326	DQ377831	AY489732	AY489664	EF469114	KM231892	DQ377831
<i>G. cylindrosporium</i>	CBS 902.70 ^T ; ATCC 22229; IFO 9326; IMI 155704; MUCL 18576; QM 9009	Soil	C. Klinsukont	Thailand	KM230963	KM231119	KM231284	KF513353	DQ366705	JQ666077	KM232179	KM232306	KF513408	DQ377841
<i>G. longibrachium</i>	CBS 126571 ^T ; MUCL 46693	Leaf litter	C. Decock & V. Robert	French Guiana	KM230961	KM231117	KM231282	KF513367	DQ278422	KM231686	KM232178	KM232305	KF513435	DQ377835
<i>Gliocladiopsis irregularis</i>	CBS 755.97 ^T ; CPC 718	Soil	A.C. Alfenas	Indonesia	KM230957	KM231113	KM231278	JQ666023	AF220977	JQ666082	KM232138	KM232302	KF513449	JQ666133
<i>G. pseudotenuis</i>	CBS 116074 ^T ; CPC 706	Soil	M.J. Wingfield	China	KM230956	KM231112	KM231277	JQ666030	AF220981	JQ666080	KM232137	KM232301	JQ666099	JQ666140
<i>G. sagariensis</i>	CBS 199.55 ^T	Soil	S.B. Saksena	India	KM230955	KM231111	KM231276	JQ666031	JQ666063	JQ666078	KM232136	KM232300	JQ666106	JQ666141
<i>Hyaloseta nolinae</i>	CBS 109837 ^T	<i>Nolina micrantha</i>	A.W. Ramaley	USA	KM231092	KM231255	KM231442	KM231600	KM231846	KM231726	KM232279	KM232422	JQ666107	–
<i>Ilyonectria capensis</i>	CBS 132815 ^T	<i>Protea</i> sp.	K. Bezuidenhout	South Africa	–	–	KM231319	JX231135	JX231151	KM515908	KM232171	KM232336	JX231119	JX231103
<i>I. coprosmae</i>	CBS 119606; GJS 85-39	<i>Metrosideros</i> sp.	G.J. Samuels	New Zealand	–	KM231151	KM231321	JF735505	JF735260	KM515910	KM232173	KM232338	JF735694	JF735373
<i>I. destructans</i>	CBS 264.65	<i>Cyclamen persicum</i>	L. Nilsson	Sweden	–	KM231148	KM231317	JF735506	AY677273	KM515927	KM232169	KM232334	JF735695	AY677256
<i>I. leucospermi</i>	CBS 132809	<i>Leucospermum</i> sp.	K. Bezuidenhout	South Africa	–	KM231150	KM231320	JX231145	JX231161	KM515917	KM232172	KM232337	JX231129	JX231113
<i>I. liriiodendri</i>	CBS 117527	<i>Vitis vinifera</i>	C. Rego	Portugal	–	KM231149	KM231318	JF735509	DQ178165	KM515922	KM232170	KM232335	JF735698	DQ178172
<i>Lectera colletotrichoides</i>	CBS 109728	<i>Medicago sativa</i>	C. Eken	Turkey	KM231100	KM231263	KM231447	KM231604	KM231851	KM231731	KM232288	KM232427	KM231987	KM232121
<i>Macroconia leptosphaeria</i>	CBS 717.74	Stroma of <i>Pyrenomycete</i>	W. Gams	France	KM231062	KM231236	KM231414	KM231564	KM231827	KM231707	KM232257	KM232390	JF735695	KM232099
	CBS 100001	<i>Urtica dioica</i>	L. Rommelaars	The Netherlands	HQ897891	KM231234	KM231412	KM231562	HQ897810	KM231705	KM232255	HQ897755	KM231959	KM232097
	CBS 112770	<i>Cucurbitaria laburni</i>	W. Gams	Austria	KM231061	KM231235	KM231413	KM231563	KM231826	KM231706	KM232256	KM232389	KM231960	KM232098

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Table 1. (Continued)

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<i>M. papilionacearum</i>	CBS 125495; DAOM 238119; TG 2007-03	Black ascomycete on <i>Fabaceae</i>	T. Gräfenhan	USA	HQ897912	KM231233	KM231411	KM231561	HQ897826	KM231704	KM232254	HQ897776	KM231958	KM232096
<i>Mariannaea campptospora</i>	CBS 209.73 ^T ; IMI 186965	Soil	E. Jansen	The Netherlands	KM231032	KM231134	KM231303	KM231473	AY624202	–	KM232147	KM232326	KM231875	AY624245
	CBS 120801	Decaying wood	W. Gams	Germany	KM231031	KM231133	KM231302	KM231472	KM231753	KM231618	KM232151	KM232325	KM231878	KM232010
<i>M. catenulatae</i>	CBS 491.92 ^T ; ATCC 56204	Wood	G.J. Samuels	Venezuela	KM231030	KM231132	KM231301	KM231471	KM231752	KM231617	KM232150	–	KM231877	KM232009
<i>M. humicola</i>	CBS 740.95 ^T ; CCT 4534	Soil	S. Baldini	Brazil	KM231034	KM231136	KM231305	KM231475	KM231755	KM231619	KM232153	KM232328	KM231880	KM232012
	CBS 102628; INIFAT C99/130-2	Decaying wood	R.F. Castañeda	Spain	KM231035	KM231137	KM231306	KM231476	KM231756	KM231620	KM232154	KM232329	KM231881	KM232013
<i>M. pinicola</i>	CBS 745.88 ^T ; CTR 71-199	<i>Pinus</i> sp.	C.T. Rogerson	Venezuela	KM231033	KM231135	KM231304	KM231474	KM231754	AY554242	KM232152	KM232327	KM231879	KM232011
<i>M. punicea</i>	CBS 239.56 ^T	Soil	J. Meyer	Zaire	KM231028	–	KM231299	KM231469	AY624201	JF415981	KM232148	JF416001	KM231876	AY624244
	CBS 105.66	Soil	J.H. van Emden	The Netherlands	KM231029	KM231131	KM231300	KM231470	KM231751	KM231616	KM232149	KM232324	JF416021	KM232008
<i>M. samuelsii</i>	CBS 746.88; CTR 71-13	Bark	C.T. Rogerson	Jamaica	KM231036	KM231138	KM231307	KM231477	KM231757	KM231621	KM232155	KM232330	KM231882	KM232014
	CBS 125515 ^T ; DAOM 235814; KAS 1307	Soil	J. Bissett	Guatemala	HQ897888	KM231139	KM231308	KM231478	HQ843767	HQ843766	KM232156	HQ897752	KM231883	KM232015
<i>Microcera coccophila</i>	CBS 310.34; NRRL 13962	Scale insect	H.W. Wollenweber	Italy	HQ897843	KM231232	KM231410	KM231560	HQ897794	KM231703	JX171462	HQ897705	JF740692	–
<i>M. larvarum</i>	CBS 738.79; BBA 62239; MUCL 19033; NRRL 20473	<i>Quadrapidiotus perniciosus</i>	W. Gerlach	Iran	KM231060	KM231230	KM231408	KM231559	KM231825	KM231701	KM232252	KM232387	KM231957	–
<i>M. rubra</i>	CBS 638.76 ^T ; BBA 62460; NRRL 20475	<i>Quadrapidiotus perniciosus</i>	W. Gerlach & D. Ershad	Iran	HQ897903	KM231231	KM231409	EU860073	HQ897820	KM231702	KM232253	HQ897767	JF740696	EU860019
<i>Nalanthamala psidii</i>	CBS 116952 ^T ; AR 4095	<i>Psidium guajava</i>	Y-F. Yen	Taiwan	KM231073	KM231245	KM231423	KM231576	AY864836	AY864837	KM232268	KM232401	KM231972	AY864838
<i>N. vermoesonii</i>	CBS 230.48; ATCC 10522; IMI 040231; MUCL 7584; NRRL 1752	<i>Citrus medica</i>	H.S. Fawcett	Spain	KM231071	KM231243	KM231421	KM231574	AY554212	AY554263	KM232266	KM232399	KM231970	AY554231
	CBS 110893 ^T ; MUCL 9504	<i>Areca</i> sp.	P. Biourge		KM231072	KM231244	KM231422	KM231575	AY554214	AY554246	KM232267	KM232400	KM231971	AY554233
<i>Nectria balansae</i>	CBS 123351; AR 4446	<i>Coronilla</i> sp.	C. Lechat	France	KM231079	GQ505977	KM231429	KM231582	HM484552	GQ505996	GQ506026	KM232407	HM484525	HM484607
	CBS 125119; GJS 86-117	Woody vine	G.J. Samuels	French Guiana	KM231078	JF832486	KM231428	KM231581	HM484857	HM484868	HM484871	KM232406	HM484848	HM484874
	CBS 129349; AR 4635	Twigs	W.Y. Zhuang & X.M. Zhang	China	KM231077	JF832485	KM231427	KM231580	JF832653	JF832711	JF832790	KM232405	JF832522	JF832908

Table 1. (Continued)

Species	Isolate nr. ¹	Substrate	Collector/ Depositor	Locality	GenBank Accession No. ²									
					<i>act1</i>	<i>act</i>	<i>cmdA</i>	<i>his3</i>	ITS	LSU	<i>rpb1</i>	<i>rpb2</i>	<i>tef1</i>	<i>tub2</i>
<i>N. cinnabarina</i>	CBS 125165 ^T ; AR 4477; CLL 7152	<i>Aesculus</i> sp.	C. Lechat	France	KM231074	HM484503	KM231424	KM231577	HM484548	HM484562	HM484577	KM232402	HM484527	HM484606
" <i>N. dacryocarpa</i> "	CBS 121.87; GJS 85-185	Tree fern	G.J. Samuels	Sulawesi	KM231097	KM231259	–	KM231587	KM231850	KM231730	KM232284	–	KM231986	KM232120
	CBS 113532	<i>Pithya cupressina</i>	S. Ryman & O. Constantinescu	Sweden	KM231094	KM231257	KM231444	KM231601	KM231848	KM231728	KM232281	KM232424	KM231984	KM232118
<i>N. mariae</i>	CBS 125294 ^T ; CLL 7187	<i>Buxus sempervirens</i>	C. Lechat	France	KM231076	JF832499	KM231426	KM231579	JF832629	JF832684	JF832789	KM232404	JF832542	JF832899
<i>N. nigrescens</i>	CBS 125148 ^T ; AR 4211	Wood	A.Y. Rossman	USA	KM231075	HM484618	KM231425	KM231578	HM484707	HM484720	HM484781	KM232403	HM484672	HM484806
<i>Neocosmospora ambrosia</i>	CBS 571.94; BBA 65390	<i>Camellia sinensis</i>	H.I. Nirenberg	India	KM231003	KM231198	KM231373	–	KM231801	KM231668	KM232220	KM232368	KM231929	KM232063
<i>N. haematococca</i>	CBS 101573	<i>Passiflora edulis</i>	C.F. Hill	New Zealand	KM231000	KM231195	KM231370	KM231522	KM231798	KM231665	KM232217	KM232365	KM231927	KM232060
	CBS 119600 ^T ; GJS 02-90	Dying tree	G.J. Samuels	Sri Lanka	KM230999	KM231194	KM231369	KM231521	KM231797	KM231664	KM232216	–	KM231926	KM232059
	CBS 123669; NRRL 45880				KM230998	KM231193	KM231368	KM231520	KM231796	KM231663	KM232215	KM232364	KM231925	KM232058
<i>N. illudens</i>	CBS 119605; GJS 85-37	<i>Metrosideros</i> sp.	G.J. Samuels	New Zealand	KM231009	KM231202	KM231379	KM231530	KM231806	KM231673	KM232225	KM232374	KM231935	KM232068
	CBS 126406; GJS 85-67	Bark	G.J. Samuels	New Zealand	KM231008	JF832443	KM231378	KM231529	JF832660	JF832762	JF832837	KM232373	KM231934	JF832841
<i>N. phaseoli</i>	CBS 265.50	<i>Phaseolus</i> sp.	W.C. Snyder	USA	KM231010	KM231203	KM231380	KM231531	KM231807	KM231674	KM232226	KM232375	HE647964	HE648035
	CBS 102429; HJS 0332	Bark	G.J. Samuels	Australia	KM231011	KM231204	KM231381	KM231532	KM231808	KM231675	KM232227	KM232376	KM231936	KM232069
<i>N. ramosa</i>	CBS 509.63 ^T ; IMUR 410; MUCL 8050	Air	A.C. Batista	Brazil	KM231004	KM231199	KM231374	KM231525	KM231802	KM231669	KM232221	KM232369	KM231930	KM232064
<i>N. rubicola</i>	CBS 320.73; ATCC 24395; IMI 131652; NRRL 22107	Soil	M.M. Musa	Sudan	KM231001	KM231196	KM231371	KM231523	KM231799	KM231666	KM232218	KM232366	DQ247551	KM232061
	CBS 101018 ^T	<i>Rubus idaeus</i>	A. Zazzerini	Italy	KM231002	KM231197	KM231372	KM231524	KM231800	KM231667	KM232219	KM232367	KM231928	KM232062
<i>N. vasinfecta</i>	CBS 325.54; ATCC 16238; IFO 7591	Soil	H.J. Swart	South Africa	KM231005	KM231200	KM231375	KM231526	KM231803	KM231670	KM232222	KM232370	KM231931	KM232065
	CBS 562.70; ATCC 32363; IMI 251387	<i>Arachis hypogaea</i>	M.A. de Freitas Barbosa	Guinea	KM231007	–	KM231377	KM231528	KM231805	KM231672	KM232224	KM232372	KM231933	KM232067
	CBS 517.71; IMI 302626	Soil	P. Rama Rao	India	KM231006	KM231201	KM231376	KM231527	KM231804	KM231671	KM232223	KM232371	KM231932	KM232066
<i>Neonectria candida</i>	CBS 151.29; IMI 113894; MUCL 28083	<i>Malus sylvestris</i>	H.W. Wollenweber	UK	KM231044	KM231146	KM231315	JF735602	AY677291	HM042436	KM232168	DQ789792	DQ789723	DQ789863

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Table 1. (Continued)

Species	Isolate nr. ¹	Substrate	Collector/ Depositor	Locality	GenBank Accession No. ²									
					<i>act1</i>	<i>act</i>	<i>cmdA</i>	<i>his3</i>	ITS	LSU	<i>rpb1</i>	<i>rpb2</i>	<i>tef1</i>	<i>tub2</i>
<i>N. lugdunensis</i>	CBS 125485; DAOM 235831; TG 2008-07	<i>Populus fremontii</i>	T. Gräfenhan	USA	HQ897867	KM231145	KM231314	KM231482	KM231762	KM231625	KM232160	HQ897731	KM231887	KM232019
<i>N. neomacrospora</i>	CBS 324.61; DSM 62489	<i>Abies concolor</i>	J.A. von Arx	The Netherlands	KM231042	KM231144	KM231313	JF735599	JF735312	HM364318	HM364335	DQ789803	HM364335	DQ789875
	CBS 198.62; BBA 9628; IMI 113890	<i>Abies concolor</i>	W. Gerlach	Germany	KM231041	KM231143	KM231312	KM231481	AJ009255	HM364316	KM232167	DQ789795	JF735788	DQ789866
<i>N. tsugae</i>	CBS 788.69 ^T	<i>Tsuga heterophylla</i>	J.E. Bier	Canada	HQ897865	KM231147	KM231316	KM231483	KM231763	HQ232146	KM232161	HQ897728	DQ789720	KM232020
<i>Ophionectria trichospora</i>	CBS 314.75 ^T ; ATCC 28509; DAOM 139482; IMI 166077	Dead wood	R.P. Korf	Jamaica	–	KM231181	KM231354	–	KM231788	KM231652	KM232203	–	–	KM232047
	CBS 109876; GJS 01-155		G.J. Samuels	Cameroon	–	–	KM231442	–	–	AF543790	AY489669	DQ522457	AF543779	DQ522520
<i>Paracremonium contagium</i>	CBS 110348 ^T ; UAMH 10141	<i>Homo sapiens</i>	S. Mohan	Canada	KM231067	KM231240	KM231417	KM231570	KM231831	HQ232118	KM232262	KM232396	KM231966	KM232103
<i>P. inflatum</i>	CBS 485.77 ^T ; CDC 77-043179	<i>Homo sapiens</i>	A.A. Padhye	India	KM231065	KM231238	KM231415	KM231568	KM231829	HQ232113	KM232260	KM232394	KM231964	KM232101
	CBS 482.78	Soil	O. Rangel	Colombia	KM231066	KM231239	KM231416	KM231569	KM231830	KM231711	KM232261	KM232395	KM231965	KM232102
<i>Penicillifer bipapillatus</i>	CBS 420.88 ^T	Bark	C.T. Rogerson	Venezuela	KM230948	KM231105	KM231270	KM231454	KM231740	KM231608	KM232129	KM232295	KM231860	KM231996
<i>P. diparietisporus</i>	CBS 376.59 ^T ; ATCC 13214; IMI 100713; QM 7720	Soil	A.A. Foster	USA	KM230949	KM231106	KM231271	KM231455	KM231741	KM231609	KM232130	KM232296	KM231861	KM231997
<i>P. penicilliferi</i>	CBS 423.88 ^T ; GJS 87-48B	Unknown	G.J. Samuels	Guyana	KM230947	KM231104	KM231269	KM231453	KM231739	KM231607	KM232128	KM232294	KM231859	KM231995
<i>P. pulcher</i>	CBS 560.67 ^T ; ATCC 18931; MUCL 11607	Soil	J.H. van Emden	The Netherlands	KM230950	KM231107	KM231272	KM231456	KM231742	KM231610	KM232131	KM232297	KM231862	KM231998
<i>Pochonia</i> sp.	CBS 401.70; NRRL 26536	Myxomycete	W. Gams	The Netherlands	KM231089	KM231252	KM231439	KM231598	KM231843	AF339518	KM232276	KM232419	KM231980	KM232114
	CBS 892.72	<i>Arcyria</i> sp.	W. Gams	The Netherlands	KM231090	KM231253	KM231440	KM231599	KM231844	KM231724	KM232277	KM232420	KM231981	KM232115
	CBS 634.75	Myxomycete	W. Gams	The Netherlands	KM231091	KM231254	KM231441	–	KM231845	KM231725	KM232278	KM232421	KM231982	KM232116
<i>Pseudonectria buxi</i>	CBS 324.53	<i>Buxus sempervirens</i>	J.A. von Arx	The Netherlands	KM230984	KM231171	KM231344	KM231502	KM231778	KM231644	KM232194	KM232353	KM231909	KM232037
	CBS 114049; AR 2716	<i>Buxus sempervirens</i>	R. Lowen	Spain	KM230985	KM231172	KM231345	KM231503	KM231779	U17416	AY489670	KM232354	KM231910	KM232038
" <i>P. coronata</i> "	CBS 696.93	<i>Buxus sempervirens</i>	F. Candoussau	France	KM231086	–	KM231437	–	KM231840	KM231721	KM232273	KM232416	KM231977	KM232111
<i>P. foliicola</i>	CBS 122566; AR 2709	<i>Buxus sempervirens</i>	A.Y. Rossmann	USA	KM230983	KM231170	KM231343	KM231501	KM231777	KM231643	KM232193	–	KM231908	KM232036
	CBS 123190 ^T ; CPC 15385	<i>Buxus sempervirens</i>	S. Trower	New Zealand	KM230982	KM231169	KM231342	KM231500	KM231776	KM231642	KM232192	KM232352	KM231907	KM232035

Table 1. (Continued)

Species	Isolate nr. ¹	Substrate	Collector/ Depositor	Locality	GenBank Accession No. ²									
					<i>act1</i>	<i>act</i>	<i>cmdA</i>	<i>his3</i>	ITS	LSU	<i>rpb1</i>	<i>rpb2</i>	<i>tef1</i>	<i>tub2</i>
<i>Rectifusarium robinianum</i>	CBS 830.85; BBA 64246; NRRL 13953	<i>Solanum tuberosum</i>	H. Nirenberg	Germany	KM230992	–	KM231359	KM231511	KM231793	KM231656	JX171461	JX171575	KM231922	KM232052
	CBS 430.91 ^T ; NRRL 25729	<i>Robinia pseudoacacia</i>	U. Kuchenbäcker	Germany	HQ897907	–	KM231360	KM231512	KM231794	KM231657	JX171520	HQ897771	KM231923	KM232053
<i>R. ventricosum</i>	CBS 748.79 ^T ; BBA 62452; NRRL 20846; NRRL 22113	Soil	W. Gams	Germany	HQ897897	KM231186	KM231361	KM231513	HQ897816	KM231658	KM232208	HQ897761	KM231924	KM232054
<i>Rodentomyces reticulatus</i>	CBS 128675 ^T ; AR 4677; DSM 23301	Rodent dung	F. Doveri	Italy	KM231096	JF832480	KM231446	KM231603	JF832659	JF832717	KM232283	KM232426	JF832543	JF832910
<i>Rugonectria neobalansae</i>	CBS 125120; GJS 85-219	Dead tree	G.J. Samuels	Indonesia	KM231023	KM231129	KM231294	KM231466	KM231750	HM364322	KM232146	KM232321	KM231874	HM352869
<i>R. rugulosa</i>	CBS 126565; GJS 09-1245	Dead tree	Y. Hirooka	Venezuela	KM231024	KM231130	KM231296	KM231468	KM231749	KM231615	KM232145	KM232320	KM231873	KM232007
	CBS 129158		Y. Hirooka	USA	KM231025	JF832515	KM231295	KM231467	JF832661	JF832761	JF832836	KM232319	KM231872	JF832911
<i>Sarcopodium circinatum</i>	CBS 587.92; CCT 5383	Soil	G. Weber	Costa Rica	–	KM231180	KM231353	–	KM231787	KM231651	KM232202	KM232360	JF832545	KM232046
	CBS 100998; INIFAT C98/9	Leaf litter	R.F. Castañeda	Brazil	–	KM231179	KM231352	KM231507	KM231786	KM231650	KM232201	KM232359	KM231917	KM232045
<i>S. circinosetiferum</i>	CBS 100251; FMR 6354	Soil	A.M. Stchigel & M. Caldich	Argentina	KM230988	KM231175	KM231348	KM231590	KM231782	KM231646	KM232197	KM232356	KM231913	KM232041
	CBS 100252; FMR 6355	Soil	A.M. Stchigel & M. Caldich	Argentina	KM230987	KM231174	KM231347	KM231589	KM231781	KM231645	KM232196	KM232355	KM231912	KM232040
<i>S. flavolanatum</i>	CBS 112283	<i>Theobroma gileri</i>	H.C. Evans & R.H. Reeder	Ecuador	–	KM231178	KM231351	KM231506	KM231785	KM231649	KM232200	KM232358	KM231916	KM232044
	CBS 128370	Decaying wood	W.Y. Zhuang & N. Ye	China	KM230989	KM231177	KM231350	KM231505	KM231784	KM231648	KM232199	KM232357	KM231915	KM232043
<i>S. macalpinei</i>	CBS 115296; HKUCC 8395	<i>Viburnum odoratissimum</i>	K.D. Hyde	Hong Kong	–	KM231176	KM231349	KM231591	KM231783	KM231647	KM232198	–	KM231914	KM232042
<i>S. vanillae</i>	CBS 100582; PD 98/8/459-1	<i>Anthurium</i> sp.	J.W. Veenbaas-Rijks	Ecuador	KM230986	KM231173	KM231346	KM231504	KM231780	HQ232174	KM232195	–	KM231911	KM232039
<i>Sarocladium kiliense</i>	CBS 400.52	<i>Ficus carica</i>	J.M. Waterston	UK	KM231095	KM231258	KM231445	KM231602	KM231849	KM231729	KM232282	KM232425	KM231985	KM232119
<i>Septofusidium berlinense</i>	CBS 731.70		G.M. Oláh		KM231087	KM231250	–	KM231584	KM231841	KM231722	KM232274	KM232417	KM231978	KM232112
<i>S. herbarum</i>	CBS 265.58 ^T ; IMI 053581	<i>Urtica dioica</i>	C. Booth	UK	KM231088	KM231251	KM231438	KM231585	KM231842	KM231723	KM232275	KM232418	KM231979	KM232113
<i>Stachybotrys chartarum</i>	CBS 129.13		H.A. Dale		–	KM231268	KM231452	KM231588	KM231858	KM231738	KM232293	KM232434	KM231994	KM232127

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Table 1. (Continued)

Species	Isolate nr. ¹	Substrate	Collector/ Depositor	Locality	GenBank Accession No. ²									
					<i>act1</i>	<i>act</i>	<i>cmdA</i>	<i>his3</i>	ITS	LSU	<i>rpb1</i>	<i>rpb2</i>	<i>tef1</i>	<i>tub2</i>
<i>Stylonectria applanata</i>	CBS 125489; TG 2008-24	<i>Betula</i> sp.	T. Gräfenhan	Canada	HQ897873	KM231218	–	KM231547	HQ897803	KM231689	KM232239	HQ897739	KM231944	KM232083
<i>S. wegeliniana</i>	CBS 125490; TG 2009-03	<i>Haploycystis bicaudata</i>	H. Voglmayr	Austria	HQ897890	KM231219	KM231396	KM231548	KM231817	KM231690	KM232240	HQ897754	KM231945	KM232084
<i>Stylonectria</i> sp.	CBS 125491; TG 2007-21	Unknown Ascomycete	T. Gräfenhan	Germany	HQ897915	KM231220	KM231397	KM231549	HQ897829	KM231691	KM232241	HQ897779	KM231946	KM232085
<i>Thelonectria discophora</i>	CBS 125153; AR 4324	<i>Pinus radiata</i>	A.Y. Rossman	New Zealand	KM231049	HM352875	KM231327	KM231489	HM364294	HM364307	HM364326	KM232344	KM231897	HM352860
<i>T. olida</i>	CBS 215.67 ^T ; ATCC 16548; DSM 62520; IMI 116873	<i>Asparagus officinalis</i>	W. Gerlach	Germany	KM231050	HM352884	KM231325	KM231487	AY677293	HM364317	HM364334	KM232342	HM364345	KM232024
<i>T. trachosa</i>	CBS 112467 ^T ; GJS 92-45; IMI 352560	Bark	D. Bradford & G.J. Samuels	Scotland	KM231051	KM231155	KM231326	KM231488	AY677297	HM364312	HM364339	KM232343	KM231896	AY677258
<i>Thyronectria lamyi</i>	CBS 417.89	<i>Berberis vulgaris</i>	H. Schmid	Germany	KM231083	JF832516	KM231434	KM231597	KM231837	KM231718	JF832830	KM232413	JF832580	KM232108
<i>T. pyrrochlorella</i>	CBS 125131; AR 2786	<i>Acer campestre</i>	A.Y. Rossman	Austria	–	HM484512	–	KM231594	HM484545	HM484570	HM484584	KM232410	HM484519	HM484598
<i>T. quercicola</i>	CBS 128976 ^T ; AR 3805	<i>Quercus ilex</i>	J. Checa	Spain	–	JF832450	KM231433	KM231595	JF832624	JF832743	JF832831	KM232411	JF832581	JF832880
<i>T. sinopica</i>	CBS 462.83	<i>Hedera helix</i>	H.A. van der Aa	The Netherlands	KM231082	GQ505973	–	KM231596	HM484542	GQ506001	GQ506031	KM232412	HM484531	HM484595
<i>Tilachlidium brachiatum</i>	CBS 505.67	<i>Hypholoma fasciculare</i>	W. Gams	Poland	KM231085	KM231249	KM231436	–	KM231839	KM231720	KM232272	KM232415	KM231976	KM232110
	CBS 363.97	<i>Agaricus</i> sp.	W. Gams	France	KM231084	KM231248	KM231435	KM231583	KM231838	KM231719	KM232271	KM232414	KM231975	KM232109
<i>Trichosphaerella ceratophora</i>	CBS 130.82	<i>Carpinus betulus</i>	E. Müller	Switzerland	KM231093	KM231256	KM231443	KM231586	KM231847	KM231727	KM232280	KM232423	KM231983	KM232117
<i>Volutella ciliata</i>	CBS 483.61; CCT 5396; MUCL 9859	Soil	G.L. Baron	Canada	KM230975	KM231163	KM231336	KM231493	KM231770	KM231635	KM232186	–	HM364356	KM232028
<i>V. consors</i>	CBS 139.79; PD 78/836	Decaying orchid bulb	G.H. Boerema	The Netherlands	HQ897853	KM231161	KM231334	KM231491	KM231768	KM231633	KM232184	HQ897715	KM231899	KM232026
<i>V. minima</i>	CBS 122767	Soil	W. Gams	The Netherlands	KM230973	KM231160	KM231333	KM231490	KM231767	KM231632	KM232183	–	KM231898	KM232025
<i>V. rosea</i>	CBS 128258	Soil	P.A. Orpurt & J.T. Curtis	USA	KM230974	KM231162	KM231335	KM231492	KM231769	KM231634	KM232185	KM232348	KM231900	KM232027
<i>Xenoacromonium falcatus</i>	CBS 400.85 ^T	<i>Pinus radiata</i>	J. Reid	New Zealand	KM231068	–	KM231418	KM231571	KM231832	HQ232025	KM232263	–	KM231967	KM232104
<i>X. recifei</i>	CBS 137.35 ^T ; IHEM 4405; MUCL 9696	<i>Homo sapiens</i>	A.E. de Arêa Leão	Brazil	KM231069	KM231241	KM231419	KM231572	KM231833	HQ232106	KM232264	KM232397	KM231968	KM232105
	CBS 541.89	Soil	L. Pfenning	Brazil	KM231070	KM231242	KM231420	KM231573	KM231834	HQ232114	KM232265	KM232398	KM231969	KM232106
<i>Xenocylindrocladium guianense</i>	CBS 112179 ^T ; CPC 3496; MUCL 41975	Plant litter	C. Decock	French Guiana	KM230971	KM231124	KM231289	KM231463	AF317348	JQ666073	KM232166	KM232314	KM231895	AF320197

Table 1. (Continued)

Species	Isolate nr. ¹	Substrate	Collector/ Depositor	Locality	GenBank Accession No. ²									
					<i>act1</i>	<i>act</i>	<i>cmdA</i>	<i>his3</i>	ITS	LSU	<i>rpb1</i>	<i>rpb2</i>	<i>tef1</i>	<i>tub2</i>
<i>X. serpens</i>	CBS 128439 ^T ; MUCL 39315	Bark	G.L. Hennebert	Ecuador	KM230972	KM231125	KM231290	KM231464	AF220982	KM231688	KM232165	–	KM231894	AF320196
<i>X. subverticillatum</i>	CBS 113660 ^T ; CPC 3397; MUCL 41834	Plant litter	C. Decock & O. Laurence	Singapore	KM230970	KM231123	KM231288	KM231462	AF317347	KM231687	–	KM232313	KM231893	AF320196
<i>Xenoglocladiopsis cypellocarpa</i>	CBS 133814; CPC 19417	<i>Eucalyptus cypellocarpa</i>	P.W. Crous	Australia	KM231039	KM231141	KM231310	KM231479	KM231760	KM231623	KM232158	KM232332	KM231885	KM232017
<i>X. eucalyptorum</i>	CPC 17153	<i>Eucalyptus</i> sp.	P.W. Crous	Australia	KM231040	KM231142	KM231311	KM231480	KM231761	KM231624	KM232159	KM232333	KM231886	KM232018
	CBS 138758 ^T ; CPC 16271	<i>Eucalyptus</i> sp.	P.W. Crous	South Africa	KM231038	KM231140	KM231309	–	KM231759	KM231622	KM232157	KM232331	KM231884	KM232016

^T Ex-type and ex-epitype cultures.

¹ AR: Collection of A.Y. Rossman; ATCC: American Type Culture Collection, U.S.A.; BBA: Biologische Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlem, Germany; CBS: CBS-KNAW Fungal Biodiversity Centre, Utrecht, The Netherlands; CMW: Forestry and Agricultural Biotechnology Institute, University of Pretoria, Pretoria, South Africa; CCT: Colecao de Culturas Tropical, Fundacao Tropical de Pesquisas e Tecnologia "André Tosello", Campinas-SP, Brazil; CDC: Centers for Disease Control and Prevention, Atlanta, GA, USA; CLL: C. Lechat collection; CPC: P.W. Crous collection; CTR: C.T. Rogerson collection; DAOM: Agriculture and Agri-Food Canada National Mycological Herbarium, Canada; DSM: Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH, Braunschweig, Germany; FMR: Facultad de Medicina, Reus, Tarragona, Spain; GJS: Gary J. Samuels collection; HJS: Hans-Josef Schroers collection; HKUCC: University of Hong Kong Culture Collection, Department of Ecology and Biodiversity, Hong Kong, China; IFO: Institute for Fermentation, Osaka, Yodogawa-ku, Osaka, Japan; IHEM: Institute of Hygiene and Epidemiology-Mycology Laboratory, Brussels, Belgium; IMI: International Mycological Institute, CABI-Bioscience, Egham, Boreham Lane, U.K.; IMUR: Institute of Mycology, University of Recife, Recife, Brazil; INIFAT: INIFAT Fungus Collection, Ministerio de Agricultura Habana; KAS: K.A. Seifert collection; MRC: National Research Institute for Nutritional Diseases, Tygerberg, South Africa; MUCL: Mycothèque de l'Université Catholique de Louvain, Belgium; NBRC: NITE Biological Resource Center, Japan; NRRL: Agricultural Research Service Culture Collection, USA; PD: Collection of the Dutch National Plant Protection Organization (NPPO-NL), Wageningen, The Netherlands; PPRI: Plant Protection Research Institute, Pretoria, South Africa; PREM: National collection of Fungi, Agriculture Department, Pretoria, South Africa; QM: Quatermaster Research and Development Center, US Army, Natick, MA, USA; TG: T. Gräfenhan collection; UAMH: University of Alberta Mold Herbarium and Culture collection, Edmonton, Canada; UFV: Universidade Federal de Viçosa, Brazil.

² *act1*: large subunit of the ATP citrate lyase; *act*: α -actin; *cmdA*: calmodulin; *his3*: histone H3; ITS: the internal transcribed spacer region and intervening 5.8S nrRNA; LSU: 28S large subunit; *rpb1*: RNA polymerase II largest subunit; *rpb2*: RNA polymerase II second largest subunit; *tef1*: translation elongation factor 1-alpha; *tub2*: β -tubulin.

Table 2. Information on loci used in the phylogenetic analyses.

Locus ¹	Primers	Nucleotide substitution models	Included sites (# excluded sites)	Phylogenetically informative sites (%)	Uninformative polymorphic sites	Invariable sites
<i>acl1</i>	acl1-230up, acl1-1220low (Gräfenhan et al. 2011)	HKY+I+G	1620 (1103)	1281 (79 %)	235	104
<i>act</i>	ACT-512F (Carbone & Kohn 1999), ACT1Rd (Groenewald et al. 2013)	GTR+I+G	985 (476)	551 (56 %)	114	320
<i>cmdA</i>	CAL-228F (Carbone & Kohn 1999), CAL2Rd (Groenewald et al. 2013)	GTR+I+G	1209 (846)	919 (76 %)	103	187
<i>his3</i>	CYLH3F, CYLH3R (Crous et al. 2004b)	GTR+I+G	788 (431)	530 (67 %)	97	161
ITS	ITS5, ITS4 (White et al. 1990)	GTR+I+G	1008 (572)	619 (61 %)	184	205
LSU	LR0R (Rehner & Samuels 1994), LR5 (Vilgalys & Hester 1990)	GTR+I+G	874 (6)	316 (36 %)	101	457
<i>rpb1</i>	RPB1-Ac, RPB1-Cr (Matheny et al. 2002)	GTR+I+G	1489 (879)	1264 (85 %)	202	23
<i>rpb2</i>	RPB2-5F2, RPB2-7cR (O'Donnell et al. 2007)	GTR+I+G	1366 (557)	919 (67 %)	399	48
<i>tef1</i>	EF1-728F (Carbone & Kohn 1999), EF2 (O'Donnell et al. 1998)	GTR+I+G	1049 (850)	854 (81 %)	101	94
<i>tub2</i>	T1 (O'Donnell & Cigelnik 1997), CYLTUB1R (Crous et al. 2004b)	GTR+I+G	898 (561)	650 (72 %)	72	176

¹ *acl1*: large subunit of the ATP citrate lyase; *act*: α -actin; *cmdA*: calmodulin; *his3*: histone H3; ITS: the internal transcribed spacer region and intervening 5.8S nrRNA; LSU: 28S large subunit; *rpb1*: RNA polymerase II largest subunit; *rpb2*: RNA polymerase II second largest subunit; *tef1*: translation elongation factor 1-alpha; *tub2*: β -tubulin.

measurements were made at $\times 1\,000$ magnification using a Zeiss Axioscope 2 microscope with differential interference contrast (DIC) illumination. The 95 % confidence levels were determined for the conidial measurements with extremes given in parentheses while only extremes are provided for other structures. Colony morphology was assessed using 7-d-old cultures on MEA, OA and/or PDA and the colour charts of Rayner (1970). All descriptions, illustrations and nomenclatural data were deposited in MycoBank (Crous et al. 2004a).

RESULTS

Phylogenetic relationships

The multi-gene alignment length was 11 286 bases including gaps, for the 10 gene regions. The phylogenetic analyses included 206 ingroup taxa, with *Stachybotrys chartarum* (CBS 129.13) as an outgroup taxon. The congruence analyses detected one conflict for the placement of *Rodentomyces reticulatus* (CBS 128675) and *Sarocladium kiliense* (CBS 400.52), which could not be resolved without excluding both from the analyses. However, as these conflicts only involved the placement of single species, this was ignored and all partitions were combined following the argument of Cunningham (1997) that combining incongruent partitions could increase phylogenetic accuracy. All ambiguously aligned regions were excluded from the analyses (Table 2). The number of polymorphic and parsimony informative sites, and evolutionary model selected for each gene region are indicated in Table 2.

The Bayesian consensus tree confirmed the tree topology obtained from the ML analysis, and therefore only the ML consensus tree with bootstrap support values (BS) and posterior probability values (PP) are indicated for well-supported clades in Figs 1 and 2. Both Figs 1 and 2 represent the same underlying phylogenetic analyses, but are two different

representations of the obtained phylogenetic tree with Fig. 1 providing a collapsed leaf overview of the genera and families, and Fig. 2 providing details at strain level. In Fig. 1, 44 well-supported clades (BS ≥ 75 %; PP ≥ 0.95) were resolved in the super-clade representing the *Nectriaceae*. Of these, 33 clades represent established genera with the remaining 11 clades representing possible new genera. Three separate single lineages were also resolved within the *Nectriaceae* super-clade, representing *Corallonectria jatrophae* (CBS 913.96), *Calostilbe striispora* (CBS 133491) and *Dematiocladium celtidis* (CBS 115994).

Several clades, representing genera traditionally classified in the *Nectriaceae*, resolved in well-supported sister clades (BS ≥ 75 %; PP ≥ 0.95) of the *Nectriaceae* super-clade. Isolates representing the species in the genera *Tilachlidium* (CBS 363.97 & CBS 505.67) and *Septofusidium* (CBS 265.58 & CBS 731.70), along with an isolate listed as "*Pseudonectria coronata*" (CBS 696.93), formed a well-supported clade (BS ≥ 75 %; PP ≥ 0.95) basal to the *Nectriaceae* super-clade. Representatives of the genera *Aphanocladium* (CBS 401.70, CBS 634.75 & CBS 892.72; BS = 100 %, PP = 1.0), *Cilicipodium* (CBS 106.13 & CBS 691.83; BS ≥ 75 %, PP ≥ 0.95), *Cylindrium* (CBS 685.83A, CBS 693.83 & CBS 115974; BS = 100 %, PP = 1.0) and *Falcocladium* (CBS 111292, CBS 121717 & CBS 120386; BS ≥ 75 %, PP ≥ 0.95), each formed separate clades outside the *Nectriaceae* super-clade.

Treatment of genera (Fig. 2)

Based on phylogenetic inference supported by morphological observations, several novel taxa were identified in this study. Recognised clades, as well as novel families, genera and species are described and discussed below. Only generic circumscriptions are provided for known taxa where the descriptions are available in MycoBank, or in recently published scientific papers.

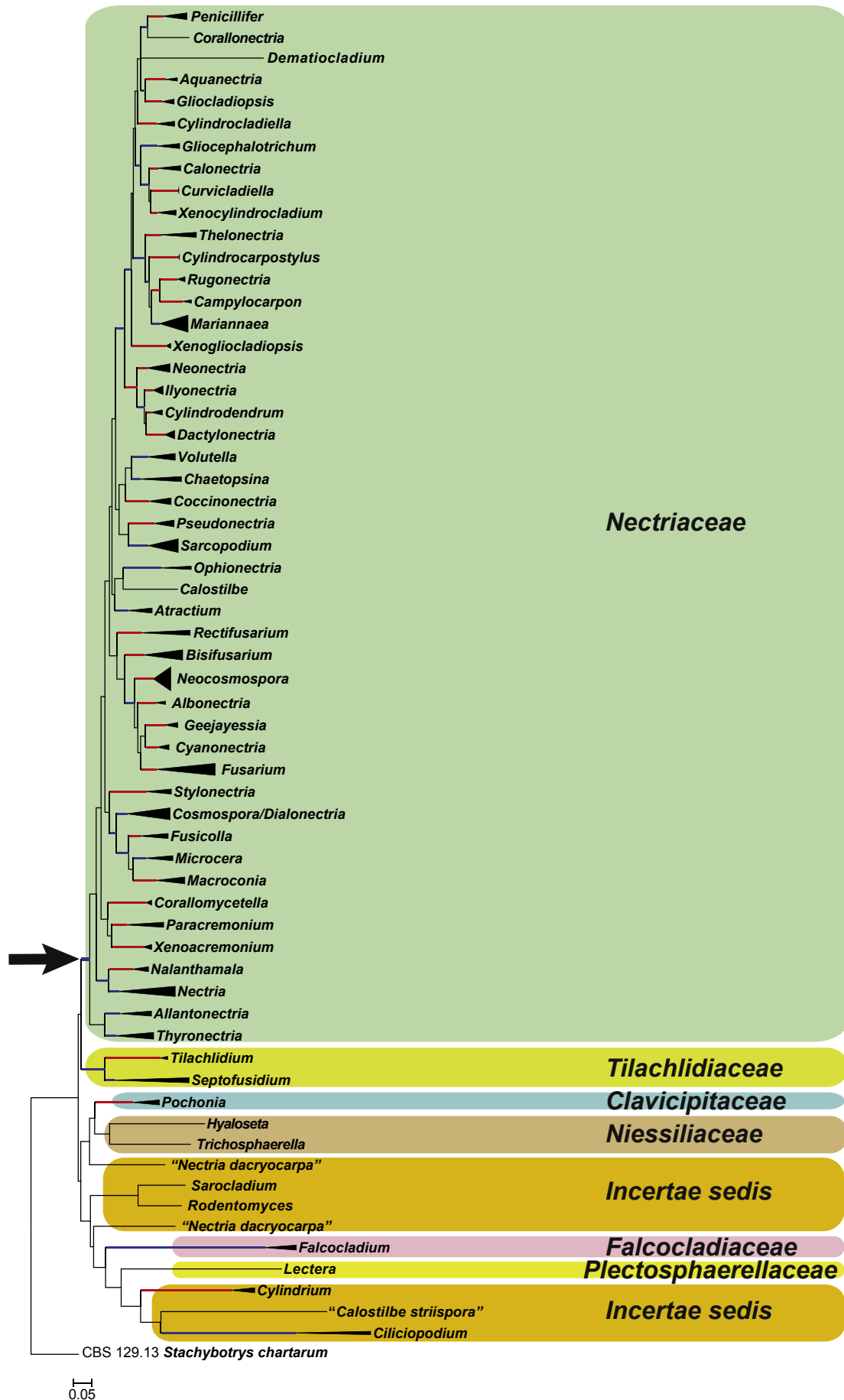


Fig. 1. Maximum Likelihood (ML) consensus tree inferred from the combined 10 genes sequence data set providing a collapsed leaf overview of the genera and families. Thickened branches indicate branches present in both the ML and Bayesian consensus trees. Branches with BS = 100 % and PP = 1.0 are in red. Branches with BS \geq 75 % and PP \geq 0.95 are in blue. The tree is rooted to *Stachybotrys chartarum* (CBS 129.13). The arrow indicates the most basal node representing *Nectriaceae*.

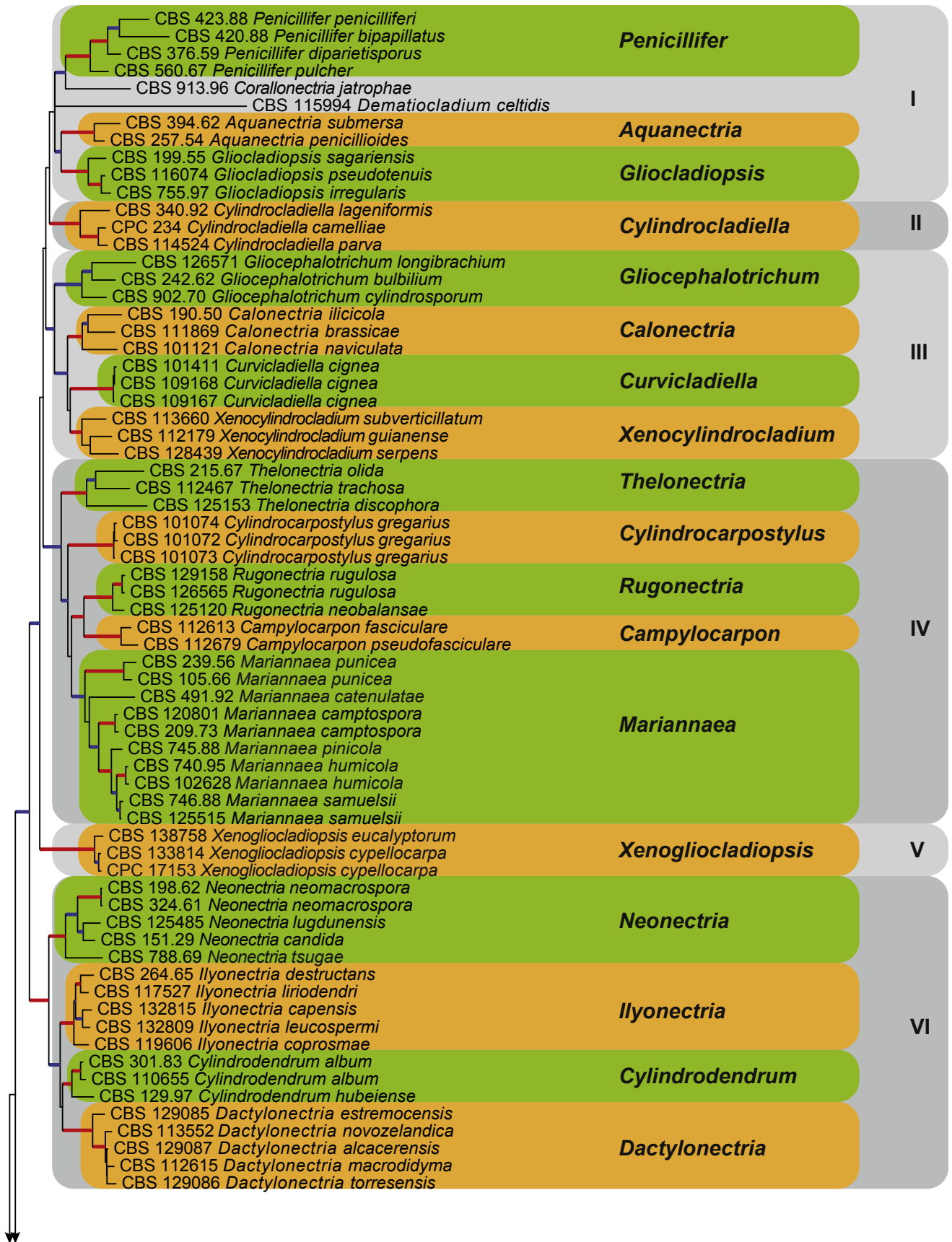


Fig. 2. The ML consensus tree inferred from the combined 10 genes sequence data set. Thickened branches indicate branches present in both the ML and Bayesian consensus trees. Branches with BS = 100 % and PP = 1.0 are in red. Branches with BS ≥ 75 % and PP ≥ 0.95 are in blue. The tree is rooted to *Stachybotrys chartarum* (CBS 129.13). Clade numbers are provided to the right of the tree and these are used for reference in the Treatment of Genera section. Coloured blocks represent the accepted genera.

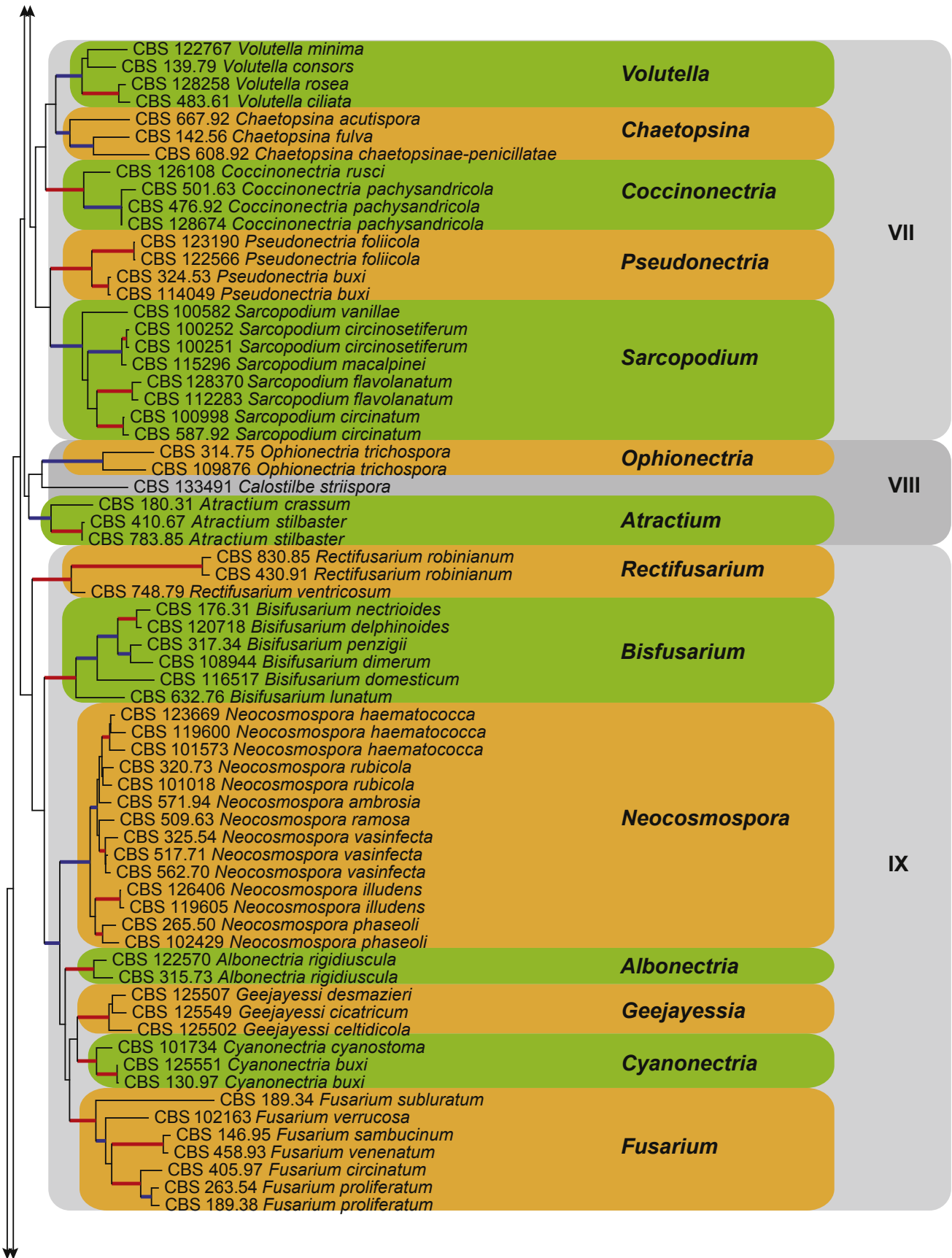


Fig. 2. (Continued).

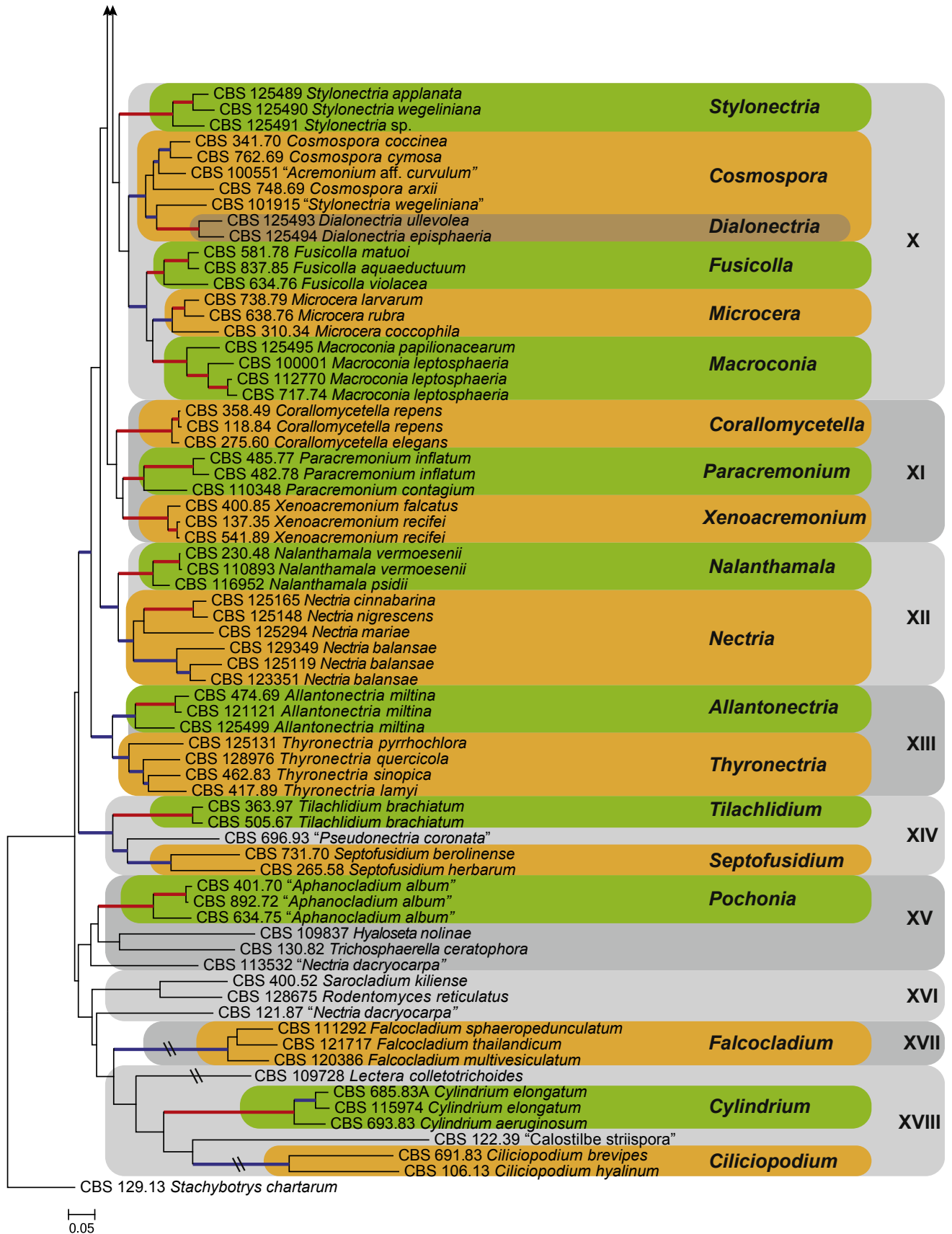


Fig. 2. (Continued).

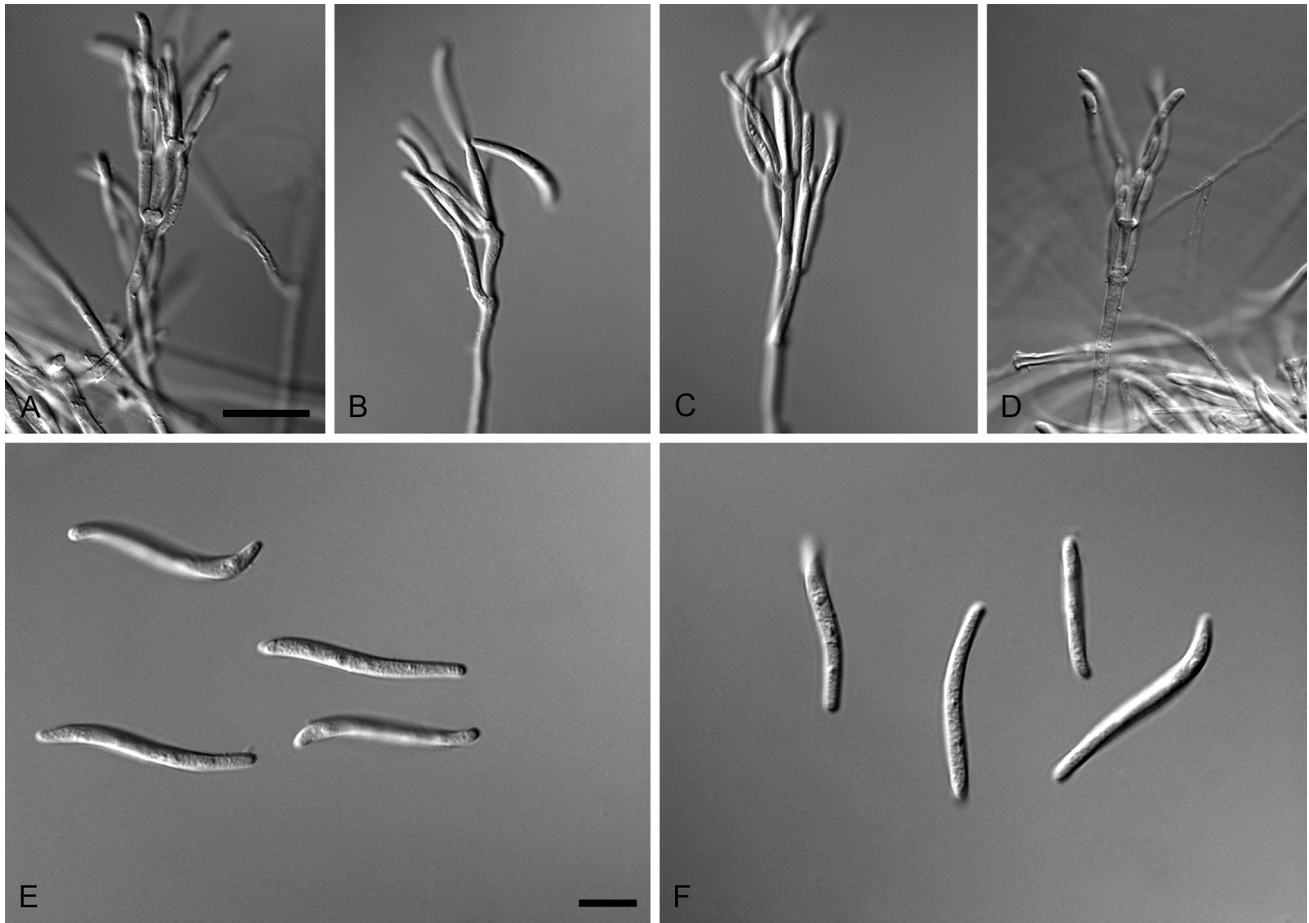


Fig. 3. *Aquanectria penicillioides* (CBS 257.54). A–D. Conidiophores. E–F. Conidia. Scale bars: A = 20 µm (apply to B–D); E = 10 µm (apply to F).

Clade I

Aquanectria L. Lombard & Crous, **gen. nov.** MycoBank MB810949.

Etymology: Name refers to the aquatic niche of these fungi.

Ascomata perithecial, superficial, scattered or aggregated in groups, ovate to subglobose, collapsing laterally when old, brown-orange to orange-red, with papillate ostiolar region. *Asci* cylindrical to clavate, 8-spored. *Ascospores* ellipsoid to fusiform, hyaline, 1-septate, with a slight constriction at the septum. *Conidiophores* in aquatic environment erect, solitary, septate, hyaline, branched, with verticillate penicillus with 1–4 phialides. *Phialides* cylindrical, tip with periclinal thickening, collarette often tubular, not flared. *Conidia* filiform, curved to slightly sigmoid, aseptate to 1-septate, hyaline, smooth. *Chlamydoconidia* formed intercalary, pale to dark brown, containing a large oil guttule, aggregating to form sclerotia (adapted from Ingold 1942 and Ranzoni 1956).

Type species: *Aquanectria penicillioides* (Ingold) L. Lombard & Crous.

Notes: The aquatic genus *Aquanectria* is established here to accommodate two fungal species previously treated as members of the genera *Flagellospora* and *Heliscus* (Ingold 1942, Ranzoni 1956, Hudson 1961). Recent studies (Baschien *et al.* 2013, Duarte *et al.* 2015) showed that species in the aquatic genus *Flagellospora* belongs to the

Helotiales based on the type species, *F. curvula*. Furthermore, Lombard *et al.* (2014b) synonymised the genus *Heliscus*, based on the type species *H. lugdunensis*, under the genus *Neonectria*. In this study, CBS 257.54 (= *F. penicillioides*) clustered with the ex-type strain (CBS 394.62) of *Heliscus submersus* in a well-supported clade (BS = 100, PP = 1.0) sister to the clade representing the genus *Gliocladiopsis*. Therefore, new combinations are required to accommodate these fungi in the genus *Aquanectria* with *A. penicillioides* as type.

Aquanectria penicillioides (Ingold) L. Lombard & Crous, **comb. nov.** MycoBank MB810950. Fig. 3.

Basionym: *Flagellospora penicillioides* Ingold, Trans. Brit. Mycol. Soc. 27: 44. 1942.

= *Nectria penicillioides* Ranzoni, Amer. J. Bot. 43: 17. 1956.

Material examined: USA, California, Napa County, Green Valley Falls, on decaying leaves of *Acer* sp. submerged in a stream, Dec. 1954, F.V. Ranzoni, culture CBS 257.54.

Descriptions and illustrations: Ingold (1942), Ranzoni (1956).

Aquanectria submersa (H.J. Huds.) L. Lombard & Crous, **comb. nov.** MycoBank MB810162.

Basionym: *Heliscus submersus* H.J. Huds., Trans. Brit. Mycol. Soc. 44: 91. 1961.

Material examined: Jamaica, St. Andrew, Hardwar Gap, on decaying leaves submerged in a stream, 1960, H.J. Hudson, (**holotype** IMI 76792 (not seen), culture ex-type CBS 394.62, sterile).

Description and illustration: Hudson (1961).

Notes: Based on the description provided by Hudson (1961), the fungus formerly known as *Heliscus submersus* belongs to the genus *Aquanectria* supported by phylogenetic inference in this study. Hudson (1961) placed this fungus in the aquatic fungal genus *Heliscus*, as the conidia formed two conical arms at the apex. Other members of the genus *Heliscus*, however, are known to produce three or more conical arms at the apex (Saccardo 1880, Ingold 1942, Webster 1959). The two conical arms of *A. submersa* could either represent an atypical character for this species or the initiation of germination tubes at the apex of the conidia. The morphology of *A. submersa* could not be confirmed, as the ex-type strain could not be induced to sporulate by the addition of sterile water, carnation leaf pieces and/or toothpicks to the culture surface.

Corallonectria C. Herrera & P. Chaverri, *Mycosystema* 32: 539. 2013. MycoBank MB803108.

Ascomata perithecial, seated on short red stalks, in clusters of two or more, ovoid to obpyriform, not collapsing or collapsing when pinched laterally, orange-red to scarlet, with white to yellow furfuraceous coating below apex, apex acute, smooth, scarlet. *Asci* clavate, apex simple, 8-spored arranged biserially. *Ascospores* smooth, fusiform-ellipsoid, sometimes reniform, 1-septate, often slightly constricted at septum, pale brown when discharged. *Synnemata* and *rhizomorphs* formed in culture. *Synnemata* cylindrical, slender to robust, straight to curved, rarely branching, appearing furfuraceous with loose, white hyphae, with a terminal cupulate capitulum, pale luteous. *Rhizomorphs* dichotomously branched, immersed in agar. *Conidiophores* unbranched or once simple monochasial or monoverticillate. *Phialides* cylindrical and hyaline. Conidial mass forming inside cupulate capitula, flame-shaped, luteous. *Conidia* fusarium-like, long-fusiform, slightly curved at the apical and basal ends, apical cell acute, basal cell pedicellate, hyaline, 3–4(–5)-septate (adapted from Herrera et al. 2013a).

Type species: *Corallonectria jatrophae* (A. Møller) C. Herrera & P. Chaverri, *Mycosystema* 32: 539. 2013. MycoBank MB803109.

≡ *Corallomyces jatrophae* A. Møller, *Bot. Mitt. Trop.* 9: 295. 1901, nom. illeg., Art. 53.

≡ *Nectria jatrophae* (A. Møller) Wollenw., *Handb. Pflanzenkrankh.*: 560. 1931.

≡ *Corallomycetella jatrophae* (A. Møller) Rossman & Samuels, *Stud. Mycol.* 42: 114. 1999.

= *Nectria madeirensis* Henn., *Hedwigia* 43: 244. 1904.

= *Macbridella amazonensis* Bat., J.L. Bezerra & C.R. Almeida, *Anais XIV Congr. Soc. Bot. Brasil.* 118. 1964.

≡ *Nectria amazonensis* (Bat., J.L. Bezerra & C.R. Almeida) Samuels, *Canad. J. Bot.* 51: 1278. 1973.

Description and illustrations: Herrera et al. (2013b).

Notes: *Corallonectria* is a monotypic genus with *C. jatrophae* as type species. Our phylogeny placed the ex-type isolate (CBS 913.96) of *C. jatrophae* basal to the clade representing *Penicillifer* (= *Viridispora*).

Dematiocladium Algr. et al., *Mycol. Res.* 109: 836. 2005. MycoBank MB28939.

Ascomatal state not known. *Setae* arising from pseudoparenchymatous cells in a basal stroma, adjacent to cells that give rise to conidiophore stipe, extending beyond the conidiophores; setae unbranched, straight to flexuous, brown, verruculose, thick-walled with basal cell initially smooth, becoming brown with age, tapering from a base which is either rounded and well-defined, or cylindrical and continuous with the cells in the pseudoparenchymatous stroma, to an acutely or subobtusely rounded apex, which is pale brown, thin-walled towards the apex; apical cell sometimes becoming fertile with age, forming an apical penicillate conidiophore. *Conidiophores* consist of a stipe, a penicillate arrangement of fertile branches, and rarely, an extension of the stipe, signifying continued growth and eventual branching of stipe and secondary penicillate conidiophores. *Stipe* septate, hyaline, smooth, brown at the base, arising from tightly arranged pale to medium brown pseudoparenchymatous cells in a basal stroma, frequently terminating in a swollen, globose apical cell, giving rise to 1–6 primary branches. *Conidiogenous apparatus* branched (–4), hyaline, smooth, with terminal branches producing 1–6 phialides. *Phialides* elongate doliiiform to reniform or subcylindrical, straight to slightly curved, aseptate; apex with minute periclinal thickening and inconspicuous collarette. *Conidia* cylindrical, rounded at both ends, straight, hyaline, 1(–2)-septate, lacking a visible abscission scar, held in parallel clusters by colourless slime. *Chlamydo-spores* globose, thick-walled, brown, in intercalary chains (adapted from Crous et al. 2005).

Type species: *Dematiocladium celtidis* Algr. et al., *Mycol. Res.* 109: 836. 2005. MycoBank MB344508.

Description and illustrations: Crous et al. (2005).

Notes: *Dematiocladium celtidis* (ex-type CBS 115994) formed a single lineage basal to the clade representing the genus *Penicillifer* and the single lineage representing *Corallonectria jatrophae*. Recently, Crous et al. (2014) introduced a second species in this genus, *D. celtidicola* from China, which was not available for this study at the time.

Gliocladiopsis S.B. Saksena, *Mycologia* 46: 662. 1954. MycoBank MB8341.

= *Glionectria* Crous & C. L. Schoch, *Stud. Mycol.* 45: 58. 2000.

Ascomata perithecial, superficial, densely gregarious, seated on a thin basal stroma, obovoid to broadly obpyriform, collapsing laterally when drying, warted, red-brown with a dark red stromatic base, changing to dark red in KOH. *Asci* unitunicate, 8-spored, cylindrical, sessile, with a flattened apex, and a refractive apical apparatus. *Ascospores* uniseriate, overlapping, hyaline, ellipsoidal, smooth, medianly 1-septate. *Conidiomata* sporodochial, consisting of numerous aggregated penicillate conidiophores, or reduced to separate penicillate or subverticillate conidiophores. *Conidiophores* monomorphic, penicillate, consisting of a stipe and a penicillate arrangement of fertile branches, rarely dimorphic, penicillate and subverticillate. *Stipe* septate, hyaline, smooth. *Conidiogenous apparatus* with several series of aseptate or 1-septate branches, each terminal branch producing 2–6(–7) phialides. *Phialides* doliiiform to cymbiform to cylindrical, hyaline, aseptate, apex with minute periclinal thickening and inconspicuous collarette. *Conidia* cylindrical, rounded

at both ends, straight to curved, (0–)1-septate, lacking visible abscission scars, but frequently with a flattened base, held in fascicles by colourless slime (adapted from [Saksena 1954](#) and [Lombard & Crous 2012](#)).

Type species: *Gliocladiopsis sagariensis* S.B. Saksena, *Mycologia* 46: 663. 1954. MycoBank MB297822.

Descriptions and illustrations: [Saksena \(1954\)](#), [Crous \(2002\)](#), [Lombard & Crous \(2012\)](#).

Notes: Representative strains of the genus *Gliocladiopsis* formed a monophyletic clade (BS = 100 %, PP = 1.0) sister to the clade representing the aquatic genus *Aquanectria*. Interestingly, these two genera clustered together in a larger clade (BS ≥ 75 %, PP ≥ 0.95), even though they do not share the same ecological niche. *Gliocladiopsis* species are characteristically soil-borne ([Lombard & Crous 2012](#)). The genera do, however, share similar conidiophore morphology.

Penicillifer Emden, *Acta Bot. Neerl.* 17: 54. 1968. MycoBank MB9256.

= *Viridispota* Samuels & Rossman, *Stud. Mycol.* 42: 166. 1999.

Ascomata non-stromatic, superficial, solitary, globose to pyriform, red, orange-brown, tan, or brown, not reacting or changing to red in KOH, coarsely warted or glabrous. *Asci* clavate, apex simple. *Ascospores* green, 1-septate and smooth. *Conidiophores* erect, solitary, septate, hyaline, unbranched and monophialidic, or with a biverticillate penicillus. *Phialides* cylindrical, tip with periclinal thickening, collarette often tubular, not flared. *Conidia* cylindrical to slightly naviculate, 1-septate, hyaline, smooth, with blunt papilla at one or both ends (adapted from [Samuels 1989](#) and [Rossman et al. 1999](#)).

Type species: *Penicillifer pulcher* Emden, *Acta Bot. Neerl.* 17: 54. 1968. MycoBank MB335703.

Descriptions and illustrations: [Samuels \(1989\)](#), [Polishook et al. \(1991\)](#), [Rossman et al. \(1999\)](#).

Notes: The sexual genus *Viridispota* was established by [Rossman et al. \(1999\)](#) to accommodate species in the genera *Nectria* ([Samuels 1989](#), [Watanabe 1990](#)) and *Neocosmospora* ([Polishook et al. 1991](#)) that had *Penicillifer* asexual morphs. *Penicillifer* was introduced by [Emden \(1968\)](#), typified by *P. pulcher*, for a fungus isolated from soil in the Netherlands. At present, the genus *Viridispota* accommodates four species, *V. alata* (= *P. bipapillatus*), *V. diparietispora* (= *P. furcatus*), *V. fragariae* (= *P. fragariae*) and *V. penicilliferi* (= *P. macrosporus*), each with its own *Penicillifer* asexual morphs ([Samuels 1989](#), [Watanabe 1990](#), [Polishook et al. 1991](#), [Rossman et al. 1999](#)). So far, only *P. japonicus* ([Matsushima 1985](#)) has no associated sexual morph. Because the generic name *Penicillifer* (1968) is older than *Viridispota* (1999) for this monophyletic group of fungi (BS = 100 %, PP = 1.0), we propose that the sexual morph, *Viridispota*, be suppressed in favour of the asexual morph, *Penicillifer*. A new combination is, however, required for *P. furcatus*, as the epithet *Pseudonectria diparietispora* (1957) pre-dates that of *Penicillifer furcatus* (1991) and is provided below.

Penicillifer diparietispora (J.H. Miller, Giddens & A.A. Foster) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810951.

Basionym: *Pseudonectria diparietispora* J.H. Miller, Giddens & A.A. Foster, *Mycologia* 49: 793. 1957 (1958, as '*diparietispora*').

≡ *Neocosmospora diparietispora* (J.H. Miller, Giddens & A.A. Foster) Rossman, Samuels & Lowen, *Mycologia* 85: 699. 1993.

≡ *Viridispota diparietispora* (J.H. Miller, Giddens & A.A. Foster) Samuels & Rossman, *Stud. Mycol.* 42: 167. 1999.

= *Neocosmospora arxii* Udagawa, Horie & P. Cannon, *Sydowia* 41: 353. 1989.

= *Neocosmospora endophytica* Polishook, Bills & Rossman, *Mycologia* 83: 798. 1991.

= *Penicillifer furcatus* Polishook, Bills & Rossman, *Mycologia* 83: 798. 1991.

Clade II

Cylindrocladiella Boesew., *Canad. J. Bot.* 60: 2289. 1982. MycoBank MB7869.

= *Nectriadiella* Crous & C. L. Schoch, *Stud. Mycol.* 45: 54. 2000.

Ascomata perithecial, superficial, solitary, basal stroma absent, globose to obpyriform, collapsing laterally when dry, smooth, with several minute, brown setae arising from the perithecial wall surface, red, changing colour in KOH, ostiole consisting of clavate cells, lined with inconspicuous periphyses. *Asci* unitunicate, 8-spored, cylindrical, sessile, thin-walled, with a flattened apex, and a refractive apical apparatus. *Ascospores* uniseriate, overlapping, hyaline, ellipsoid to fusoid with obtuse ends, smooth, 1-septate. *Conidiophores* monomorphic, penicillate, or dimorphic (penicillate and subverticillate), mononematous, hyaline. Penicillate conidiophores consist of a stipe, a penicillate arrangement of fertile branches, a stipe extension, and a terminal vesicle. Subverticillate conidiophores consist of a stipe, and one or two series of phialides. *Stipe* septate, hyaline, smooth. *Stipe extensions* aseptate, straight, thick-walled, with one basal septum, terminating in a thin-walled vesicle of characteristic shape. *Conidiogenous apparatus* with primary branches aseptate to 1-septate, secondary branches aseptate, terminating in 2–4 phialides. *Phialides* cylindrical, straight or doliform to reniform to cymbiform, hyaline, aseptate, apex with minute periclinal thickening and collarette. *Conidia* cylindrical, rounded at both ends, straight, (0–)1(–)3-septate, frequently slightly flattened at the base, held in asymmetrical clusters by colourless slime. *Chlamydospores* brown, thick-walled, more frequently arranged in chains than clusters (adapted from [Boesewinkel 1982](#) and [Lombard et al. 2012](#)).

Type species: *Cylindrocladiella parva* (P.J. Anderson) Boesew., *Canad. J. Bot.* 60: 2289. 1982.

≡ *Cylindrocladium parvum* P.J. Anderson, *Mass. Agric. Exp. Sta. Bull.* 183: 37. 1919.

Descriptions and illustrations: [Boesewinkel \(1982\)](#), [Lombard et al. \(2012\)](#).

Note: Representatives strains of the genus *Cylindrocladiella* formed a monophyletic clade (BS = 100 %, PP = 1.0), sister to the members of Clade I.

Clade III

Calonectria De Not., *Comment. Soc. Crittog. Ital.* 2: 477. 1867. MycoBank MB746.

- = *Cylindrocladium* Morgan, Bot. Gaz. 17: 191. 1892.
 = *Candelospora* Rea & Hawley, Proc. Roy. Irish Acad., B. 13: 11. 1912.

Ascomata perithecial, solitary or in groups, globose to subglobose to ovoid, yellow to orange to red or red-brown to brown, turning darker red to red-brown in KOH, rough-walled; perithecial apex consisting of flattened, thick-walled hyphal elements with rounded tips forming a palisade, discontinuous with warty wall, gradually becoming thinner towards the ostiolar canal, and merging with outer periphyses; perithecial base consisting of dark brown-red, angular cells, merging with a erumpent stroma, cells of the outer wall layer continuing into the pseudoparenchymatous cells of the erumpent stroma. *Asci* 8-spored, clavate, tapering to a long thin stalk. *Ascospores* aggregated in the upper third of the ascus, hyaline, smooth, fusoid with rounded ends, straight to sinuous, unstricted, or constricted at the septa. *Megaconidiophores* if present, borne on the agar surface or immersed in the agar; stipe extensions mostly absent; conidiophores unbranched, terminating in 1–3 phialides, or sometimes with a single subterminal phialide; phialides straight to curved, cylindrical, seemingly producing a single conidium; periclinal thickening and an inconspicuous, divergent collarette rarely visible. *Megaconidia* hyaline, smooth, frequently remaining attached to the phialide, multi-septate, widest in the middle, bent or curved, with a truncated base and rounded apical cell. *Macroconidiophores* consist of a stipe, a penicillate arrangement of fertile branches, a stipe extension, and a terminal vesicle; stipe septate, hyaline or slightly pigmented at the base, smooth or finely verruculose; stipe extensions septate, straight to flexuous, mostly thin-walled, terminating in a thin-walled vesicle of characteristic shape. *Conidiogenous apparatus* with 0–1-septate primary branches; up to eight additional branches, mostly aseptate, each terminal branch producing 1–6 phialides; phialides cylindrical to allantoid, straight to curved, or doliiform to reniform, hyaline, aseptate, apex with minute periclinal thickening and inconspicuous divergent collarette. *Macroconidia* cylindrical, rounded at both ends, straight or curved, widest at the base, middle, or first basal septum, 1- to multi-septate, lacking visible abscission scars, held in parallel cylindrical clusters by colourless slime. *Microconidiophores* consist of a stipe and a penicillate or subverticillate arrangement of fertile branches. Primary branches 0–1-septate, subcylindrical; secondary branches 0–1-septate, terminating in 1–4 phialides; phialides cylindrical, straight to slightly curved, apex with minute periclinal thickening and marginal frill. *Microconidia* cylindrical, straight to curved, rounded at apex, flattened at base, 1(–3)-septate, held in asymmetrical clusters by colourless slime (adapted from Crous 2002).

Type species: *Calonectria pyrochroa* (Desm.) Sacc., Michelia 1: 308. 1878.

- ≡ *Nectria pyrochroa* Desm., Bull. Soc. Bot. France 4: 998. 1857.
 = *Calonectria daldiniana* De Not., Comment. Soc. Crittog. Ital. 2: 477. 1867.
 = *Ophionectria puiggarii* Speg., Bol. Acad. Nac. Ci. 11: 532. 1889.
 = *Nectria abnormis* Henn., Hedwigia 36: 219. 1897.
 = *Cylindrocladium ilicicola* (Hawley) Boedijn & Reitsma, Reinwardtia 1: 57. 1950.
 ≡ *Candelospora ilicicola* Hawley, Proc. Roy. Irish Acad., B. 31: 11. 1912.

Descriptions and illustrations: Rossman et al. (1999), Crous (2002), Lombard et al. (2010b).

Notes: Representative strains of the genus *Calonectria* formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related to the

clades representing *Curviciadiella* and *Xenocylindrocladium*, respectively. Based on the ICN for algae, fungi and plants, new combinations are required for *C. morganii* and *C. scoparia* as there are older epithets available for both species.

Calonectria candelabra (Viégas) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810952.

Basionym: *Cylindrocladium candelabrum* Viégas, Bragantia 6: 370. 1946.

= *Calonectria scoparia* Ribeiro & Matsuoka, In: Ribeiro, M.Sc. Thesis, Heterotalismo em *C. scoparium* Morgan: 28. 1978 (nom. inval., Art. 29).

≡ *Calonectria scoparia* Peeraly, Mycotaxon 40: 341. 1991.

Calonectria cylindrospora (Ellis & Everh.) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810953.

Basionym: *Diplocladium cylindrosporum* Ellis & Everh., Bull. Torrey Bot. Club 27: 58. 1900.

= *Cylindrocladium scoparium* Morgan, Bot. Gaz. 17: 191. 1892.

= *Cylindrocladium pithecolobii* Petch, Ann. Roy. Bot. Gard. (Peradeniya) 6: 244. 1917.

= *Cylindrocladium ellipticum* Alfieri, C.P. Seym. & Sobers, Phytopathology 60: 1213. 1970.

= *Calonectria morganii* Crous, Alfenas & M.J. Wingf. Mycol. Res. 97: 706. 1993.

Curviciadiella Decock & Crous, Stud. Mycol. 55: 225. 2006. MycoBank MB500866.

Ascomatal state unknown. *Conidiomata* sporodochial or synnematal, consisting of numerous penicillate conidiophores arising from a stroma of brown, thick-walled chlamydospores. *Conidiophores* consist of a thick-walled, smooth to finely verruculose, septate, pale brown to brown basal stipe, a conidiogenous apparatus and several sterile stipe extensions that have 1(–2) apical and one basal septum; stipe extensions aviculate; apical cell thick-walled, verruculose, pale brown, prominently curved, tapering towards a bluntly rounded acute apex. *Conidiogenous apparatus* with several hyaline, smooth, subcylindrical, straight to slightly curved conidiophore branches; phialides hyaline, smooth, doliiform to reniform or subcylindrical, apex with minute periclinal thickening, and inconspicuous, flared collarette. *Conidia* cylindrical, septate, lacking a visible abscission scar, held in heads of colourless slime. *Chlamydospores* arranged intercalarily, often aggregating to form microsclerotia (adapted from Decock & Crous 1998 and Crous et al. 2006).

Type species: *Curviciadiella cigneae* Decock & Crous, Stud. Mycol. 55: 225. 2006.

Descriptions and illustrations: Decock & Crous (1998), Crous et al. (2006)

Note: The monotypic genus *Curviciadiella* formed a well-supported clade (BS = 100 %, PP = 1.0) closely related to the genera *Calonectria* and *Xenocylindrocladium*.

Gliocephalotrichum J.J. Ellis & Hesselt., Bull. Torrey Bot. Club 89: 21. 1962. MycoBank MB8340.

Ascomata perithecial, superficial, globose to subglobose, scarlet, turning purple in KOH, with a white to pale luteous amorphous coating and hyphal stromatic base. *Asci* unitunicate, narrowly clavate, 8-spored, with flattened apex and a minute refractive ring. *Ascospores* hyaline, ellipsoidal, smooth, aseptate.



Fig. 4. *Xenocyliandrocladium serpens* (ex-type CBS 128439). A–C. Conidiophores. D–G. Conidiogenous apparatus with doliform to reniform phialides. H–I. Avesiculate stipe extensions. J. Conidia. K. Chlamydozoospores. Scale bars: A = 50 μm (apply to B–C); D = 10 μm (apply to E–G); H = 10 μm (apply to I–K).

Conidiophores consisting of a septate, hyaline, pale luteous to pale brown stipe and a penicillate arrangement of fertile branches subtended by septate stipe extensions. *Stipe extensions* hyaline, septate, terminating in narrowly to broadly clavate vesicles. *Conidiogenous apparatus* with a series of aseptate, hyaline to pale brown branches, each terminating in 2–8 phialides. *Phialides* clavate to cylindrical, hyaline, aseptate, constricted at the apex, with minute periclinal thickening. *Conidia* cylindrical to ellipsoidal, straight to slightly curved, aseptate, accumulating in a white to luteous mucoid mass above the phialides (adapted from Rossman *et al.* 1993 and Lombard *et al.* 2014a).

Type species: *Gliocephalotrichum bulbilium* J.J. Ellis & Hesselt., Bull. Torrey Bot. Club 89: 21. 1962.

Descriptions and illustrations: Rossman *et al.* (1993), Lombard *et al.* (2014a).

Notes: Species of *Gliocephalotrichum* are soil-borne fungi generally associated with post-harvest fruit spoilage of several important tropical fruit crops (Lombard *et al.* 2014a). Representatives of *Gliocephalotrichum* clustered in a monophyletic clade ($\text{BS} \geq 75\%$, $\text{PP} \geq 0.95$), basal to the clades representing *Calonectria*, *Curviciadiella* and *Xenocyliandrocladium*.

Xenocyliandrocladium Decock *et al.*, Mycol. Res. 101: 788. 1997. MycoBank MB27788. Fig. 4.

= *Xenocalonectria* Crous & C.L. Schoch, Stud. Mycol. 45: 50. 2000.

Ascomata perithecial, superficial, solitary or aggregated, globose to subglobose, warty, yellow to red and with a dark red stromatic base; ostiolar periphyses hyaline, tubular with rounded ends. *Asci* unitunicate, 8-spored, cylindrical, with long basal stalks, a flattened apex, and a refractive apical apparatus. *Ascospores* aggregate in the upper third of the ascus, hyaline, broadly to narrowly ellipsoidal, smooth, medianly 1-septate.

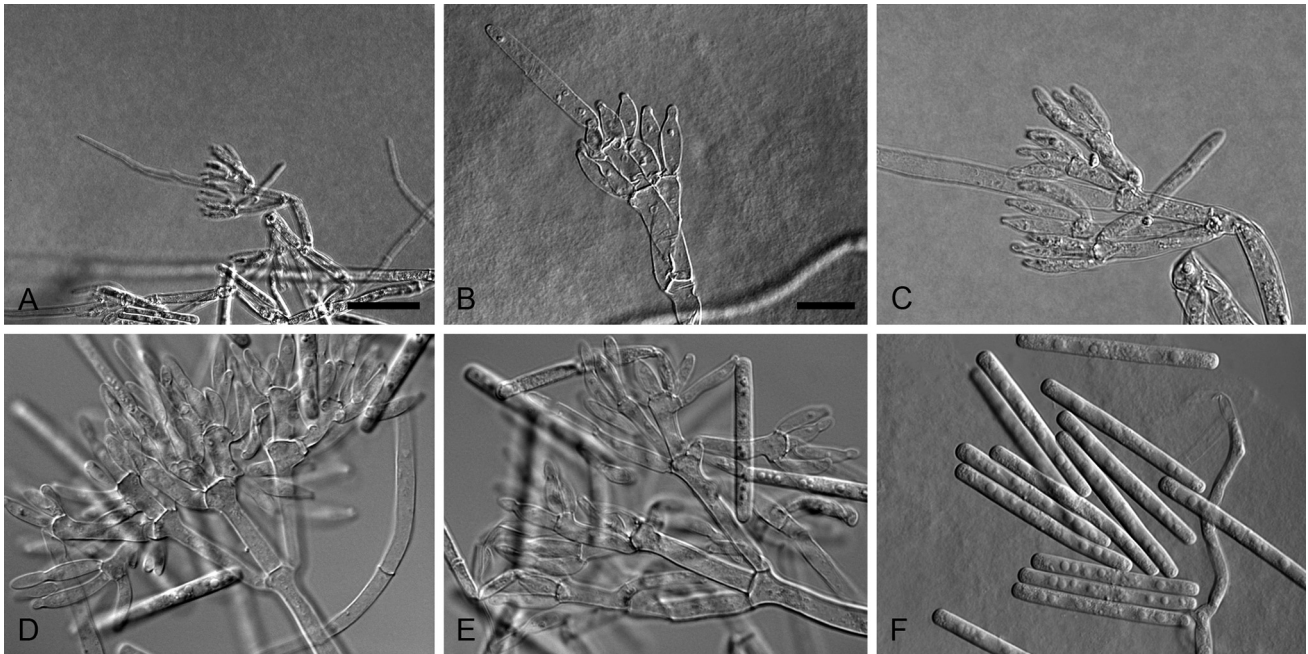


Fig. 5. *Cylindrocarpostylus gregarius* (ex-type CBS 101072). A–C. Conidiophores. D–E. Conidiogenous apparatus with cylindrical to allantoid phialides. F. Conidia. Scale bars: A = 50 μ m; B = 10 μ m (apply to C–F).

Conidiophores consisting of a stipe, a penicillate arrangement of fertile branches, and an aversiculate stipe extension. *Stipe* septate, hyaline, smooth; stipe extensions septate, straight to flexuous or sinuous. *Conidiogenous apparatus* with aseptate or 1-septate primary branches; aseptate secondary, tertiary and quaternary branches, each terminal branch producing 2–6 phialides; phialides doliiform to reniform, hyaline, aseptate, apex with minute periclinal thickening and inconspicuous collarete. *Conidia* cylindrical, rounded at both ends, straight or curved, septate, lacking visible abscission scars, held in parallel cylindrical clusters by slime (adapted from Decock et al. 1997).

Type species: Xenocyliandrocladium serpens Decock et al., Mycol. Res. 101: 788. 1997.

Notes: The genus *Xenocyliandrocladium* includes three species described from the tropics, isolated from plant debris (Decock et al. 1997, Crous et al. 2001). At the same time, Decock et al. (1997) introduced the sexual morph of *X. serpens* as *Nectria serpens*, which was later transferred to the genus *Xenocalonectria* by Schoch et al. (2000). Given the name changes required if the genus name *Xenocalonectria* was used, we propose that the generic name *Xenocalonectria* be suppressed in favour of *Xenocyliandrocladium*, which also has priority by date and therefore no new combinations are required. Representatives of the genus *Xenocyliandrocladium* formed a monophyletic clade (BS = 100 %, PP = 1.0), closely related to the genera *Curviciadiella* and *Calonectria*.

Clade IV

Campylocarpon Halleen et al., Stud. Mycol. 50: 448. 2004. MycoBank MB28858.

Ascomatal state unknown. Asexual state cylindrocarpon-like. *Conidiophores* arise laterally from single or fasciculate aerial

hyphae, carried singularly or aggregated, consisting of a stipe bearing several phialides or a penicillus of irregular branches with terminal branches bearing one or several phialides. *Phialides* cylindrical or narrowly flask-shaped. *Macroconidia* cylindrical, typically curved, (1–)3–4(–5)-septate, with minute tapering, obtuse ends, sometimes somewhat more strongly tapering at the base; base with or without an obscure hilum. *Microconidia* and *chlamydoconidia* not observed (adapted from Halleen et al. 2004).

Type species: Campylocarpon fasciculare Schroers et al., Stud. Mycol. 50: 448. 2004.

Description and illustrations: Halleen et al. (2004).

Notes: The monophyletic clade (BS = 100 %, PP = 1.0) representing the asexual genus *Campylocarpon* is closely related but separate from the clade representing the genus *Rugonectria*. Both these genera share several morphological characters, such as having cylindrocarpon-like asexual states. Neither is known to produce chlamydoconidia in culture.

Cylindrocarpostylus R. Kirschner & Oberw., Mycol. Res. 103: 1155. 1999. MycoBank MB28330. Fig. 5.

Ascomatal state unknown. *Conidiophores* arise from hyphae, consisting of a stipe and penicillate arrangement of fertile branches. *Stipe* septate, smooth, becoming verruculose with age, initially hyaline, turning yellow to brown. *Conidiogenous apparatus* with aseptate primary, secondary, tertiary and quaternary branches, each terminal branch producing 2–4 phialides; phialides cylindrical to allantoid, hyaline, aseptate, apex with minute periclinal thickening and inconspicuous collarete. *Conidia* hyaline, smooth, cylindrical, rounded at both ends, straight or slightly curved, 0–3-septate, lacking visible abscission scars (adapted from Kirschner & Oberwinkler 1999).

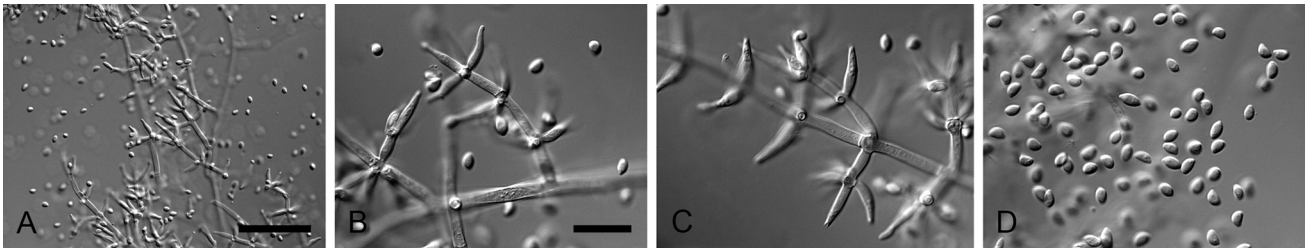


Fig. 6. *Mariannaea humicola* (ex-type CBS 740.95). A–C. Conidiophores with verticillate phialides. D. Conidia. Scale bars: A = 50 µm; B = 10 µm (apply to C–D).

Type species: Cyliandrocarpostylus gregarius (Bres.) R. Kirschner & Oberw., Mycol. Res. 103: 1155. 1999.

- ≡ *Diplocladium gregarium* Bres., Ann. Mycol. 1: 127. 1903.
- ≡ *Cyliandrocladium gregarium* (Bres.) de Hoog, Persoonia 10: 75. 1978.

Description and illustrations: Kirschner & Oberwinkler (1999).

Note: Representatives of the monotypic genus *Cyliandrocarpostylus* formed a monophyletic clade (BS = 100 %, PP = 1.0), separate from all other members of Clade IV.

Mariannaea G. Arnaud ex Samson, Stud. Mycol. 6: 74. 1974. MycoBank MB8846.

Ascomata perithecial with inconspicuous or absent stroma, solitary, globose with a flat apex, not collapsing or collapsing laterally by pinching when dry, pale yellow, orange or brown, not reacting in KOH. Perithecial wall smooth or finely roughened. *Asci* cylindrical to narrowly clavate, sometimes with an inconspicuous apical ring, 8-spored. *Ascospores* 1-septate, hyaline, smooth to spinulose. *Conidiophores* verticillate to penicillate, hyaline, with phialides arising directly from the stipe or forming whorls of metulae on lower parts of the stipe. Stipe hyaline, becoming yellow-brown at the base. *Phialides* monophialidic, flask-shaped, hyaline, usually with obvious periclinal thickening and inconspicuous collarettes. *Conidia* aseptate, hyaline, in chains that collapse to form slimy heads. *Chlamydospores* globose to ellipsoidal, hyaline, formed in intercalary chains (adapted from Samson 1974).

Type species: Mariannaea elegans (Corda) Samson, Stud. Mycol. 6: 75. 1974.

- ≡ *Penicillium elegans* Corda, Icones Fung. 2: 17. 1838.
- ≡ *Hormodendron elegans* (Corda) Bonorden, Handb. Allg. Mykol.: 76. 1851.
- ≡ *Spicaria elegans* (Corda) Harz., Bull. Soc. Imp/Nat. Moscou 44: 238. 1871.
- ≡ *Paecilomyces elegans* (Corda) Mason & Hughes *apud* Hughes, Mycol. Pap. 45: 27. 1951.

Descriptions and illustration: Samson (1974), Gräfenhan et al. (2011).

Note: Unfortunately no culture or sequences of *M. elegans* were available to be included in this phylogenetic study.

Mariannaea catenulatae (Samuels) L. Lombard & Crous, **comb. nov.** MycoBank MB810163.

Basionym: Chaetopsina catenulata Samuels, Mycotaxon 22: 28. 1985.

- ≡ *Nectria chaetopsinae-catenulatae* Samuels, Mycotaxon 22: 28. 1985.
- ≡ *Cosmospora chaetopsinae-catenulatae* (Samuels) Rossman & Samuels, Stud. Mycol. 42: 119. 1999.

- ≡ *Chaetopsinectria chaetopsinae-catenulatae* (Samuels) J. Luo & W.Y. Zhuang, Mycologia 102: 979. 2010.

Description and illustration: Samuels (1985).

Notes: Based on phylogenetic inference in this study, the ex-type culture CBS 491.92, previously known as *Chaetopsinectria chaetopsinae-catenulatae* (Samuels 1985, Luo & Zhuang 2010), clustered in the monophyletic clade (BS ≥ 75 %, PP ≥ 0.95) representing the genus *Mariannaea*. Therefore, a new combination is provided in the genus *Mariannaea*. This is the first study to include this ex-type strain in a molecular phylogeny.

Mariannaea pinicola L. Lombard & Crous, **nom. nov.** MycoBank MB810164.

- ≡ *Nectria mariannaea* Samuels & Seifert, Mycotaxon 110: 101. 2009.
- ≡ *Nectria mariannaea* Samuels & Seifert, Sydowia 43: 257. 1991. (nom. Inval., Art 23.4).

Etymology: Name derived from the plant host *Pinus* sp., from which it was collected.

Descriptions and illustrations: Samuels & Seifert (1991).

Notes: Gräfenhan *et al.* (2011) refrained from transferring *Nectria mariannaea* to the genus *Mariannaea* based on insufficient taxonomic information available at that time. As the use of the same epithet would create a tautonym (Art. 23.4), we choose to provide this species with a new epithet.

Mariannaea humicola L. Lombard & Crous, **sp. nov.** MycoBank MB810165. Fig. 6.

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

Ascomatal state not observed. *Conidiophores* arising from the agar surface from aerial hyphae or fascicles, mostly 80–100 µm long, axis 3–7 µm wide, branching verticillately at 2–3 levels, with a terminal whorl of 1–5 phialides, and 1–2 lower nodes of 1–3 phialides, rarely with single phialides. *Phialides* subulate, sometimes with base slightly swollen, 10–20 µm, 2–4 µm at the broadest part, with periclinal thickening and inconspicuous collarette. *Conidia* fusiform to ellipsoidal to obovoid, hyaline, smooth, (3–)4–6 × 2–3 µm (av. 5 × 3 µm), with a distinct hilum at both or at one end. *Chlamydospores* not seen.

Culture characteristics: Colonies slow growing on MEA, 45–50 mm diam in 14 d at 24 °C. Surface dirty white in the centre becoming tan to sienna towards the margins with dirty white, irregularly distributed tufts of fascicles; aerial mycelium abundant. Reverse chestnut becoming umber at the margins.

Materials examined: **Brazil**, Sao Paulo, from rhizosphere soil under *Araucaria angustifolia*, Apr. 1995, S. Baldini (holotype CBS H-21953, culture ex-type CBS 740.95 = CCT 4534). **Spain**, Canary Islands, La Gomera, on decaying wood of unknown tree, Oct. 1999, R.F. Castañeda, culture CBS 102628 = INIFAT C99/130-2.

Notes: *Mariannaea humicola* is introduced here for two isolates (CBS 740.95 & CBS 102628), which were listed as "*Nectria mariannaea*" (= *M. pinicola*) in the CBS collection. Both isolates clustered together in a clade (BS = 100 %, PP = 1.0) separate from the ex-type culture (CBS 754.88) of *M. pinicola*. The conidia of *M. humicola* [(3–)4–6 × 2–3 µm (av. 5 × 3 µm)] are smaller than those of *M. pinicola* [5–9(–17) × (2–)2.5–4.5 µm; Samuels & Seifert 1991] and no chlamydospores were observed for *M. humicola*, which are readily formed by *M. pinicola* (Samuels & Seifert 1991).

Rugonectria P. Chaverri & Samuels, Stud. Mycol. 68: 73. 2011. MycoBank MB518563.

Ascomata perithecial, formed on or partially immersed within a stroma, globose to subglobose, warted, orange to red, turning dark red in KOH. Asci cylindrical to clavate, 8-spored. Ascospores 1-septate, ellipsoidal to oblong, hyaline or sometimes yellow. Asexual state cylindrocarpon-like. *Microconidiophores* monophialidic or sparsely branched, terminating in cylindrical phialides. *Microconidia* 0–1-septate, ovoid to cylindrical, with rounded ends, hyaline, lacking a prominent basal hilum. *Macroconidiophores* irregularly branched or in fascicles, terminating in cylindrical phialides. *Macroconidia* (3–)5–7(–9)-septate, fusiform, curved, tapering towards the ends with an inconspicuous basal hilum. *Chlamydospores* absent (adapted from Chaverri et al. 2011).

Type species: *Rugonectria rugulosa* (Pat. & Gaillard) Samuels et al., Stud. Mycol. 68: 73. 2011.

≡ *Nectria rugulosa* Pat. & Gaillard, Bull. Soc. Mycol. France 4: 115. 1888.

≡ *Neonectria rugulosa* (Pat. & Gaillard) Mantiri & Samuels, Canad. J. Bot. 79: 339. 2001.

= *Cylindrocarpon rugulosum* Brayford & Samuels, Sydowia 46: 146. 1994.

Description and illustration: Chaverri et al. (2011).

Note: Representatives of the genus *Rugonectria* formed a monophyletic clade (BS = 100 %, PP = 1.0), closely related but separate from the clade representing *Campylocarpon*.

Thelonectria P. Chaverri & C. Salgado, Stud. Mycol. 68: 76. 2011. MycoBank MB518567.

Ascomata perithecial formed superficial or seated on an immersed inconspicuous stroma, globose, subglobose, or pyriform to elongated, smooth or warted, with a prominently darkened papilla or darkly pigmented apex. Asci cylindrical and 8-spored. Ascospores 1-septate, hyaline, ellipsoidal to oblong, becoming pigmented with age. Asexual morph cylindrocarpon-like; microconidiophores and microconidia rare. *Macroconidiophores* irregularly branched or in fascicles, terminating in cylindrical phialides; macroconidia (3–)5–7(–9)-septate, curved, often broadest at upper third, with rounded apical cell and flattened or rounded basal cells with inconspicuous hilum.

Chlamydospores rare, abundant in one species (adapted from Chaverri et al. 2011).

Type species: *Thelonectria discophora* (Mont.) P. Chaverri & C. Salgado, Stud. Mycol. 68: 76. 2011.

≡ *Sphaeria discophora* Mont., Ann. Sci. Nat., Bot. II 3: 353. 1835.

≡ *Neonectria discophora* (Mont.) var. *discophora* Mantiri & Samuels, Canad. J. Bot. 79: 339. 2001.

= *Nectria tasmanica* Berk. in Hooker, Flora Tasmaniae 2: 279. 1860.

= *Nectria mammoidea* W. Phillips & Plowr., Grevillea 3: 126. 1875.

≡ *Creonectria mammoidea* (W. Phillips & Plowr.) Seaver, Mycologia 1: 188. 1909.

= *Nectria nelumbicola* Henn., Verh. Bot. Ver. Prov. Brandenb. 40: 151. 1898.

= *Nectria umbilicata* Henn., Hedwigia 41: 3. 1902.

= *Nectria mammoidea* var. *rugulosa* Weese, Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 125: 552. 1916.

= *Cylindrocarpon ianthothele* var. *majus* Wollenw., Z. Parasitenk. 1: 161. 1928.

= *Nectria mammoidea* var. *minor* Reinking, Zentbl. Bakt. Parasitenk., Abt. II, 94: 135. 1936.

= *Cylindrocarpon ianthothele* var. *minus* Reinking, Zentbl. Bakt. Parasitenk., Abt. II, 94: 135. 1936.

= *Creonectria discostiolata* Chardón, Bol. Soc. Venez. Ci. Nat. 5: 341. 1939.

= *Cylindrocarpon ianthothele* var. *rugulosum* C. Booth, Mycol. Pap. 104: 25. 1966.

= *Cylindrocarpon pineum* C. Booth, Mycol. Pap. 104: 26. 1966.

Description and illustration: Chaverri et al. (2011).

Note: Representatives of the genus *Thelonectria* formed a monophyletic clade (BS = 100 %, PP = 1.0), distinct from the other member genera in Clade IV even though this genus shares some morphological characters with the genera *Campylocarpon* and *Rugonectria*.

Clade V

Xenogliocladiopsis Crous & W.B. Kendr., Canad. J. Bot. 72: 63. 1994. MycoBank MB27282.

Ascomatal state unknown. *Conidiophores* separate or aggregated in sporodochia, consisting of a stipe, a penicillate arrangement of fertile branches, and an avesculate stipe extension; stipe septate, hyaline, smooth; stipe extensions septate, straight to flexuous. *Conidiogenous apparatus* with aseptate primary, secondary, tertiary and additional branches, each terminal branch producing 2–6 phialides. *Phialides* cylindrical to cymbiform, hyaline, aseptate; collarette absent. *Conidia* hyaline, aseptate, cylindrical to fusiform with acutely rounded ends (adapted from Crous & Kendrick 1994).

Type species: *Xenogliocladiopsis eucalyptorum* Crous & W.B. Kendr., Canad. J. Bot. 72: 63. 1994. Fig. 7.

Materials examined: **South Africa**, Limpopo Province, Gold River Game Resort, *Eucalyptus* leaf litter, May 1991, P.W. Crous, holotype PREM 51299; Northern Cape Province, Kleinsee, on leaves of *Eucalyptus* sp., 27 Feb. 2009, leg. Z.A. Pretorius, isol. P.W. Crous (epitype designated here CBS H-21952, MBT198395, culture ex-epitype CBS 138758 = CPC 16271).

Notes: When Crous & Kendrick (1994) introduced the asexual genus *Xenogliocladiopsis* based on *X. eucalyptorum*, they incorrectly linked it to the *Dothidiomycete* sexual morph *Arnau-diella eucalyptorum*. Phylogenetic inference in the current study clearly shows that the genus *Xenogliocladiopsis* belongs to the *Nectriaceae*, forming a well-supported clade (BS = 100 %, PP = 1.0) basal to Clades I–IV.

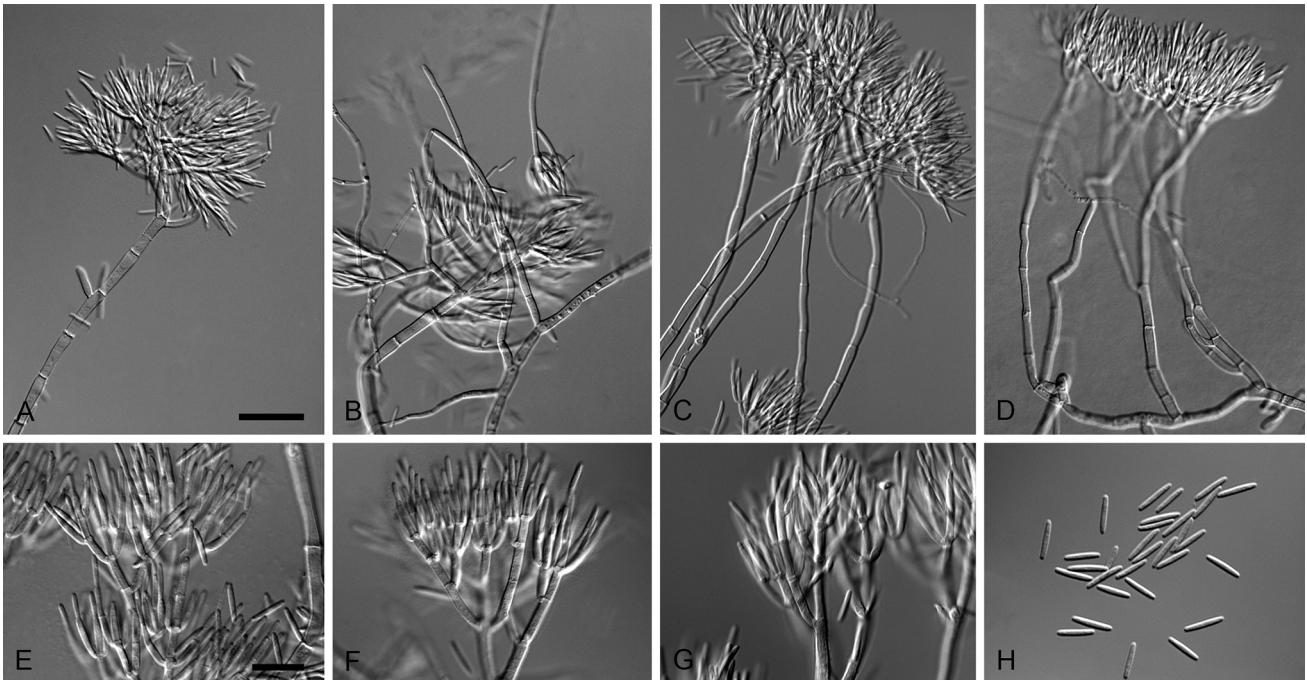


Fig. 7. *Xenogliocladiopsis eucalyptorum* (ex-epitype CBS 138758). A–D. Conidiophores. E–G. Conidiogenous apparatus with cylindrical to cymbiform phialides. F. Conidia. Scale bars: A = 50 µm (apply to B–D); E = 10 µm (apply to F–H).

Xenogliocladiopsis cypellocarpa L. Lombard & Crous, **sp. nov.** MycoBank MB810166. **Fig. 8.**

Etymology: Name derived from the plant host *Eucalyptus cypellocarpa*, from which it was isolated.

Ascomatal state not observed. **Conidiophores** hyaline, separate or aggregated in sporodochia, consisting of a stipe bearing a penicillate arrangement of fertile branches, and an avesculate stipe extension; stipe septate, hyaline, smooth, 19–105 × 4–11 µm; stipe extension septate, straight to flexuous, 70–190 µm long, 2–4 µm wide at the apical septum. **Conidiogenous apparatus** 70–115 µm wide, and 65–105 µm long; primary branches aseptate, 15–30 × 3–7 µm; secondary branches aseptate, 10–20 × 2–6 µm; tertiary branches aseptate, 7–22 × 2–5 µm; quaternary branches and additional branches (–8) aseptate, 6–15 × 1–4 µm, each terminal branch producing 2–6 phialides; phialides cylindrical to cymbiform, hyaline, aseptate, 8–11 × 1–3 µm, collarette absent. **Conidia** cylindrical to fusiform, rounded at both ends, straight, 8–10 × 1–2 µm (av. 9 × 1 µm).

Culture characteristics: Colonies moderately fast growing on MEA, 60–80 mm diam after 10 d at 24 °C. Surface white to pale luteous with pale luteous to yellow tufts of sporodochia forming at the margins; aerial mycelium abundant in the centre becoming immersed towards the margins, with conidiophores forming on the aerial mycelium and on the surface at the margins. Reverse similar in colour.

Material examined: **Australia**, Northern territories, Darwin, Kurralong Height, on leaves of *Eucalyptus cypellocarpa*, 25 Apr. 2011, P.W. Crous (**holotype** CBS H-21951, culture ex-type CBS 133814 = CPC 19417); Queensland, Slaughter Falls, on leaves of *Eucalyptus* sp., 16 Jul. 2009, P.W. Crous, culture CPC 17153.

Notes: *Xenogliocladiopsis cypellocarpa* is introduced here as a new species in the genus *Xenogliocladiopsis*. This species forms shorter stipe extensions (up to 190 µm) than *X. eucalyptorum* (up

to 220 µm), and the conidia of *X. cypellocarpa* are also slightly smaller than those of *X. eucalyptorum* (7.5–11 × 1–1.5 µm; Crous & Kendrick 1994).

Clade VI

Cylindrodendrum Bonord., Handb. allg. Mykol.: 98. 1851. MycoBank MB7873.

Ascomatal state unknown. **Conidiophores** initially as lateral phialides on somatic hyphae, sometimes verticillate, hyaline. **Phialides** monopialidic, elongate doliiform to reniform to obpyriform, with the terminal part frequently having a swollen tip, apex with minute periclinal thickening and inconspicuous collarette. **Conidia** cylindrical, rounded at both ends, straight, 0–1-septate, with visible abscission scars (adapted from Lombard *et al.* 2014b).

Type species: *Cylindrodendrum album* Bonord., Handb. Allg. Mykol.: 48. 1851.

Description and illustrations: Lombard *et al.* (2014b).

Notes: Chaverri *et al.* (2011) suggested that the asexual morph-typified genus *Cylindrodendrum* could be considered as a synonym of “*Cylindrocarpon*”. Morphologically however, members of *Cylindrodendrum* more closely resemble the asexual morphs of fungal species in the genera *Atractium*, *Cosmospora*, *Dialonectria*, *Fusicolla*, *Macroconia* and *Stylonectria*, with the exception of conidium morphology (Gräfenhan *et al.* 2011). Based on phylogenetic inference, *Cylindrodendrum* isolates included in this study formed a monophyletic clade (BS = 100 %, PP = 1.0), sister to the monophyletic clade representing *Dactylonectria*.

Dactylonectria L. Lombard & Crous, Phytopathol. Medit. 53: 348. 2014. MycoBank MB810142.

Ascomata perithecial, superficial, solitary or aggregated in groups, ovoid to obpyriform, dark red, becoming purple-red in

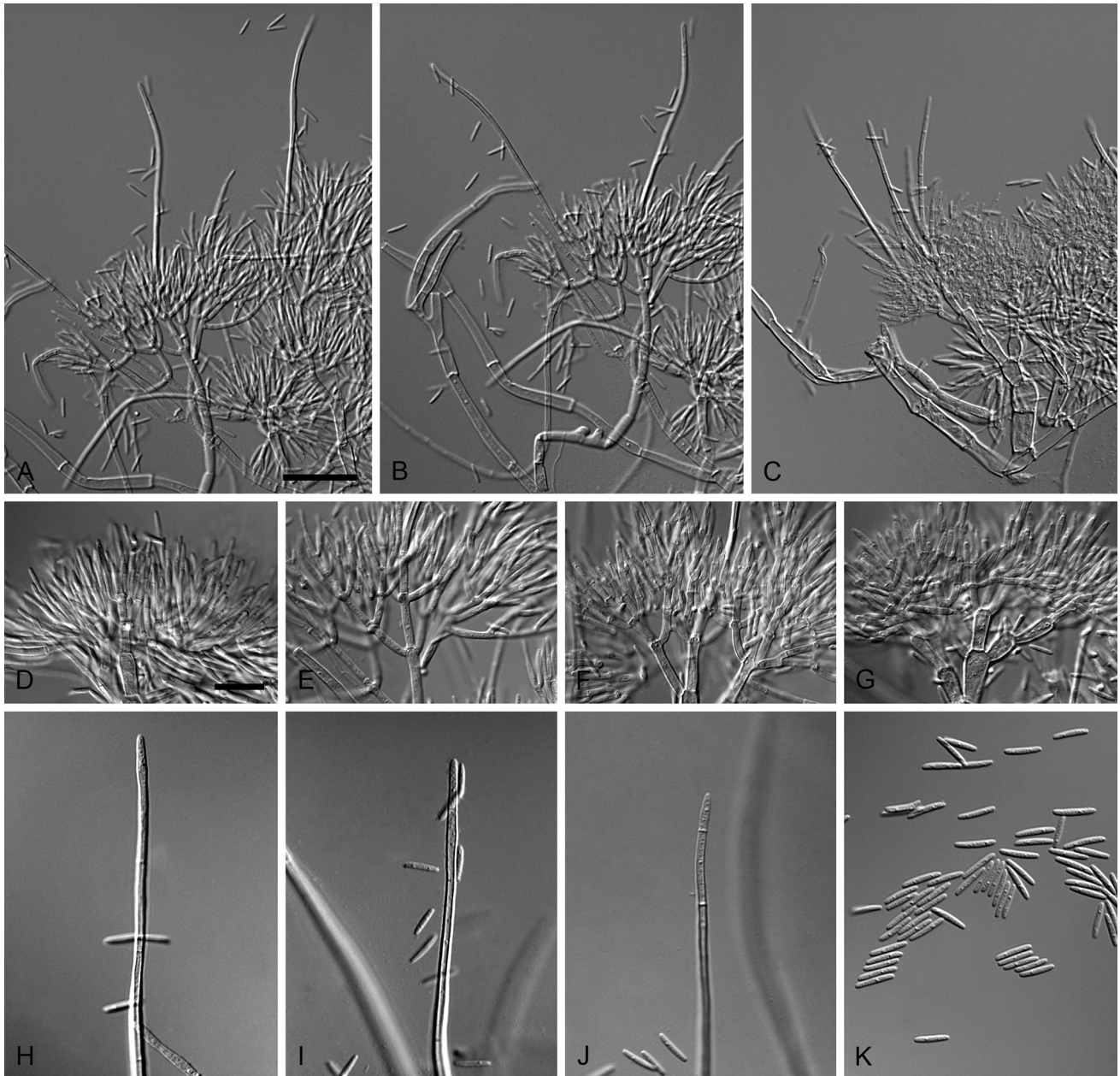


Fig. 8. *Xenogliocladiopsis cypellocarpa* (ex-type CBS 133814). A–C. Conidiophores. D–G. Conidiogenous apparatus with cylindrical to cymbiform phialides. H–J. Avesiculate stipe extensions. K. Conidia. Scale bars: A = 50 µm (apply to B–C); D = 10 µm (apply to E–K).

KOH, smooth to finely warted, with papillate apex; without recognisable stroma. *Asci* clavate to narrowly clavate, 8-spored; apex rounded, with a minutely visible ring. *Ascospores* ellipsoidal to oblong-ellipsoidal, somewhat tapering towards the ends, medianly septate, smooth to finely warted. *Conidiophores* simple or aggregated to form sporodochia; simple conidiophores arising laterally or terminally from aerial mycelium, solitary to loosely aggregated, unbranched or sparsely branched, septate, bearing up to three phialides. *Phialides* monophialidic, more or less cylindrical, tapering slightly in the upper part towards the apex. *Macroconidia* cylindrical, hyaline, straight to slightly curved, 1–4-septate, apex or apical cell typically slightly bent to one side and minutely beaked, base with visible, centrally located or laterally displaced hilum. *Microconidia* ellipsoid to ovoid, hyaline, straight, aseptate to 1-septate, with a minutely or clearly laterally displaced hilum. *Chlamydospores* rarely formed, globose to subglobose, smooth but often appear rough due to deposits, thick-walled, mostly occurring in chains.

Type species: Dactylonectria macrodidyma (Halleen, et al.) L. Lombard & Crous, *Phytopathol. Medit.* 53: 352. 2014.

≡ *Neonectria macrodidyma* Halleen et al., *Stud. Mycol.* 50: 445. 2004.

≡ *Ilyonectria macrodidyma* (Halleen et al.) P. Chaverri & C. Salgado, *Stud. Mycol.* 68: 71. 2011.

= *Cylindrocarpon macrodidymum* Halleen et al., *Stud. Mycol.* 50: 446. 2004.

Notes: Species in the genus *Dactylonectria* were initially regarded as members of the genus *Ilyonectria*. However, phylogenetic studies (Cabral et al. 2012a, Lombard et al. 2014b), showed that the genus *Ilyonectria*, as originally conceived, was paraphyletic. This led to the introduction of the genus *Dactylonectria* to accommodate *Ilyonectria* species isolated from grapevines (Cabral et al. 2012a, Lombard et al. 2014b). The clade representing the genus *Dactylonectria* (BS = 100 %, PP = 1.0) is monophyletic, and is sister to the clade representing *Cylindrodendrum*. Both clades are distinct from *Ilyonectria*.

Ilyonectria P. Chaverri & C. Salgado, Stud. Mycol. 68: 69. 2011. MycoBank MB518558.

Ascomata perithecial, superficial, solitary or in groups, loosely attached to substrate, red, turning purple-red in KOH, globose to subglobose, or ovoid to obpyriform with a broadly conical papilla or flattened apex, scaly to slightly warted. *Asci* narrowly clavate or cylindrical, 8-spored; apex subtruncate, with a minutely visible ring. *Ascospores* ellipsoidal, 1-septate, smooth hyaline. Asexual morph cylindrocarpon-like. *Conidiophores* simple or complex or sporodochial. Simple conidiophores arising laterally or terminally from aerial mycelium, solitary or loosely aggregated, unbranched or sparsely branched, bearing up to three phialides. Complex conidiophores solitary or aggregated in small sporodochia, repeatedly and irregularly branched. *Phialides* cylindrical, tapering towards the apex. *Microconidia* 0–1-septate, oval to ovoid to fusiform to ellipsoid, with a minutely or clearly laterally displaced hilum, formed in heads on solitary conidiophores or as masses on sporodochia. *Macroconidia* straight, cylindrical, 1–3(–4)-septate, with both ends obtusely rounded, base sometimes with a visible, centrally located to laterally displaced hilum, forming flat domes of slimy masses. *Chlamydospores* globose to subglobose, thick-walled, intercalary or solitary, initially hyaline, becoming brown with age (adapted from Chaverri et al. 2011).

Type species: Ilyonectria destructans (Zinssm.) Rossman, L. Lombard & Crous.

Description and illustration: Chaverri et al. (2011).

Notes: Representatives of the genus *Ilyonectria* clustered together in a well-supported clade (BS = 100 %, PP = 1.0), distinct from the clades representing *Cylindrodendrum* and *Dactylonectria*. Chaverri et al. (2011) applied the epithet '*radicicola*' (1963) to the type of this genus, whereas the older epithet '*destructans*' (1918) is available. Therefore, a new combination is provided below for the type species of *Ilyonectria*. Furthermore, a new combination is provided for *Neonectria macroconidialis*, which Cabral et al. (2012a) showed to belong to this genus.

Ilyonectria destructans (Zinssm.) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810954.

Basionym: Ramularia destructans Zinssm., Phytopathology 8: 570. 1918.

≡ *Cylindrocarpon destructans* (Zinssm.) Scholten, Netherl. J. Plant Path. 70 suppl. (2): 9. 1964.

= *Cylindrocarpon radicicola* Wollenw., Fus. Autogr. Del. 2: 651. 1924.

= *Nectria radicicola* Gerlach & L. Nilsson, Phytopathol. Z. 48: 225. 1963.

≡ *Neonectria radicicola* (Gerlach & L. Nilsson) Mantiri & Samuels, Canad. J. Bot. 79: 339. 2001.

≡ *Ilyonectria radicicola* (Gerlach & L. Nilsson) P. Chaverri & C. Salgado, Stud. Mycol. 68: 71. 2011.

Ilyonectria macroconidialis (Brayford & Samuels) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810955.

Basionym: Cylindrocarpon macroconidialis Brayford & Samuels, Mycol. Res. 94: 440. 1990.

≡ *Nectria radicicola* var. *macroconidialis* Samuels & Brayford, Mycol. Res. 94: 440. 1990.

≡ *Neonectria macroconidialis* (Samuels & Brayford) Seifert, Phytopathology 93: 1541. 2003.

Neonectria Wollenw., Ann. Mycol. 15: 52. 1917. MycoBank MB3469.

= *Chitinonectria* Morelet, Bull. Soc. Sci. Nat. Archéol. Toulon & Var 178: 6. 1969.

= *Heliscus* Sacc., Michelia 2: 35. 1880.

Ascomata perithecial, solitary or in groups, seated on an erumpent stroma, red, turning dark red in KOH, smooth to scruffy, subglobose to broadly obpyriform, with a blunt or acute apex. *Asci* narrowly clavate to cylindrical, 8-spored. *Ascospores* ellipsoidal, smooth or finely verruculose, 1-septate, hyaline becoming pale brown with age. *Paraphyses* septate when present, slightly constricted at each septum. *Conidiophores* simple or complex forming sporodochia. Simple conidiophores solitary or loosely aggregated, unbranched or sparsely branched. Complex conidiophores irregularly branched, solitary or aggregated to form sporodochia. *Phialides* cylindrical, tapering towards the apex. *Microconidia* formed by simple conidiophores, hyaline, smooth, ellipsoidal to oblong, 0–1-septate. *Macroconidia* mostly formed by complex conidiophores, hyaline, smooth, straight or slightly curved towards the ends, 3–7(–9)-septate, lacking a scar or basal hilum. *Chlamydospores* globose to subglobose, hyaline (adapted from Chaverri et al. 2011).

Type species: Neonectria candida (Ehrenb.) Rossman, L. Lombard & Crous.

Description and illustration: Chaverri et al. (2011).

Notes: The genus *Neonectria* is monophyletic, forming a well-supported clade (BS = 100 %, PP = 1.0), distinct from the genera included in Clade VI. A new combination is required for *N. ramulariae* (1917) as there is an older epithet *Fusarium candidum* (1818), available for this species.

Neonectria candida (Ehrenb.) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810956.

Basionym: Fusarium candidum Ehrenb., Syl. Mycol. Berol. 24: 1818.

≡ *Ramularia candida* (Ehrenb.) Wollenw., Phytopathology 1: 220. 1913.

≡ *Cylindrocarpon ehrenbergii* Wollenw., Fus. Autogr. Del.: 461. 1916.

= *Fusarium obtusiusculum* Sacc., Michelia 2: 297. 1881.

≡ *Fusarium oxysporum* var. *obtusiusculum* (Sacc.) Cif., Ann. Bot., Roma 16: 221. 1924.

≡ *Cylindrocarpon obtusiusculum* (Sacc.) U. Braun, Cryptog. Bot. 4: 113. 1993.

= *Fusarium eichleri* Bres., Ann. Mycol. 1: 130. 1903.

= *Neonectria ramulariae* Wollenw., Ann. Mycol. 15: 52. 1917.

≡ *Nectria ramulariae* (Wollenw.) E. Müll., Beitr. Kryptogamenfl. Schweiz 11: 634. 1962.

= *Cylindrocarpon magnusianum* Wollenw., Z. Parasitenk. 1: 172. 1928.

Clade VII

Chaetopsina Rambelli, Atti Accad. Sci. Ist. Bologna, Cl. Sci. Fis., Rendiconti: 5. 1956. MycoBank MB7584.

= *Chaetopsinectria* J. Luo & W.Y. Zhuang, Mycologia 102: 979. 2010.

Ascomata perithecial, solitary, non-stromatic, superficial, obpyriform, with an acute apex, red, becoming dark red in KOH, smooth. *Asci* unitunicate, clavate, 8-spored, with a simple apex or an apical ring. *Ascospores* ellipsoid to fusiform, 1-septate, hyaline, smooth to striate. *Conidiophores* erect, setiform, tapering towards acutely rounded apex, mostly flexuous, yellow-

brown, turning red-brown in KOH, fertile in mid region, unbranched, verruculose, thick-walled, base bulbous. Fertile region consisting of irregularly branched dense aggregated conidiogenous cells. *Conidiogenous cells* ampulliform to lageniform, hyaline, smooth, mono- to polyphialidic. *Conidia* hyaline, smooth, guttulate, subcylindrical, aseptate, apex and base bluntly rounded, base rarely with flattened hilum (adapted from Rambelli 1956 and Luo & Zhuang 2010).

Type species: Chaetopsina fulva Rambelli, Atti Accad. Sci. Ist. Bologna, Cl. Sci. Fis. Rendiconti: 5. 1956.

= *Nectria chaetopsinae* Samuels, Mycotaxon 22: 18. 1985.

≡ *Cosmospora chaetopsinae* (Samuels) Rossman & Samuels, Stud. Mycol. 42: 119. 1999.

≡ *Chaetopsinectria chaetopsinae* (Samuels) J. Luo & W.Y. Zhuang, Mycologia 102: 979. 2010.

Descriptions and illustrations: Rambelli (1956), Samuels (1985), Luo & Zhuang (2010).

Notes: *Chaetopsinectria*, a sexual genus based on *Cosmospora chaetopsinae* (Samuels 1985), was established by Luo & Zhuang (2010) for a group of fungi having *Chaetopsina* asexual morphs. We propose that the sexual genus *Chaetopsinectria* (2010) be suppressed in favour of asexual genus *Chaetopsina* (1956), which has priority by date and would require no new combinations. The clade representing *Chaetopsina* (BS \geq 75 %, PP \geq 0.95), which includes the type species, *C. fulva* (ex-type CBS 142.56), is closely related to but separate from the clade representing the genus *Volutella*. In addition, these two genera do not share any morphological characters.

Coccinonectria L. Lombard & Crous, **gen. nov.** MycoBank MB810176.

Etymology: Name refers to the scarlet ascomata produced by these fungi.

Ascomata perithecial, superficial, solitary or aggregated in groups, developing on old sporodochia of volutella-like asexual morphs, subovoid to subglobose, orange to orange-red to carmine red, becoming pink to purple in KOH, initially rough surface due to short, thick-walled setae, with a short papillate ostiole; perithecial wall consists of two regions; inner region composed of thin-walled, flattened, hyaline cells; outer region composed of thick-walled ellipsoid to elongated cells. *Setae* scattered on surface of the perithecia except at the ostiolar region, hyaline, thick-walled, straight to curved, aseptate, narrowing toward the apex. *Asci* unitunicate, clavate, 8-spored, apex simple, truncate with hyaline, thin-walled moniliform paraphyses between the asci. *Ascospores* narrowly ellipsoid to fusiform, aseptate or medianly septate, slightly constricted at the septum, hyaline, becoming dark yellow with age, finely verrucose. *Conidiophores* sporodochial, ochraceous to amber or light russet, with hyaline to lightly coloured aseptate setae. *Conidia* aseptate, hyaline, guttulate, ellipsoidal to fusiform.

Type species: Coccinonectria pachysandricola (B.O. Dodge) L. Lombard & Crous.

Notes: The sexual genus *Coccinonectria* is established here to accommodate fungal species previously incorrectly treated as members of the genus *Pseudonectria* (Rossman et al. 1999,

Gräfenhan et al. 2011). *Coccinonectria* is distinguished from *Pseudonectria* by its orange to scarlet ascomata with short, thick-walled setae extending from the ascomatal surface (Dodge 1944, Rossman et al. 1999). The latter genus is characterised by yellow to greyish yellow-green ascomata with longer setae on the ascomatal surface (Rossman et al. 1999). Phylogenetic inference also shows that the genus *Coccinonectria* is closely related to the genera *Chaetopsina* and *Volutella*, but clearly distinct from the genus *Pseudonectria*.

Coccinonectria pachysandricola (B.O. Dodge) L. Lombard & Crous, **comb. nov.** MycoBank MB810177.

Basionym: *Pseudonectria pachysandricola* B.O. Dodge, Mycologia 36: 536. 1944.

≡ *Volutella pachysandricola* B.O. Dodge, Mycologia 36: 536. 1944.

Description and illustrations: Dodge (1944).

Coccinonectria rusci (Lechat, Gardiennet & J. Fourn.) L. Lombard & Crous, **comb. nov.** MycoBank MB810179.

Basionym: *Pseudonectria rusci* Lechat et al., Persoonia 32: 297. 2014.

Description and illustrations: Crous et al. (2014).

Note: *Coccinonectria rusci* (ex-type CBS 126108) clustered in a monophyletic clade representing the genus *Coccinonectria*, and therefore a new combination is proposed for this species.

Pseudonectria Seaver, Mycologia 1: 48. 1909. MycoBank MB4460. **emend.** L. Lombard & Crous.

≡ *Nectriella* Sacc., Michelia 1: 51. 1877.

≡ *Nectriella* subgen. *Notarisiella* Sacc., Syll. Fung. 2: 452. 1883.

≡ *Notarisiella* (Sacc.) Clements & Shear, The genera of Fungi: 280. 1931.

Ascomata perithecial, superficial, solitary, with an inconspicuous basal stroma, globose to pyriform, with a pointed apex, pale yellow to greyish yellow-green, not changing in KOH; ascomatal wall smooth, with or without sparse to numerous hyaline to orange setae; ascomatal surface of cells with irregularly thickened walls and joined by pores. *Asci* cylindrical to narrowly clavate, 8-spored. *Ascospores* aseptate, fusiform to ellipsoidal. *Conidiophores* simple or sporodochial. Simple conidiophores as lateral phialides on somatic hyphae or monochasial or verticillate, hyaline. Sporodochial conidiophores consist of a stipe and a penicillate arrangement of fertile branches. *Conidiogenous apparatus* consists of aseptate primary, secondary and rarely tertiary branches with each terminal branch producing 2–4 phialides. *Phialides* hyaline, cylindrical to allantoid, tapering towards the apex, with obvious periclinal thickening and inconspicuous collarettes. *Conidia* aseptate, hyaline, fusiform to ellipsoidal. *Chlamydo-spores* hyaline, globose to subglobose, formed intercalarily in chains (adapted from Rossman et al. 1993, 1999).

Type species: Pseudonectria buxi (DC.) Seifert et al., Stud. Mycol. 68: 107. 2011. Fig. 9.

≡ *Tubercularia buxi* DC., Flore française, Edn. 3 (Paris) 6: 110. 1815.

≡ *Chaetostroma buxi* (DC.) Corda, Icon. Fung. 2: 30. 1838.

≡ *Volutella buxi* (DC.) Berk., Ann. Mag. Nat. Hist. 5: 465. 1850.

≡ *Chaetodochium buxi* (DC.) Höhn., Mitt. Bot. Lab. TH Wien 9: 45. 1932.

= *Psilonia rosea* Berk., The English Flora, Fungi 5-2: 353. 1836.

= *Pseudonectria rousseiliana* (Mont.) Clements & Shear, The genera of Fungi: 280. 1931.

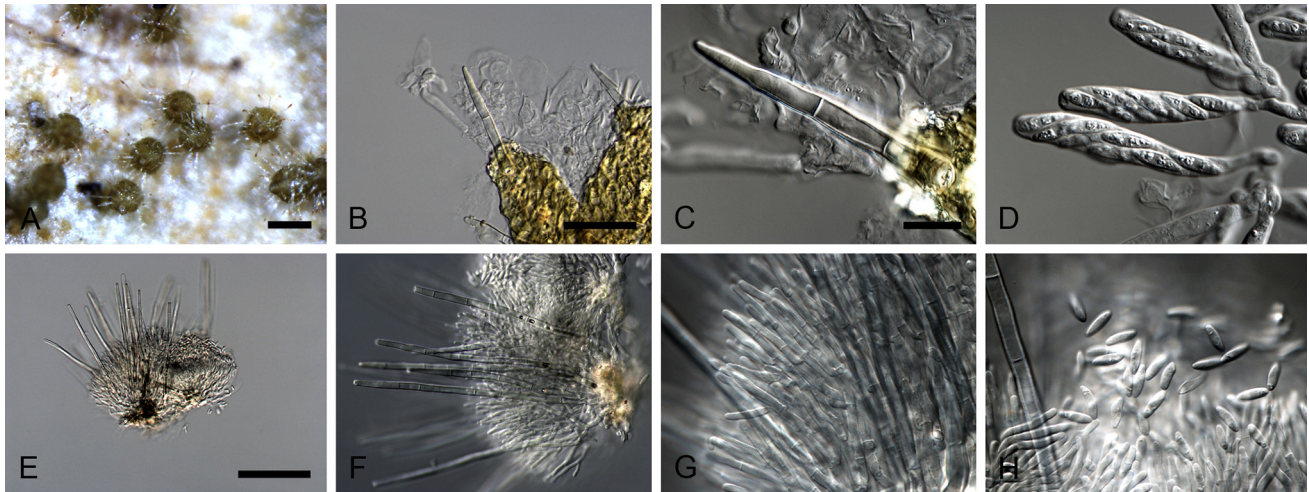


Fig. 9. *Pseudonectria buxi* (CBS 324.53). A. Ascomata on the leaf of *Buxus sempervirens*. B–C. Setae on ascomatal surface. D. Asci with ascospores. E–F. Sporodochial conidiophores. G. Conidiogenous apparatus with cylindrical to allantoid phialides. H. Conidia. Scale bars: A = 500 µm; B = 50 µm (apply to F); C = 10 µm (apply to D, G–H); E = 100 µm.

≡ *Nectria rousseliana* Mont. in Castagne, Cat. Pl. Marseille Suppl.: 44. 1851.

≡ *Stigmatea rousseliana* (Mont.) Fuckel, Jahrb. Nassauischen Vereins Naturk. 23/24: 97. 1870.

≡ *Notarisiella rousseliana* (Mont.) Clements & Shear, The genera of Fungi: 280. 1931.

= *Nectria rousseliana* Mont. var. *viridis* Berk. & Br., Ann. Mag. Nat. Hist. ser. 3, 3: 21. 1859, *vide* Lowen 1991.

Descriptions and illustrations: Rossman *et al.* (1993, 1999).

Note: Representatives of the genus *Pseudonectria* formed a monophyletic clade (BS = 100 %, PP = 1.0), sister to the clade representing the genus *Sarcopodium*.

***Pseudonectria foliicola* L. Lombard & Crous, sp. nov.**
MycoBank MB810180. Fig. 10.

Etymology: Name refers to the natural habitat of this species, which is a foliar pathogen.

Ascomatal state not observed. *Conidiophores* simple or sporodochial. Simple conidiophores monochasial or verticillate or as lateral phialides on somatic hyphae; phialides aseptate hyaline, cylindrical to allantoid, 12–35 × 2–3 µm. Sporodochial conidiophores without setae, consisting of a stipe and a penicillate arrangement of fertile branches; stipe hyaline, smooth, 0–1-septate, 10–25 × 2–3 µm. *Conidiogenous apparatus* 75–95 µm wide, 85–100 µm long; primary branches aseptate, 25–40 × 2–4 µm, secondary branches aseptate, 15–20 × 2–4 µm, tertiary branches rare, aseptate, 12–15 × 2–3 µm, each terminal branch producing 2–4 phialides; phialides hyaline, cylindrical to allantoid, 9–14 × 2–4 µm, tapering towards the apex, with obvious periclinal thickening and inconspicuous collarettes. *Conidia* hyaline, aseptate, fusiform to ellipsoid, (5–)6.5–7.5(–8) × 2–3 µm (av. 7 × 3 µm), forming flat domes of pink to salmon slimy masses on the sporodochia. *Chlamydospores* hyaline, globose to subglobose, 35–60 µm diam, formed intercalarily in chains or solitary.

Culture characteristics: Colonies fast growing on MEA, reaching 90 mm in 10 d at 24 °C. Surface white with abundant aerial mycelium, with scattered pink to salmon slimy masses of conidia on sporodochia at the margins. Reverse white.

Material examined: **New Zealand**, South Auckland, Ardmore, on leaves of *Buxus sempervirens*, 1 May 2008, S. Trower (**holotype** CBS H-21950, culture ex-type CBS 123190 = CPC 15385). **USA**, Maryland, Beltsville, Prince George's Co., on leaves of *B. sempervirens*, 10 May 1992, A.Y. Rossman, culture CBS 122566 = AR 2709.

Notes: *Pseudonectria foliicola* can be distinguished from *P. buxi* by the formation of simple conidiophores in the asexual state, something not reported for *P. buxi* (Bezerra 1963, Rossman *et al.* 1993). Also, no setae were observed surrounding the sporodochia of *P. foliicola*, while setae formation is characteristic of *P. buxi* (Bezerra 1963, Rossman *et al.* 1993). The conidia of *P. foliicola* are also smaller than those of *P. buxi*, which are 8–12 × 2.5–3 µm (Bezerra 1963).

***Sarcopodium* Ehrenb. ex Schlecht., Synop. Pl. Crypt. 2: 101. 1824.** MycoBank MB9788.

≡ *Sarcopodium* Ehrenb., Syl. Mycol. Berol. 23. 1818.

= *Tricholeconium* Corda, Icon. Fung. 1: 17. 1837.

= *Cyphina* Sacc., Syll. Fung. 3: 623. 1884.

= *Periopsis* Maire, Ann. Mycol. 11: 357. 1913.

= *Actinostilbe* Petch, Ann. Roy. Bot. Gard. (Peradeniya) 9: 327. 1925.

= *Kutilakesa* Subram., J. Indian Bot. Soc. 35: 478. 1956.

= *Kutilakesopsis* Agnihoth. & Barua, J. Indian Bot. Soc. 36: 308. 1957.

= *Lanatonectria* Samuels & Rossman, Stud. Mycol. 42: 137. 1999.

Ascomata perithecial, solitary or in groups, superficial on a minute stroma, on an erumpent, previously conidial stroma, or at the base of a synnema, subglobose to broadly obpyriform, red, turning dark red in KOH, non-papillate or with a minute papilla, with hyaline to yellow hyphal hairs; hairs smooth, spinulose, hooked or straight, septate, thin-walled, arising from the surface of the ascomatal wall and forming around the ascomatal base, sometimes forming a tomentum on the ascomatal surface. *Asci* clavate to fusiform, 8-spored, apex simple or with a ring. *Ascospores* ellipsoid to fusiform, 1-septate, hyaline to pale yellow-brown, striate. *Conidiomata* sporodochial, cupulate to synnematal, superficial. *Setae* simple, septate, rarely branched, smooth or verruculose, straight or circinate, brown. *Conidiophores* macronematous, irregularly, verticillately, or penicillately branched, hyaline, smooth. *Phialides* hyaline, smooth, cylindrical or doliiform to reniform. *Conidia* aggregated in slimy masses, straight, cylindrical to ellipsoid, hyaline,

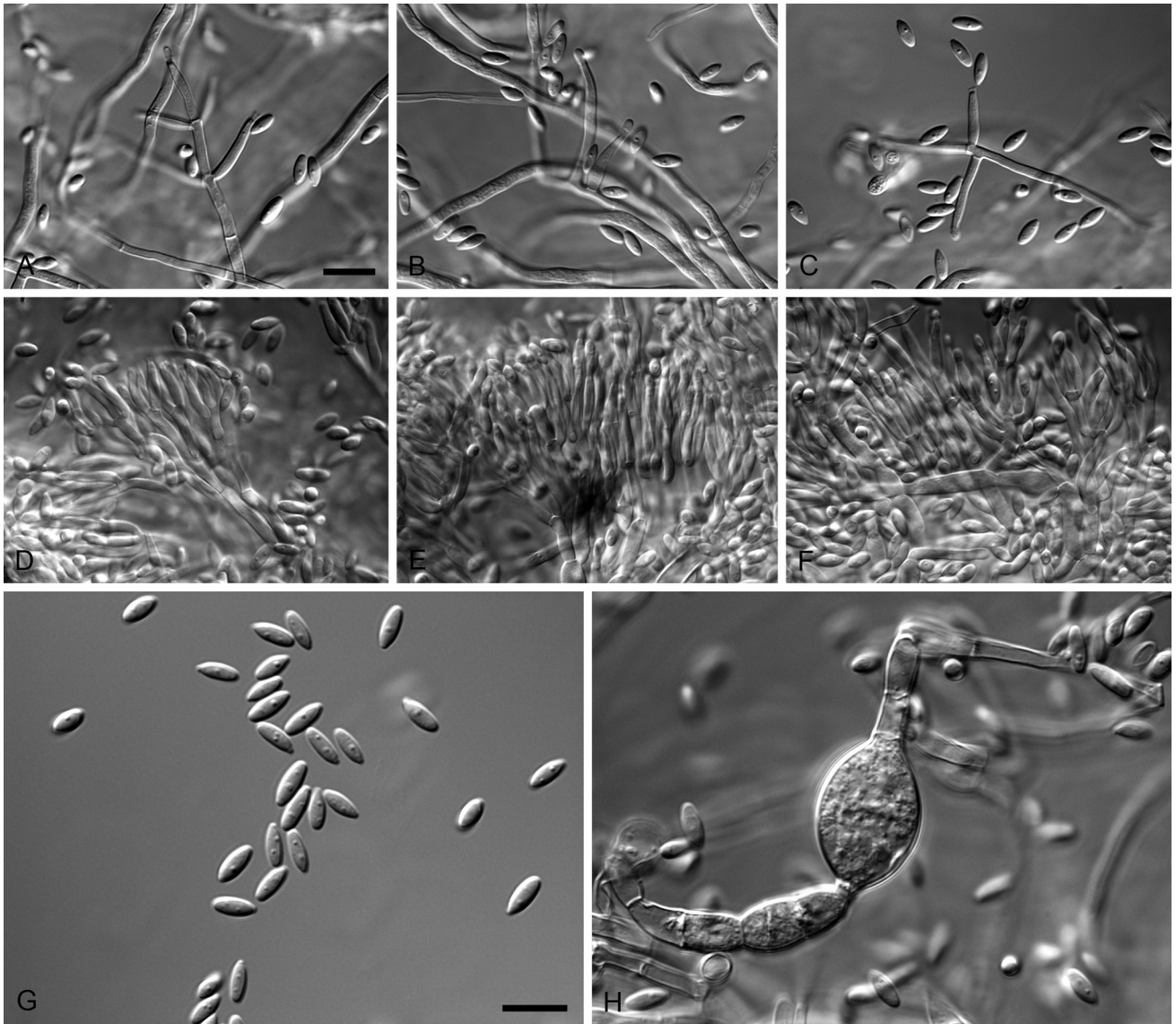


Fig. 10. *Pseudonectria foliicola* (ex-type CBS 123190). A–C. Simple conidiophores. D–F. Sporodochial conidiophores. G. Conidia. H. Chlamydospores. Scale bars: A = 10 μ m (apply to B–F); G = 10 μ m (apply to H).

0–1-septate (adapted from Sutton 1981 and Rossman *et al.* 1999).

Type species: *Sarcopodium circinatum* Ehrenb. ex Schlecht., Synop. Pl. Crypt. 2: 101. 1824. Fig. 11.

- ≡ *Sarcopodium circinatum* Ehrenb., Syl. Mycol. Berol. 12 & 23. 1818.
- ≡ *Thelephora circinata* (Ehrenb.) Fr., Elenchus Fung. 1: 226. 1828.
- ≡ *Corticium circinatum* (Ehrenb.) Fr., Epi. Syst. Mycol.: 556. 1838.
- ≡ *Hymenochaete circinata* (Ehrenb.) Lév., Ann. Sci. Nat., Bot. 5: 133. 1846.

Descriptions and illustrations: Sutton (1981), Rossman *et al.* (1999).

Notes: Representatives of the genus *Sarcopodium* formed a monophyletic clade (BS \geq 75 %, PP \geq 0.95), closely related to the genus *Pseudonectria*. Rossman *et al.* (1999) established the sexual genus *Lanatonectria*, based on *L. flocculenta*, for nec-triaceous fungi with *Actinostilbe* asexual morphs. Later, Rossman *et al.* (2013) proposed that the genus name *Lanatonectria* be suppressed in favour of *Actinostilbe* based on priority, as per the ICN (McNiell *et al.* 2012). However, Sutton (1981) had already synonymised *Actinostilbe* under the asexual morph genus *Sarcopodium*. Furthermore, Rossman *et al.* (2013) synonymised

L. flocculenta (= *A. macalpinei*) under *A. flocculenta*. *Actinostilbe flocculenta* should be regarded as a synonym of *S. macalpinei* as proposed by Sutton (1981). Phylogenetic inference in this study clearly supports the findings of Sutton (1981). Therefore, we regard *Actinostilbe* as a synonym of *Sarcopodium* and introduce several new combinations below.

Sarcopodium flavolanatum (Berk. & Broome) L. Lombard & Crous, **comb. nov.** MycoBank MB810181.

Basionym: *Nectria flavolanata* Berk. & Broome, J. Linn. Soc., Bot. 14: 114. 1873.

- ≡ *Actinostilbe flavolanata* (Berk. & Broome) Rossman, Samuels & Seifert, IMA Fungus 4: 46. 2013.
- = *Nectria radians* Penz. & Sacc., Malpighia 11: 510. 1897.
- = *Nectria tijbodensis* Penz. & Sacc., Malpighia 11: 512. 1897.
- = *Chilonectria javanica* Penz. & Sacc., Malpighia 11: 508. 1897.
- = *Calonectria sulphurella* Starbäck, Bih. Kungl. Svenska Vetenskapakad. Handl. 25: 30. 1899.
- = *Sphaerostilbe ochracea* Pat., in Duss, Énum. Champ. Guadeloupe: 79. 1903.

Sarcopodium mammiforme (Chardón) L. Lombard & Crous, **comb. nov.** MycoBank MB810182.

Basionym: *Sphaerostilbe mammiformis* Chardón, Sci. Surv. Porto Rico & Virgin Islands 8: 46. 1926.

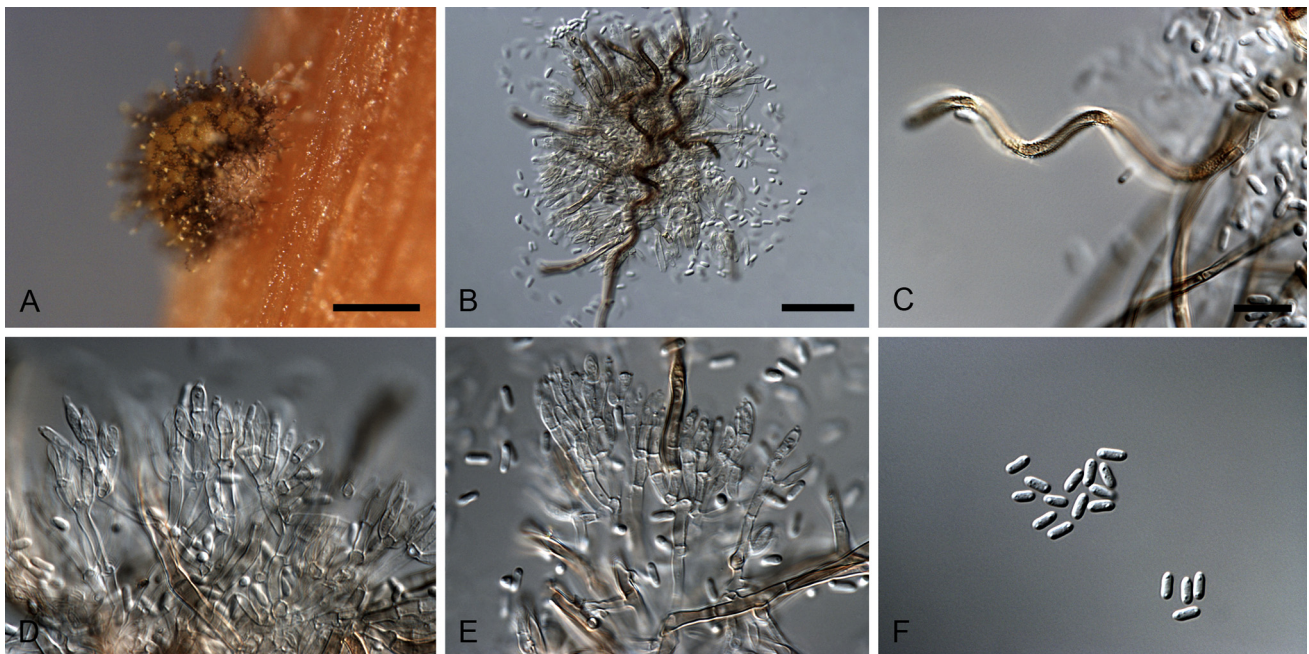


Fig. 11. *Sarcopodium circinatum* (CBS 100998). A–B. Sporodochial conidiomata. C. Circinate setae. D–E. Conidiophores. F. Conidia. Scale bars: A, B = 100 µm; C = 10 µm (apply to D–F).

- ≡ *Nectria mammiformis* (Chardón) Samuels, *Caldasia* 13: 393. 1982.
- ≡ *Lanatonectria mammiformis* (Chardón) Samuels & Rossman, *Stud. Mycol.* 42: 139. 1999.
- = *Actinostilbe mammiformis* (Cif.) Seifert & Samuels, *Stud. Mycol.* 42: 139. 1999.
- ≡ *Stromatographium mammiforme* Cif., *Sydowia* 8: 264. 1954.

Sarcopodium oblongisporum (Y. Nong & W.Y. Zhuang) L. Lombard & Crous, **comb. nov.** MycoBank MB810183.
Basionym: *Lanatonectria oblongispora* Y. Nong & W.Y. Zhuang, *Fungal Diversity* 19: 98. 2005.
 ≡ *Actinostilbe oblongispora* (Y. Nong & W.Y. Zhuang) Rossman *et al.*, *IMA Fungus* 4: 46. 2013.

Sarcopodium raripilum (Penz. & Sacc.) L. Lombard & Crous, **comb. nov.** MycoBank MB810184.
Basionym: *Nectria raripila* Penz. & Sacc., *Malpighia* 15: 228. 1901.
 = *Lanatonectria raripila* (Penz. & Sacc.) Samuels & Rossman, *Stud. Mycol.* 42: 140. 1999.

Volutella Tode 1790: Fr. 1832. *Fungi Mecklenb. Sel.* 1: 28. 1790: *Syst. Mycol.* 3: 458, 466. 1832. MycoBank MB7573.
 = *Volutellonectria* J. Luo & W.Y. Zhuang, *Phytotaxa* 44: 3. 2012.

Ascomata perithecial, solitary, on a thin basal stroma, superficial, obpyriform to pyriform, with an acute apex, orange to red, turning dark red in KOH, smooth or hairy. *Asci* unitunicate, subcylindrical to clavate, 8-spored, with an apical ring. *Ascospores* 1-septate, hyaline, fusiform to biconic, smooth or finely roughened. *Conidiophores* aggregated into sporodochia or synnemata, with an inconspicuous stroma; unbranched, hyaline setae around the margin of conidiomata. *Synnemata* when produced, determinate, pale, composed of a stipe of parallel hyphae and a divergent capitulum of conidiophores giving rise to a slimy conidial mass. *Conidiophore* branching once or twice monochasial, 2-level verticillate, monovercillate or irregularly biverticillate. *Conidiogenous cells* monophialidic, hyaline, subulate, usually with conspicuous periclinal thickening. *Conidia* aseptate, hyaline, ellipsoidal, ovate or oblong, forming slimy white, yellow, orange or pink masses (adapted from Gräfenhan *et al.* 2011 and Luo & Zhuang 2012).

Type species: *Volutella ciliata* (Alb. & Schw.: Fr.) Fr., *Syst. Mycol.* 3: 466. 1832. Fig. 12.

Descriptions and illustrations: Gräfenhan *et al.* (2011), Luo & Zhuang (2012).

Notes: Representatives of the genus *Volutella* formed a monophyletic clade (BS ≥ 75 %, PP ≥ 0.95), distinct from the clades representing *Coccinonectria* and *Pseudonectria*. *Volutella* shares several morphological characters of the asexual morph with these genera.

Volutella asiana (J. Luo, X.M. Zhang & W.Y. Zhuang) L. Lombard & Crous, **comb. nov.** MycoBank MB810185.
Basionym: *Volutellonectria asiana* J. Luo, X.M. Zhang & W.Y. Zhuang, *Phytotaxa* 44: 5. 2012.

Notes: Luo & Zhuang (2012) established the sexual genus *Volutellonectria* (Vo.), with *Vo. consors* as type, and indicated that *Volutella* (*V.*) *minima* represents the asexual morph. However, Gräfenhan *et al.* (2011) synonymised *V. minima* under *Vo. consors*. Additionally, Luo & Zhuang (2012) introduced two more species in the genus *Volutellonectria*, namely *Vo. asiana* as a new species, and *Vo. ciliata* (= *V. ciliata*) as a new combination. Given the obscurity of *Volutellonectria* and the number of name changes that would be required if the use of this name were perpetuated, we propose that the sexual genus *Volutellonectria* be suppressed in favour of the asexual genus *Volutella*, which also has priority by date. Therefore only the single new combination proposed in this study is required.

Clade VIII

Atractium Link: Fr., *Mag. Ges. naturf. Freunde, Berlin* 3: 10. 1809: Fries, *Syst. Mycol.* 1: xli. 1821. MycoBank MB7291.

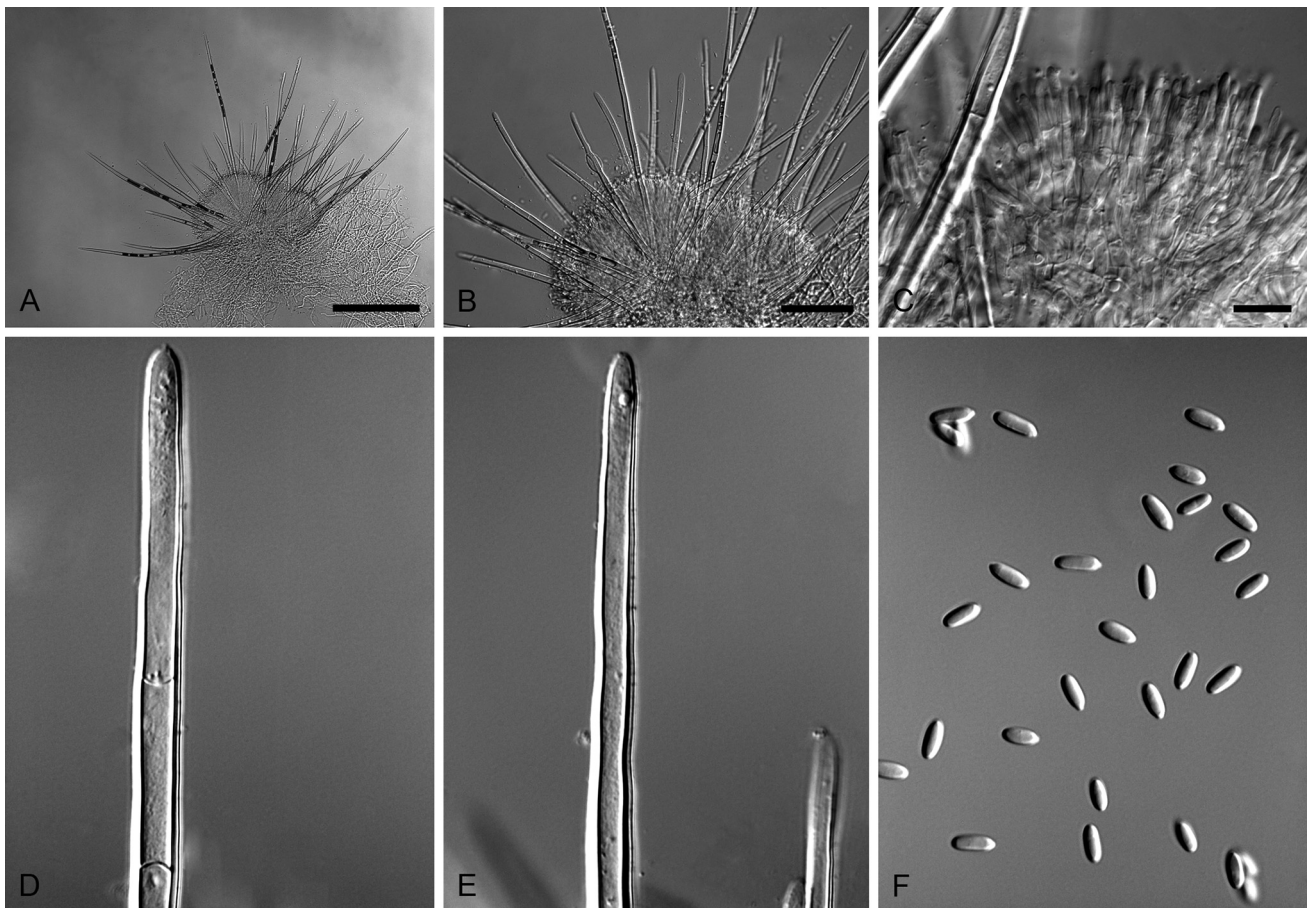


Fig. 12. *Volutella ciliata* (CBS 483.61). A–B. Sporodochial conidiomata. C. Conidiophores. D–E. Setae. F. Conidia. Scale bars: A = 100 µm; B = 50 µm; C = 10 µm (apply to D–F).

Ascomatal state unknown. *Conidiophores* aggregated into sporodochia or synnemata, non-stromatic. *Synnemata* determinate, pale brown, composed of a stipe of parallel hyphae and a divergent capitulum of conidiophores giving rise to a slimy conidial mass. *Conidiophore* branching once or twice monochasial, 2-level verticillate, monovercillate or irregularly biverticillate. *Conidiogenous cells* monophialidic, hyaline, subulate with conspicuous periclinal thickening. *Conidia* (0–)1–5-septate, clavate, obovoid or gently curved, rarely ellipsoidal, with a rounded apical cell, and somewhat conical basal cell, lacking a differentiated foot, forming yellow to orange masses (adapted from Gräfenhan et al. 2011).

Type species: Atractium stilbaster Link, Mag. Ges. naturf. Freunde, Berline 3: 10. 1809.

≡ *Fusarium stilbaster* (Link) Link, Caroli Linné Sp. Pl. Ex. Pl. Rite Cogn. Gen. Relat. 6: 106. 1825.

= *Atractium fuscum* Sacc., Syll. Fung. 2: 514. 1883.

≡ *Stilbella fusca* (Sacc.) Seifert, Stud. Mycol. 27: 77. 1985.

= *Atractium flavoviride* Sacc., Syll. Fung. 2: 514. 1883.

= *Stilbum madidum* Peck, Annual Rep. New York St. Mus. Nat. Hist. 46: 35. 1893.

= *Didymostilbe eichleriana* Bres. & Sacc., C. r. Congr. Bot. Palermo: 59. 1902.

= *Didymostilbe capillacea* Bres. & Sacc., Anns Mycol. 1: 28. 1903.

= *Didymostilbe obovoidea* Matsush. Icon. Microfung. Matsush. Lect.: 60. 1975.

Description and illustrations: Gräfenhan et al. (2011).

Note: Representatives of the genus *Atractium* formed a monophyletic clade (BS ≥ 75 %, PP ≥ 0.95), closely related to the genera *Calostilbe* and *Ophionectria*.

Calostilbe Sacc. & Syd., Syll. Fung. 16: 591. 1902. MycoBank MB758.

= *Nectria* subgen. *Phaeonectria* Sacc., Syll. Fung. 11: 359. 1895.

≡ *Phaeonectria* (Sacc.) Sacc. & Trotter, Syll. Fung. 22: 485. 1913.

= *Calostibella* Höhn., Ber. Deutsch. Bot. Ges. 37: 160. 1919.

Stromata well-developed, originating from a central point, pseudoparenchymatous below the ascomata, giving rise to synnemata, ascomata forming at the base and on rhizoids that arise from the stromata, growing under bark and breaking through at points. *Ascomata* perithecial, superficial, densely aggregated, ovoid, not collapsing or collapsing laterally when dry, orange, turning sienna in KOH, apical region with acute papilla. *Ascomata* surface prosenchymatous, walls thickened. *Asci* clavate, apex simple, base pointed to pedicellate. *Ascospores* fusiform to ellipsoidal, 1-septate, slightly constricted or not, yellow-brown, coarsely striate, appearing as longitudinal furrows. Asexual morph synnematal, arising throughout the stromata. Hyphae of the synnemata parallel, branched, with the ends of the hyphae at the surface with small “cork screws”, giving the surface a granular-crystalline aspect. *Phialides* formed in a well-defined, hemispherical cluster, with a swollen, often slightly flared apex at the tip and cylindrical base. Sterile elements interspersed with phialides, straight, smooth, thin-walled, septate. *Conidia* ellipsoidal, 1-septate, yellow-brown, thick-walled in the centre becoming hyaline and thin-walled at the ends, held in a solitary, brown drop of liquid at the apex (adapted from Rossman et al. 1999).

Type species: Calostilbe striispora (Ellis & Everh.) Seaver, Mycologia 20: 248. 1928.

- ≡ *Nectria striispora* Ellis & Everh., Bull. Iowa Univ. Lab. Nat. Hist. 2: 398. 1893.
- ≡ *Macbridella striispora* (Ellis & Everh.) Seaver, Mycologia 1: 196. 1909.
- ≡ *Letendraea striispora* (Ellis & Everh.) Weese, Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 125: 514. 1916.
- = *Sphaerostilbe longiasca* Möller, Bot. Mitt. Tropen 9: 122. 1901.
- ≡ *Calostilbe longiasca* (Möller) Sacc. & P. Syd., Syll. Fung. 16: 591. 1902.
- ≡ *Letendraea longiasca* (Möller) Weese, Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 128: 742. 1919.
- ≡ *Nectria longiasca* (Möller) E. Müll., Beitr. Kryptogamenfl. Schweiz 11: 636. 1962.
- = *Sphaerostilbe musarum* Ashby, Bull. Dept. Agric. Jamaica 2: 118. 1914.
- = *Calostibella calostilbe* Höhn., Ber. Deutsch. Bot. Ges. 37: 160. 1919.
- = *Xenostilbum sydowii* Petr., Sydowia 13: 106. 1919.
- = *Calostilbe ledermannii* Syd., Engl. Bot. Jahrb. 57: 322. 1922.

Description and illustrations: [Rossman et al. \(1999\)](#).

Notes: We recommend that the generic name *Calostilbe* be protected over the generic name *Calostibella* based on priority. Therefore, *Calostibella calostilbe* should be regarded as a synonym of *Calostilbe striispora*.

Ophionectria Sacc., *Michelia* 1: 323. 1878. MycoBank MB3608.

= *Antipodium* Piroz., *Canad. J. Bot.* 52: 1143. 1974.

Ascomata perithecial, solitary or aggregated in groups, sometimes seated on a white to bright yellow subiculum of thick-walled, minutely warted septate hyphae, each cell swollen at one end, superficial, ovoid to elongate-ovoid to cylindrical, often truncate at the apex, red-orange to scarlet, turning dark red to bay in KOH, covered with conspicuous, concolorous warts of loosely compacted, irregularly globose, pigmented cells; *ascomata* often naked towards the apex. *Asci* clavate, 8-spored, with simple apex. *Ascospores* long-fusiform, often somewhat bent, vermiform, multi-septate, the proximal end slightly inflated and bluntly rounded, the distal end tapering and narrowly rounded, thick-walled, hyaline, with faint longitudinal striations or smooth. *Conidiophores* arise laterally from hyphae, septate, unbranched, erect, straight, thin-walled, hyaline tapering toward the apex, terminating in a cylindrical phialide. *Conidia* (2–)3–5(–6)-septate, with the two middle cells larger than the end cells, fusiform and not constricted at the septa, or broadly ellipsoidal to ovoid and somewhat constricted at the median septum, initially hyaline turning olive-yellow with age (adapted from [Pirozynski 1974](#) and [Rossman et al. 1999](#)).

Type species: *Ophionectria trichospora* (Berk. & Broome) Sacc., *Michelia* 1: 323. 1878.

- ≡ *Nectria trichospora* Berk & Broome, J. Linn. Soc., Bot. 14: 115. 1875.
- ≡ *Dialonectria trichospora* (Berk. & Broome) Cooke, *Grevillea* 12: 111. 1884.
- ≡ *Tubeufia trichospora* (Berk. & Broome) Petch, *Ann. Roy. Gard. Peradeniya* 5: 285. 1912.
- = *Calonectria ornata* A.L. Smith, J. Linn. Soc., Bot. 35: 8. 1901.
- = *Calonectria cinnabarina* P. Henn., *Hedwigia* 36: 220. 1897.
- ≡ *Ophionectria cinnabarina* (P. Henn.) P. Henn., *Hedwigia* 41: 7. 1902.
- = *Calonectria theobromae* Pat., in Duss, *Énum. Champ. Guadeloupe*: 81. 1903.
- = *Ophionectria portoricensis* Chardón, *Mycologia* 13: 285. 1912.
- = *Antipodium spectabile* Piroz., *Canad. J. Bot.* 52: 1143. 1974.

Descriptions and illustrations: [Pirozynski \(1974\)](#), [Rossman \(1977\)](#), [Rossman et al. \(1999\)](#).

Notes: *Ophionectria trichospora*, the type of the genus ([Rossman 1977](#)), is directly linked to the type of the asexual genus

Antipodium ([Pirozynski 1974](#)), known as *A. spectabile*. [Rossman \(1977\)](#) re-evaluated the generic status of *Ophionectria* and retained only the type species. Later, [Rossman \(1983\)](#) added *O. magniverrucosa* to the genus. A second species isolated from *Arechae catechu*, *A. arechae*, was added to the genus *Antipodium* by [Matsushima \(1980\)](#). However, based on the description and illustrations provided, this species should be considered a member of the genus *Trichothecium* ([Summerbell et al. 2011](#)). Since the generic name *Ophionectria* (1878) has priority over the generic name *Antipodium* (1974), we recommend that the generic name *Ophionectria* be protected against *Antipodium*.

Clade IX

Albonectria Rossman & Samuels, *Stud. Mycol.* 42: 105. 1999. MycoBank MB27953.

Ascomata perithecial, solitary to gregarious on a sparse to well-developed stroma, superficial, globose to subglobose to ellipsoidal or ovoid to obovoid, white to pale yellow to pale ochraceous, not changing colour in KOH, warty, with or without a small pointed papilla. *Asci* narrowly clavate or broadly clavate to ellipsoidal, 4–8-spored. *Ascospores* ellipsoidal to long-ellipsoidal or fusiform to long-fusiform, multiseptate, hyaline to yellow-brown, smooth to striate. *Conidiophores* monophialidic, polyphialidic or sporodochial. *Microconidia* variable in shape, 0–1-septate, hyaline, smooth, with or without a flattened basal papilla, or with or without a poorly developed foot cell. *Macroconidia* cylindrical to broadly fusiform or long fusiform to clavate, multiseptate, curved, with curved, pointed tip and foot-cell, or distinctly beaked at both ends (adapted from [Gerlach & Nirenberg 1982](#) and [Rossman et al. 1999](#)).

Type species: *Albonectria rigidiuscula* (Berk. & Broome) Rossman & Samuels, *Stud. Mycol.* 42: 105. 1999.

- ≡ *Nectria rigidiuscula* Berk. & Broome, J. Linn. Soc., Bot. 14: 116. 1873.
- ≡ *Calonectria rigidiuscula* (Berk. & Broome) Sacc., *Michelia* 1: 313. 1878.
- = *Calonectria lichenigena* Speg., *Bol. Acad. Nac. Ci.* 11: 530. 1889.
- = *Calonectria eburnean* Rehm., *Hedwigia* 37: 196. 1898.
- = *Calonectria sulcata* Starbäck, *Bih. Kongl. Svenska Vetenskapskad. Handl.* 25: 29. 1899.
- = *Calonectria meliae* Zimm., *Centralbl. Bakteriol. Parasitenk.* 7: 106. 1901.
- = *Calonectria cremea* Zimm., *Centralbl. Bakteriol. Parasitenk.* 7: 140. 1901.
- = *Calonectria hibiscicola* Henn., *Hedwigia* 48: 105. 1908.
- = *Fusarium decemcellulare* Brick, *Jahresber. Vereinigung. Angew. Bot.* 6: 277. 1908.
- = *Scoleconectria tetraspora* Seaver, *North Amer. Flora* 3: 27. 1910.
- ≡ *Calonectria tetraspora* (Seaver) Sacc. & Trotter, *Syll. Fung.* 22: 487. 1913.

Descriptions and illustrations: [Gerlach & Nirenberg \(1982\)](#), [Rossman et al. \(1999\)](#).

Notes: The sexual genus *Albonectria* was introduced by [Rossman et al. \(1999\)](#) to accommodate species with white to pale yellow *ascomata* associated with *Fusarium* asexual morphs. Representatives of this genus formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related but separate from the clades representing *Cyanonectria*, *Geejayessia* and *Fusarium*.

Bisifusarium L. Lombard, Crous & W. Gams, **gen. nov.** MycoBank MB810226. [Fig. 13](#).

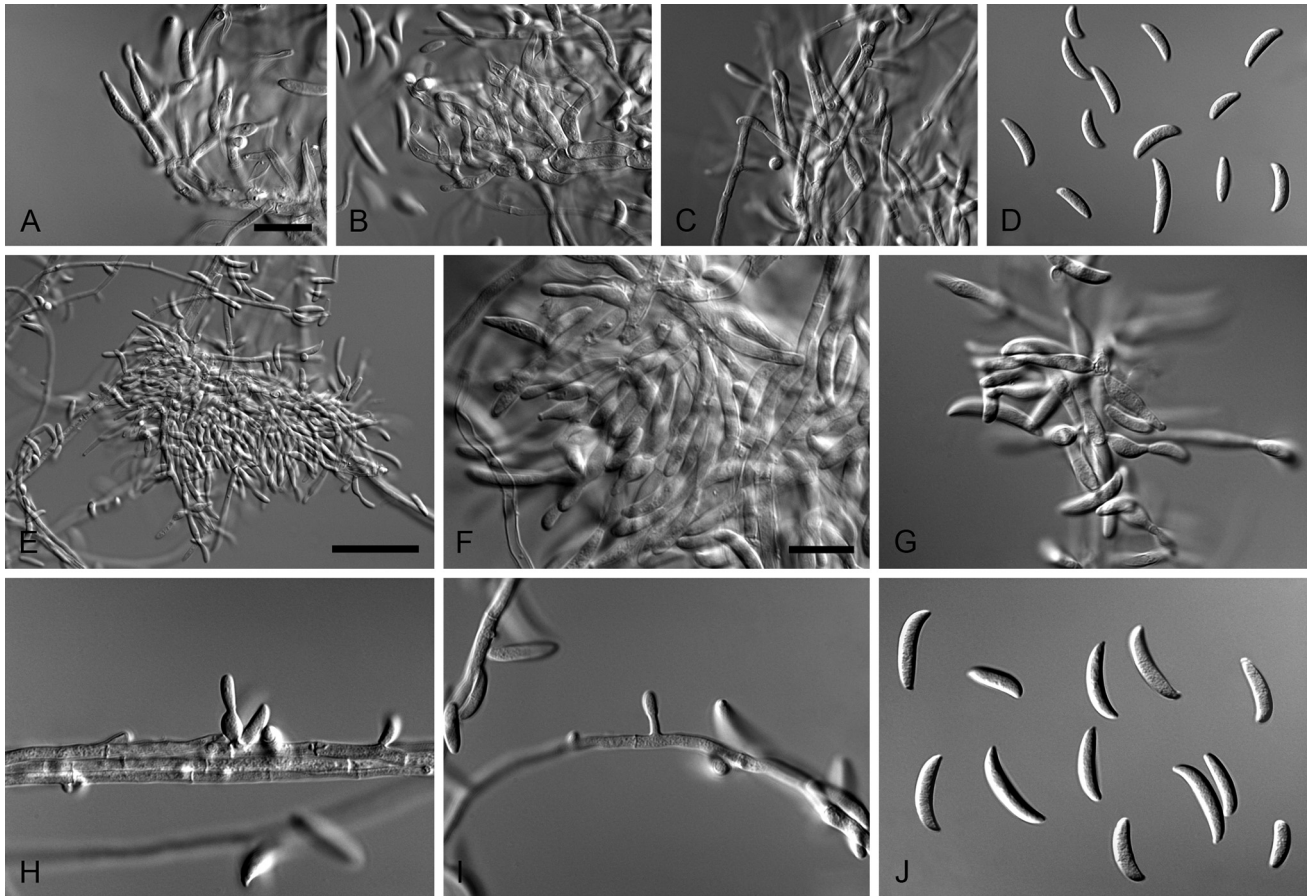


Fig. 13. *Bisifusarium*. A–D. *B. dimerum* (ex-type CBS 108944). A–C. Sporodochia. D. Conidia. E–J. *B. delphinooides* (ex-type CBS 120718). E–G. Sporodochia. H–I. Lateral phialidic pegs. J. Conidia. Scale bars: A = 10 μ m (apply to B–D); E = 50 μ m; F = 10 μ m (apply to G–J).

Etymology: Name refers to the 2-celled macroconidia characteristically formed by these fungi.

Ascomatal state unknown. *Conidiophores* macronematous, lateral phialidic, simple or sporodochial. Later phialidic pegs arising from superficial or submerged hyphae. Simple conidiophores monophialidic, rarely polyphialidic, cylindrical and slightly tapering towards the apex, or flask-shaped, solitary or aggregated when forming terminally or laterally on hyphae. *Sporodochia* pionnotal or hemispherical. Pionnotal sporodochia poorly developed, consisting of densely arranged phialides or short supporting cells with whorls of phialides; whorls arising laterally from hyphae or from irregularly branched conidiophores. Hemispherical sporodochia consisting of a core of angular, uniformly thin-walled, hyaline cells bearing cylindrical phialide-subtending cells or monophialides. *Microconidia* 0(–1)-septate, ellipsoidal and straight or allantoid, broadly lunate to reniform or curved and tapering at both ends, mostly formed by monophialidic conidiophores and lateral phialidic pegs as inconspicuous heads. *Macroconidia* (0–)1–2(–3)-septate, curved to lunate, with a distal end slightly more bent than the proximal end or with both ends equally bent, both ends tapering, the proximal end typically slightly pedicellate, mostly formed as masses on poorly or well-developed sporodochia. *Chlamydospores*, if present, globose to subglobose to ellipsoidal, solitary or in chains, sometimes aggregated into sclerotia (adapted from [Schroers et al. 2009](#)).

Type species: *Bisifusarium dimerum* (Penz.) L. Lombard & Crous.

Notes: The genus *Bisifusarium* is established here to accommodate fusarium-like species previously classified in the genus *Fusarium*. Species of *Bisifusarium* can be distinguished from species in *Fusarium* by their short, (0–)1–2(–3)-septate macroconidia and the formation of lateral phialidic pegs arising from the hyphae ([Gerlach & Nirenberg 1982](#), [Schroers et al. 2009](#)), rarely seen in the genus *Fusarium*. Past phylogenetic studies ([Schroers et al. 2009](#), [O'Donnell et al. 2013](#)) showed that species of *Bisifusarium* (as the *Fusarium dimerum* species group; [Schroers et al. 2009](#)) formed a well-supported monophyletic clade, closely related but separate to “the *Fusarium* terminal clade” ([Geiser et al. 2013](#)). Phylogenetic inference in this study further supports this observation, with representatives of *Bisifusarium* forming a well-supported clade (BS = 100 %, PP = 1.0) closely related but separate from the clade representing the genus *Fusarium*.

Bisifusarium biseptatum (Schroers, Summerbell & O'Donnell) L. Lombard & Crous, **comb. nov.** MycoBank MB810227.

Basionym: *Fusarium biseptatum* Schroers, Summerbell & O'Donnell, *Mycologia* 101: 59. 2009. [non *Fusarium biseptatum* Sawada, *Special Publ. Coll. Agric. Natl. Taiwan Univ.* 8: 228. 1959, nom. inval.]

Description and illustrations: [Schroers et al. \(2009\)](#).

Bisifusarium delphinooides (Schroers, Summerbell, O'Donnell & Lampr.) L. Lombard & Crous, **comb. nov.** MycoBank MB810228.

Basionym: *Fusarium delphinoides* Schroers, Summerbell, O'Donnell & Lampr., *Mycologia* 101: 57. 2009.

? = *Fusarium dimerum* var. *majusculum* Wollenw., *Fus. Autogr. Del.* 1: 90. 1916.

Description and illustrations: [Schroers et al. \(2009\)](#).

Bisifusarium dimerum (Penz.) L. Lombard & Crous, **comb. nov.** MycoBank MB810229.

Basionym: *Fusarium dimerum* Penz., *Michelia* 2: 484. 1882.

≡ *Fusarium pusillum* Wollenw., *Fus. Autogr. Del.* 2: 550. 1924.

≡ *Fusarium aquaeductum* var. *dimerum* (Penz.) Rallo, *Fungi of the genus Fusarium*: 279. 1950.

≡ *Microdochium dimerum* (Penz.) Arx, *Trans. Brit. Mycol. Soc.* 83: 374. 1984.

? = *Fusarium dimerum* var. *pusillum* Wollenw., *Fus. Autogr. Del.* 3: 851. 1930.

Descriptions and illustrations: [Gerlach & Nirenberg \(1982\)](#), [Schroers et al. \(2009\)](#).

Bisifusarium domesticum (Fr.) L. Lombard & Crous, **comb. nov.** MycoBank MB810230.

Basionym: *Trichothecium domesticum* Fr., *Syst. Mycol.* 3: 427. 1832.

≡ *Fusarium domesticum* (Fr.) Bachm., *LWT – Food Sci. Tech.* 38: 405. 2005.

Description and illustrations: [Schroers et al. \(2009\)](#).

Bisifusarium lunatum (Ellis & Everh.) L. Lombard & Crous, **comb. nov.** MycoBank MB810231.

Basionym: *Gloeosporium lunatum* Ellis & Everh., *Proc. Acad. Nat. Sci. Philadelphia*. 43: 82. 1891.

≡ *Fusarium lunatum* (Ellis & Everh.) Arx, *Verh. Kon. Akad. Wetensch., Afd. Natuurk.* 51: 101. 1957.

≡ *Microdochium lunatum* (Ellis & Everh.) Arx, *Trans. Brit. Mycol. Soc.* 83: 374. 1984.

= *Fusarium dimerum* var. *violaceum* Wollenw., *Fus. Autogr. Del.* 3: 854. 1930.

Description and illustrations: [Schroers et al. \(2009\)](#).

Bisifusarium nectrioides (Wollenw.) L. Lombard & Crous, **comb. et stat. nov.** MycoBank MB810232.

Basionym: *Fusarium dimerum* var. *nectrioides* Wollenw., *Fus. Autogr. Del.* 3: 855. 1930.

= *Fusarium nectrioides* (Wollenw.) Schroers, Summerbell & O'Donnell, *Mycologia* 101: 59. 2009.

Description and illustrations: [Schroers et al. \(2009\)](#).

Bisifusarium penzigii (Schroers, Summerbell & O'Donnell) L. Lombard & Crous, **comb. nov.** MycoBank MB810233.

Basionym: *Fusarium penzigii* Schroers, Summerbell & O'Donnell, *Mycologia* 101: 61. 2009.

Description and illustrations: [Schroers et al. \(2009\)](#).

Cyanonectria Samuels & Chaverri, *Mycol. Progress* 8: 56. 2009. MycoBank MB537057.

Ascomata perithecial, gregarious or caespitose, with a reduced or well-developed stroma, smooth, thin-walled, ampulliform to obpyriform or pyriform, dark bluish or red to red-brown,

becoming darker in KOH, with darker bluish purple to black apex. *Asci* cylindrical to narrowly clavate, with rounded or flattened apex, with or without refractive ring, 8-spored. *Ascospores* ellipsoidal, 1-septate, not or slightly constricted at the septum, pale yellow-brown, smooth or finely warted. *Conidiophores* monophialidic, polyphialidic or sporodochial. *Macroconidia* (1–)5–7(–8)-septate, long-fusiform, with gently curving ends, pedicellate foot cell, with a hooked apical cell. *Chlamydospores* formed from cells of macroconidia, subglobose, not formed by hyphae.

Type species: *Cyanonectria cyanostoma* (Sacc. & Flageolet) Samuels & Chaverri, *Mycol. Progress* 8: 56. 2009.

≡ *Nectria cyanostoma* Sacc. & Flageolet, *Atti Congr. Bot. Palermo*: 53. 1902.

≡ *Fusarium cyanostomum* (Sacc. & Flageolet) O'Donnell & Geiser, *Phytopathology* 103: 404. 2013.

Description and illustrations: [Samuels et al. \(2009\)](#), [Schroers et al. \(2011\)](#).

Notes: [Samuels et al. \(2009\)](#) introduced the sexual genus *Cyanonectria*, based on *C. cyanostoma*, to accommodate the sexual morphs of an unnamed *Fusarium* sp., characterised by bicoloured perithecia. Later, [Schroers et al. \(2011\)](#) synonymised *F. buxicola* under *C. buxi*, recognising that the genus *Cyanonectria* formed a strongly supported clade distinct from other sexual genera associated with *Fusarium* asexual morphs. Phylogenetic inference in this study supports the findings of [Samuels et al. \(2009\)](#) and [Schroers et al. \(2011\)](#) with representatives of *Cyanonectria* forming a well-supported monophyletic clade (BS = 100 %, PP = 1.0).

Fusarium Link, *Mag. Ges. Naturf. Freunde Berlin* 3: 10. 1809. MycoBank MB8284.

= *Selenosporium* Corda, *Icon. Fungorum H. Cogn.* 1: 7. 1837.

= *Pionnotes* Fr., *Summa Veg. Scand.* 2: 481. 1849.

= *Gibberella* Sacc., *Michelia* 1: 43. 1877.

= *Sporotrichella* P. Karst., *Meddeland. Soc. Fuana Fl. Fenn.* 14: 96. 1887.

= *Ustilaginoidella* Essed, *Ann. Bot.* 25: 351. 1911.

= *Rachisia* Linder, *Deutsche Essigind.*: 467. 1913.

= *Stagonostroma* Died., *Kryptog. Fl. Mark Brandenburg* 9: 561. 1914.

= *Discofusarium* Petch, *Trans. Brit. Mycol. Soc.* 7: 143. 1921.

= *Pseudomicrocera* Petch, *Trans. Brit. Mycol. Soc.* 7: 164. 1921.

= *Fusidomus* Grove, *J. Bot.* 67: 201. 1929.

= *Botryocrea* Petr., *Sydowia* 3: 140. 1949.

= *Bidenticula* Deighton, *Trans. Brit. Mycol. Soc.* 59: 425. 1972.

= *Pycnofusarium* Punith., *Trans. Brit. Mycol. Soc.* 61: 63. 1973.

Ascomata perithecial, solitary or aggregated into groups, non-stromatic or on a thin stroma, superficial, globose to subglobose to pyriform, white, yellow, orange, red, bluish purple, bluish black or black, changing colour or not changing colour in KOH, slightly rugose to tuberculate to warted. *Asci* narrowly clavate to clavate to cylindrical, 8-spored, with or without an apical ring. *Ascospores* (0–)1–3-septate, mostly ellipsoidal, hyaline or pale yellow-brown. *Conidiophores* mono- or polyphialidic or sporodochial. *Microconidia* absent or present, 0–1(–2) septate. *Macroconidia* 1–multiseptate, straight or curved, with or without a hooked apical cell. *Chlamydospores* absent or present, globose, subglobose to ellipsoidal, formed terminally or intercalarily in chains or singular, sometime aggregating to form sclerotia (adapted from [Gerlach & Nirenberg 1982](#)).

Type species: Fusarium sambucinum Fuckel, Hedwigia 2: 135. 1863.

- = *Fusarium roseum* Link, Mag. Ges. Naturf. Freunde Berlin 3: 10. 1809.
 - ≡ *Fusidium roseum* (Link) Link, Mag. Ges. Naturf. Freunde Berlin 8: 31. 1816.
- = *Sphaeria pulicaris* Kunze, Mykol. Hefte 2: 37. 1823.
 - ≡ *Gibbera pulicaris* (Kunze) Fr., Summa Veg. Scand. 2: 402.
 - ≡ *Botryosphaeria pulicaris* (Kunze) Ces. & De Not. 1963.
 - ≡ *Nectria pulicaris* (Kunze) Tul. & C. Tul. Selec. Fung. Carpol. 3: 63. 1865.
 - ≡ *Cucurbitaria pulicaris* (Kunze) Quéf. Mém. Soc. Émul. Montbéliard. 5: 511. 1875.
 - ≡ *Gibberella pulicaris* (Kunze) Sacc., Michelia 1: 43. 1877.

See [Wollenweber & Reinking \(1935\)](#), [Booth \(1971\)](#) and Index Fungorum (www.indexfungorum.org) for more synonymies.

Notes: The genus *Fusarium* as treated here accommodates *Fusarium* spp. belonging to the *Gibberella* clade ([O'Donnell et al. 2013](#)). This genus includes many important plant pathogenic and medically important species, and includes various *Fusarium* species groups, which could result in the segregation of this genus into more genera. However, a monographic study, which includes a more robust phylogeny, is required to identify and introduce these genera. In this study, representatives of this genus formed a well-supported monophyletic clade (BS = 100 %, PP = 1.0) distinct from the clades representing *Albonectria*, *Cyanonectria* and *Geejayessia*. A new combination is required for *F. sambucinum* (1863), the type species of the genus, as the epithet of *Sphaeria pulicaris* (1823) is older. However, we refrain from doing so here as *F. sambucinum* is extensively used in literature and better known among plant pathologists and other applied biologists.

Description and illustrations: [Gerlach & Nirenberg \(1982\)](#).

Geejayessia [Schroers et al.](#), Stud. Mycol. 68: 124. 2011. MycoBank MB519479.

Ascomata perithecial, aggregated into groups of five or more, broadly ampulliform with a short necks, or broadly ellipsoidal, pale orange, brownish to reddish orange, bright red or black, changing colour in KOH if not black. **Asci** cylindrical or clavate, with a broadly rounded or flattened apex, with or without a minute refractive ring, 8-spored. **Ascospores** 1-septate, broadly ellipsoidal to ellipsoidal, slightly constricted at the septum, verruculose, hyaline to pale brown. **Conidiophores** monophialidic, polyphialidic or sporodochial. **Microconidia** usually absent, when present, then oblong ellipsoidal, gently curved, rounded at both ends or with an asymmetrical hilum. **Macroconidia** formed in white to pale yellow slimy masses, gently curved, with pronounced pedicellate foot cell, and more or less inequilaterally fusoid, hooked apical cell (adapted from [Schroers et al. 2011](#)).

Type species: Geejayessi cicatricum (Berk.) [Schroers](#), Stud. Mycol. 68: 124. 2011.

- ≡ *Sphaeria sanguinea* var. *cicatricum* Berk., Mag. Zool. Bot. 1: 48. 1837.
- ≡ *Nectria cicatricum* (Berk.) Tul. & C. Tul., Selec. Fung. Carpol. 3: 77. 1865.
- ≡ *Fusarium cicatricum* (Berk.) O'Donnell & Geiser, Phytopathology 103: 404. 2013.

Description and illustrations: [Schroers et al. \(2011\)](#).

Notes: The sexual genus *Geejayessia* was introduced to accommodate fusarium-like species characterised by their

broadly ampulliform to broadly ellipsoidal, multicoloured ascospores ([Schroers et al. 2011](#)), and represents a well-supported monophyletic clade (BS = 100 %, PP = 1.0) distinct from the *Fusarium* clade.

Neocosmospora E.F. Sm., U.S.D.A. Div. Veg. Pathol. Bull. 17: 45. 1899. MycoBank MB3447.

- = *Lachnidium* Giard., Compt. Rend. Hebd. des Séances Acad. Sci.: 1520. 1891. (*nom. conf.*)
- = *Hyaloflorea* Bat. & H. Maia, Anais Soc. Biol. Pernambuco 13: 154. 1955.
- ? = *Haematonectria* Samuels & Nirenberg, Stud. Mycol. 42: 134. 1999.

Ascomata perithecial solitary, or aggregated in groups, non-stromatic or with a basal stroma, superficial, globose to pyriform, yellow to orange-brown to red, darkening in KOH, smooth to roughly warted. **Asci** narrowly clavate to cylindrical, simple apex or with a refractive ring, 8-spored. **Ascospores** 0–1-septate, globose to ellipsoidal, hyaline to yellow to yellow-brown, finely striate. **Conidiophores** generally simple, arising laterally from hyphae, rarely polyphialidic or forming poorly developed sporodochia. **Microconidia** 0–1-septate, oval, ellipsoidal to subcylindrical, hyaline, sometimes aggregated in slimy masses. **Macroconidia** subcylindrical, slightly curved with the tips cell slightly hooked, basal cell somewhat pedicellate, multi-septate. **Chlamydospores** when present hyaline to pale yellow, globose to obovoid, terminal or intercalary (adapted from [Rossman et al. 1999](#) and [Nalim et al. 2011](#)).

Type species: Neocosmospora vasinfecta E.F. Sm., U.S.D.A. Div. Pathol. Bull. 17: 45. 1899.

- ≡ *Fusarium neocosmosporiellum* O'Donnell & Geiser, Phytopathology 103: 405. 2013.
- = *Neocosmospora vasinfecta* var. *tracheiphila* E.F. Sm., U.S.D.A. Div. Veg. Pathol. Bull. 17: 45. 1899.
- = *Neocosmospora vasinfecta* var. *nivea* E.F. Sm., U.S.D.A. Div. Veg. Pathol. Bull. 17: 45. 1899.
- = *Pseudonectria ornata* Bat. & Maia, Anais Soc. Biol. Pernambuco 13: 74. 1955.
- = *Neocosmospora vasinfecta* var. *major* Rama Rao, Mycopathol. Mycol. Appl. 21: 218. 1963.
- = *Neocosmospora vasinfecta* var. *conidiifera* Kamyschko, Novoti Sist. Nizsh. Rast. 2: 115. 1965.
- = *Neocosmospora ornamentata* M.A.F. Barbosa, Garcia de Orta, sér. Est. Argon.: 17. 1965.
- = *Neocosmospora vasinfecta* var. *africana* (Arx) P.F. Cannon & D. Hawksw., Trans. Brit. Mycol. Soc. 82: 676. 1984.

Descriptions and illustrations: [Rossman et al. \(1999\)](#), [Nalim et al. \(2011\)](#).

Notes: Three generic names, *Haematonectria* (1999), *Lachnidium* (1891) and *Neocosmospora* (1899) could be applied to this group of fungi ([Rossman et al. 1999](#), [Summerbell & Schroers 2002](#)). However, the generic name *Lachnidium* is based on a *nomen confusum* (see [Madelin 1966](#) and [Kendrick 1974](#)), and can therefore not be used. The genus *Neocosmospora* includes fusarium-like spp. also associated with the sexual genus *Haematonectria*. [Rossman et al. \(1999\)](#) could distinguish these genera based on ascomatal morphology and the reduced asexual morph of *Neocosmospora*. [O'Donnell \(1996\)](#) argued that the asexual morphs of *Neocosmospora* are microconidial *Fusarium* spp. that lost the ability to produce macroconidia and septate ascospores. Recent phylogenetic studies ([Gräfenhan et al. 2011](#), [Nalim et al. 2011](#), [O'Donnell et al. 2013](#)), which included representatives of both genera, showed that these genera are congeneric. As the generic name *Neocosmospora* (1899) is older than the generic name

Haematonectria (1999), the name *Neocosmospora* takes priority for these fungi. Further support is provided by Nalim *et al.* (2011) whom stabilised the name *Nectria haematococca* through epitypification and provided a new combination for this species under the genus name *Neocosmospora* (as *Neo. haematococca*). Phylogenetic inference in this study supported these findings with the clade representing the sexual genus *Neocosmospora* being well-supported (BS \geq 75 %, PP \geq 0.95). However, as with the genus *Fusarium*, a monographic study is required to identify all the species belonging to this genus, and therefore only a few new combinations are introduced at this time. The ex-type strain of *Hyaloflorea ramosa* (CBS 509.63), the type species of the genus *Hyaloflorea* (Batista & Maia 1955) clustered within the *Neocosmospora* clade, and therefore this genus is regarded as a synonym of *Neocosmospora* and a new combination is provided. Two isolates listed in the CBS collection as "*F. ventricosum*" (CBS 320.73 and CBS 101018) also clustered within this clade, separate from other known species, and are therefore described here as new.

Neocosmospora ambrosia (Gadd & Loos) L. Lombard & Crous, **comb. nov.** MycoBank MB810957.

Basionym: *Monacrospium ambrosium* Gadd & Loos, Trans. Brit. Mycol. Soc. 30: 13. 1947.

≡ *Fusarium ambrosium* (Gadd & Loos) Agnihothr. & Nirenberg, Stud. Mycol. 32: 98. 1990.

≡ *Dactylolla ambrosia* (Gadd & Loos) K.Q. Zhang, X.Z. Liu & L. Cao, Mycosystema 7: 112. 1995.

= *Fusarium bugnicourtii* Brayford, Trans. Brit. Mycol. Soc. 89: 350. 1987.

Neocosmospora falciformis (Carrión) L. Lombard & Crous, **comb. nov.** MycoBank MB810958.

Basionym: *Cephalosporium falciforme* Carrión, Mycologia 43: 523. 1951.

≡ *Acremonium falciforme* (Carrión) W. Gams, Cephalosporium-artige Schimmelpilze: 139. 1971.

≡ *Fusarium falciforme* (Carrión) Summerb. & Schroers, J. Clin. Microbiol. 40: 2872. 2002.

Neocosmospora illudens (Berk.) L. Lombard & Crous, **comb. nov.** MycoBank MB810959.

Basionym: *Nectria illudens* Berk., in Hooker, Botany of the Antarctic Voyage II. Flora of New Zealand 7: 203. 1855.

≡ *Cucurbitaria illudens* (Berk.) Kuntze, Rev. Gen. Plant. 3: 461. 1898.

≡ *Haematonectria illudens* (Berk.) Samuels & Nirenberg, Stud. Mycol. 42: 136. 1999.

= *Fusarium illudens* C. Booth, The genus *Fusarium*: 53. 1971.

Neocosmospora ipomoeae (Halst.) L. Lombard & Crous, **comb. nov.** MycoBank MB810960.

Basionym: *Nectria ipomoeae* Halst., Rep. New Jersey Agric. Exp. Sta. 12: 281. 1891.

≡ *Cucurbitaria ipomoeae* (Halst.) Kuntze, Rev. Gen. Plant. 3: 461. 1898.

≡ *Creonectria ipomoeae* (Halst.) Seaver, N. Amer. Flora 3: 22. 1910.

≡ *Hypomyces ipomoeae* (Halst.) Wollew., Phytopathology 3: 34. 1913.

≡ *Haematonectria ipomoeae* (Halst.) Samuels & Nirenberg, Stud. Mycol. 42: 136. 1999.

= *Fusarium javanicum* Koord., Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk. 13: 247. 1907.

= *Hypomyces solani* f. *cucurbitae* W.C. Snyder & H.N. Hansen, Amer. J. Bot. 28: 741. 1941.

Neocosmospora monilifera (Berk. & Broome) L. Lombard & Crous, **comb. nov.** MycoBank MB810961.

Basionym: *Nectria monilifera* Berk. & Broome, J. Linn. Soc., Bot. 14: 114. 1875.

≡ *Nectriella monilifera* (Berk. & Broome) Sacc., Michelia 1: 279. 1878.

≡ *Dialonectria monilifera* (Berk. & Broome) Cooke, Grevillea 12: 110. 1884.

≡ *Neoskofitzia monilifera* (Berk. & Broome) Höhn., Ann. Mycol. 8: 467. 1910.

≡ *Haematonectria monilifera* (Berk. & Broome) Samuels & Rossman, Stud. Mycol. 42: 137. 1999.

Neocosmospora phaseoli (Burkh.) L. Lombard & Crous, **comb. nov.** MycoBank MB810962.

Basionym: *Fusarium martii* f. *phaseoli* Burkh., Mem. Cornell Univ. Agric. Exp. Sta. 26: 1007, 1919.

≡ *Fusarium solani* f. *phaseoli* (Burkh.) W.C. Snyder & H.N. Hansen, Amer. J. Bot. 28: 740. 1941.

≡ *Fusarium phaseoli* (Burkh.) T. Aoki & O'Donnell, Mycologia 95: 671. 2003.

Neocosmospora plagianthi (Dingley) L. Lombard & Crous, **comb. nov.** MycoBank MB810963.

Basionym: *Nectria plagianthi* Dingley, Trans. Roy. Soc. New Zealand 79: 196. 1951.

≡ *Fusarium plagianthi* (Dingley) O'Donnell & Geiser, Phytopathology 103: 404. 2013.

Neocosmospora ramosa (Bat. & H. Maia) L. Lombard & Crous, **comb. nov.** MycoBank MB810242.

Basionym: *Hyaloflorea ramosa* Bat. & H. Maia, Anais Soc. Biol. Pernambuco 13: 155. 1955.

Neocosmospora rubicola L. Lombard & Crous, **sp. nov.** MycoBank MB810243. Fig. 14.

Etymology: Name derived from the plant host *Rubus idaeus*, from which it was collected.

Ascomatal state not observed. *Conidiophores* mononematous, simple, unbranched or aggregated into sporodochia. *Mononematous conidiophores* 13–129 μ m long, 3–7 μ m at the base, hyaline, aseptate or septate, terminating in a single phialide or a penicillate or verticillate arrangement of 2–4 phialides; single phialides 17–60 \times 3–5 μ m, cylindrical, tapering towards the apex, with periclinal thickening and slightly flared collarette; penicillate or verticillate phialides, 13–43 \times 3–4 μ m, cylindrical to allantoid, tapering towards the apex, with periclinal thickening and slightly flared collarette. *Sporodochial conidiophores* irregularly branched, sometimes slightly stipitate; sporodochial phialides cylindrical to allantoid, tapering towards the apex, 11–25 \times 3–4 μ m, with periclinal thickening, with or without slightly flared collarette. *Microconidia* mostly produced by mononematous conidiophores, 0–1(–2)-septate; 0-septate microconidia ellipsoidal to fusiform or obovoid, (8–)9–13(–19) \times (2–)3–4(–5) μ m (av. 11 \times 4 μ m); 1-septate microconidia, ellipsoidal to fusiform, straight to slightly curved, apex acutely rounded, base sometime flattened (13–)15–20(–22) \times (3–)4–6 μ m (av. 18 \times 5 μ m); 2-septate microconidia rarely formed, ellipsoidal to fusiform, straight to slightly curved, 20–22(–24) \times 4–6 μ m (av. 22 \times 5 μ m). *Macroconidia* 3–5-septate, cylindrical, straight or curving at both ends, beaked at both ends: 3-septate macroconidia (27–)32–44(–47) \times 4–6 μ m (av. 38 \times 5 μ m); 4-septate macroconidia (35–)38–48(–53) \times 4–6 μ m (av. 43 \times 5 μ m); 5-septate macroconidia (44–)45–49(–51) \times 5–6 μ m (av. 47 \times 5 μ m). *Chlamydospores* not observed.

Culture characteristics: Colony on PDA reaching 35–40 mm after 7 d at 24 °C, forming abundant white to pale luteous aerial



Fig. 14. *Neocosmospora rubicola* (ex-type CBS 101018). A–C. Sporodochial conidiophores. D. Conidiogenous apparatus with cylindrical to allantoid phialides. E–H. Simple conidiophores. I. Microconidia. J. Macroconidia. Scale bars: B = 50 μ m (apply to C, E–F); D = 10 μ m (apply to G–H); I = 10 μ m (apply to J).

mycelium, arranged in concentric rings, richly sporulating on the aerial mycelium; reverse concolorous. On SNA with sterile carnation leaf pieces, aerial mycelium absent, mononematous conidiophores arising on the surface of the agar; white sporodochia formed abundantly on the surface of the carnation leaf pieces.

Materials examined: **Italy**, on *Rubus idaeus*, Jun. 1998, A. Zizzerini (holotype CBS H-21949, culture ex-type CBS 101018); **Sudan**, isolated from soil, Feb. 1973, M.M. Musa, culture CBS 320.73 = ATCC 24395 = IMI 131652 = NRRL 22107 = NRRL 22122.

Notes: *Neocosmospora rubicola* is described here as a new species in the genus *Neocosmospora*. Sequence comparisons on the FUSARIUM-ID (<http://isolate.fusariumdb.org>; O'Donnell et al. 2010) and *Fusarium* MLST (<http://www.cbs.knaw.nl/fusarium>; O'Donnell et al. 2012) databases were inconclusive, identifying both isolates (CBS 101018 & CBS 320.73) as part of the *F. solani* complex only.

***Neocosmospora solani* (Mart.) L. Lombard & Crous, comb. nov.** MycoBank MB810964.

Basionym: *Fusisporium solani* Mart., Die Kartoffel-Epidemie der letzten Jahre oder die Stockfäule und Räude der Kartoffeln: 20. 1842.

\equiv *Fusarium solani* (Mart.) Sacc. Michelia 2: 296. 1881.
= *Fusarium martii* Appel & Wollew. Arb. Kaiserl. Biol. Anst. Ld.-u. Forstw. 8: 83. 1910.

= *Nectria cancri* Rutgers, Ann. Jard. Bot. Buitenzorg 2: 59. 1913.

= *Fusarium striatum* Sherb., Mem. Cornell Univ. Agric. Exp. Sta. 6: 255. 1915.

(See Index Fungorum (www.indexfungorum.org) and MycoBank (www.mycobank.org) for more synonyms).

Note: Nalim et al. (2011) concluded that *Neocosmospora solani* (= *F. solani*) is not congeneric with *Neo. haematococca* (= *Haematonectria haematococca*) and therefore a new combination is provided here.

***Neocosmospora termitum* (Höhn.) L. Lombard & Crous, comb. nov.** MycoBank MB810965.

Basionym: *Neoskofitzia termitum* Höhn., Sitzungsber. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 117: 998. 1908.

\equiv *Haematonectria termitum* (Höhn.) Samuels & Rossman, Stud. Mycol. 42: 137. 1999.

***Neocosmospora tucumaniae* (T. Aoki, O'Donnell, Yos. Homma & Lattanzi) L. Lombard & Crous, comb. nov.** MycoBank MB810966.

Basionym: *Fusarium tucumaniae* T. Aoki, O'Donnell, Yos. Homma & Lattanzi, Mycologia 95: 664. 2003.

***Neocosmospora virguliformis* (O'Donnell & T. Aoki) L. Lombard & Crous, comb. nov.** MycoBank MB810967.

Basionym: *Fusarium virguliforme* O'Donnell & T. Aoki, Mycologia 95: 667. 2003.

Rectifusarium L. Lombard, Crous & W. Gams, **gen. nov.**
Mycobank MB810252.

Etymology: Name refers to the erect, acremonium-like conidiophores characteristic of these fungi.

Ascomata perithecial, aggregated in groups, dark red, smooth-walled, globose to subglobose, with a papillate ostiolar region, ringed by a short collar of hyphal tips, smooth. *Asci* clavate, 8-spored, with a rounded apex containing a refractive apical ring. *Ascospores* ellipsoidal, 1-septate, constricted at the septum, verrucose, light brown. *Conidiophores* simple, mononematous, straight to flexuous, hyaline, septate, unbranched or rarely branched, terminating in a single phialide. *Phialides* cylindrical, tapering towards the apex, with periclinal thickening and flared collarettes. *Sporodochia* not formed. *Microconidia* rare, ellipsoidal to fusiform, 0–1-septate, hyaline. *Macroconidia* 3-septate, hyaline, ellipsoidal to fusiform, with both ends slightly curved, sometimes with a basal foot cell, apex acutely rounded. *Chlamydospores* hyaline, forming laterally or terminally, globose to subglobose (adapted from Gerlach & Nirenberg 1982).

Type species: *Rectifusarium ventricosum* (Appel & Wollenw.) L. Lombard & Crous.

Notes: The genus *Rectifusarium* is established here to include the fusarium-like species previously treated as *F. ventricosum*. Wollenweber (1913) established the section *Ventricosum* to accommodate *F. ventricosum*, recognising this *Fusarium* sp. as unique in the genus in having no sporodochia. Phylogenetic inference in this study showed that representatives of this group of fungi formed a distinct well-supported clade (BS = 100 %, PP = 1.0), basal to the other clades included in Clade IX.

Rectifusarium robinianum L. Lombard & Crous, **sp. nov.**
Mycobank MB810258. Fig 15.

Etymology: Name derived from the plant host *Robinia pseudoacacia*, from which it was isolated.

Ascomatal state not observed. *Conidiophores* arising laterally from hyphae, simple, unbranched or sparsely branched, mononematous, straight to flexuous, septate, 110–197 × 4–7 µm, terminating in a single phialide; phialides cylindrical, tapering towards the apex, 40–85 × 2–6 µm, with periclinal thickening and slightly flared collarette. *Microconidia* rare, (0–)1-septate, straight and fusiform, or slightly curved and ellipsoidal, 12–16(–17) × 3–4 µm (av. 14 × 3 µm). *Macroconidia* (1–)3-septate, straight or slightly curved, fusiform to ellipsoidal, (22–)25–31(–33) × 5–7 µm (av. 28 × 6 µm), with rounded apex and flattened basal cell. *Chlamydospores* hyaline, verruculose, globose to subglobose, 6–10 µm diam, forming laterally or terminally.

Culture characteristics: Colony on PDA reaching 90 mm after 7 d at 24 °C, forming abundant white to pale luteous aerial mycelium, richly sporulating on the aerial mycelium; reverse concolorous.

Materials examined: **Germany**, Köln, on twig of *Robinia pseudoacacia*, May 1991, U. Kuchenbäcker (**holotype** CBS H-21948, culture ex-type CBS 430.91 = NRRL 25729); Berlin, from *Solanum tuberosum*, Dec. 1985, H. Nirenberg, culture CBS 830.85 = BBA 64246 = NRRL 13953.

Note: *Rectifusarium robinianum* can be distinguished from *R. ventricosum* by its smaller macroconidia and rarely branching acremonium-like conidiophores.

Rectifusarium ventricosum (Appel & Wollenw.) L. Lombard & Crous, **comb. nov.** Mycobank MB810253. Fig. 16.

Basionym: *Fusarium ventricosum* Appel & Wollenw., *Phytopathology* 3: 32. 1913.

≡ *Fusarium solani* var. *ventricosum* (Appel & Wollenw.) Joffe, *Plant and Soil* 38: 440. 1973.

= *Fusarium cuneiforme* Sherb., *Mem. Cornell Univ. Agric. Exp. Sta.* 6: 129. 1915.

Materials examined: **Germany**, Berlin, on tuber of *Solanum tuberosum*, Oct. 1909, H.W. Wollenweber [**holotype** B 700021849 (as *Fusarium argillaceum*)]; (**epitype designated here**: **Germany**, Kiel, from soil in wheat field, Dec. 1979, W. Gerlach, epitype CBS H-21947, MB198380, culture ex-epitype CBS 748.79 = BBA 62452 = NRRL 20846 = NRRL 22113).

Notes: Wollenweber (1917) synonymised *F. ventricosum* and *F. cuneiforme* under *F. argillaceum*. This decision was based on Fuckel's *Fungi Rhenani* no. 226, which Booth (1971) rejected as a misdetermination of *F. argillaceum* as it did not agree with the description of Fries (1832) for *F. argillaceum*. Comparisons of the type material (B 700021849; as *F. argillaceum*) and Wollenweber's *Fusaria autographice delineate* no. 431 agree with the description and illustrations provided by Booth (1971) for *F. ventricosum* based on the isolate CBS 748.79, and therefore we agree with Booth's argument that *F. ventricosum* is not synonymous with *F. argillaceum*.

Clade X

Cosmospora Rabenh., *Hedwigia* 2: 59. 1862. Mycobank MB1273.

= *Cryosogluten* Briosi & Farneti, *Atti Is. Bot. Univ. Lab. Critt. Pavia* 8: 117. 1904.

? = *Dialonectria* (Sacc.) Cooke, *Grevillea* 12: 109. 1884.

≡ *Nectria* subgen. *Dialonectria* Sacc., *Syll. Fung.* 2: 490. 1883.

Ascomata perithecial, scattered or gregarious, with inconspicuous or absent stroma, obpyriform with an acute or papillate apex, orange red or bright red, turning dark red in KOH, smooth walled. *Asci* narrowly clavate to cylindrical, with an apical ring, 8-spored. *Ascospores* initially hyaline, becoming yellow brown to reddish brown, 1-septate, becoming tuberculate when mature. *Conidiophores* acremonium-like, consisting of lateral phialides on somatic hyphae, or with one or two levels of monochasial branching, or verticillate, hyaline. *Phialides* monophalidic, cylindrical to subulate to subclavate, hyaline. *Microconidia* ellipsoidal, oblong or clavate or slightly allantoid, aseptate, hyaline, forming slimy heads. *Macroconidia* absent or rare, subcylindrical, curved, slightly narrowing towards each end, apical cell often slightly hooked with a more or less pointed tip, basal cell not or scarcely pedicellate, 3–5-septate, hyaline (adapted from Rossman *et al.* 1999 and Gräfenhan *et al.* 2011).

Type species: *Cosmospora coccinea* Rabenh., *Hedwigia* 2: 59. 1862 [non *Nectria coccinea* (Pers.) Fr. 1849].

= *Nectria cosmariospora* Ces. & De Not., *Comment. Soc. Crittog. Ital.* 1: 195. 1863.

≡ *Dialonectria cosmariospora* (Ces. & De Not.) Moraves, *Česká Mykol.* 8: 92. 1954.

= *Verticillium olivaceum* W. Gams, *Cephalosporium-artige Schimmelpilze*: 129. 1971.

Descriptions and illustrations: Rossman *et al.* (1999), Gräfenhan *et al.* (2011).

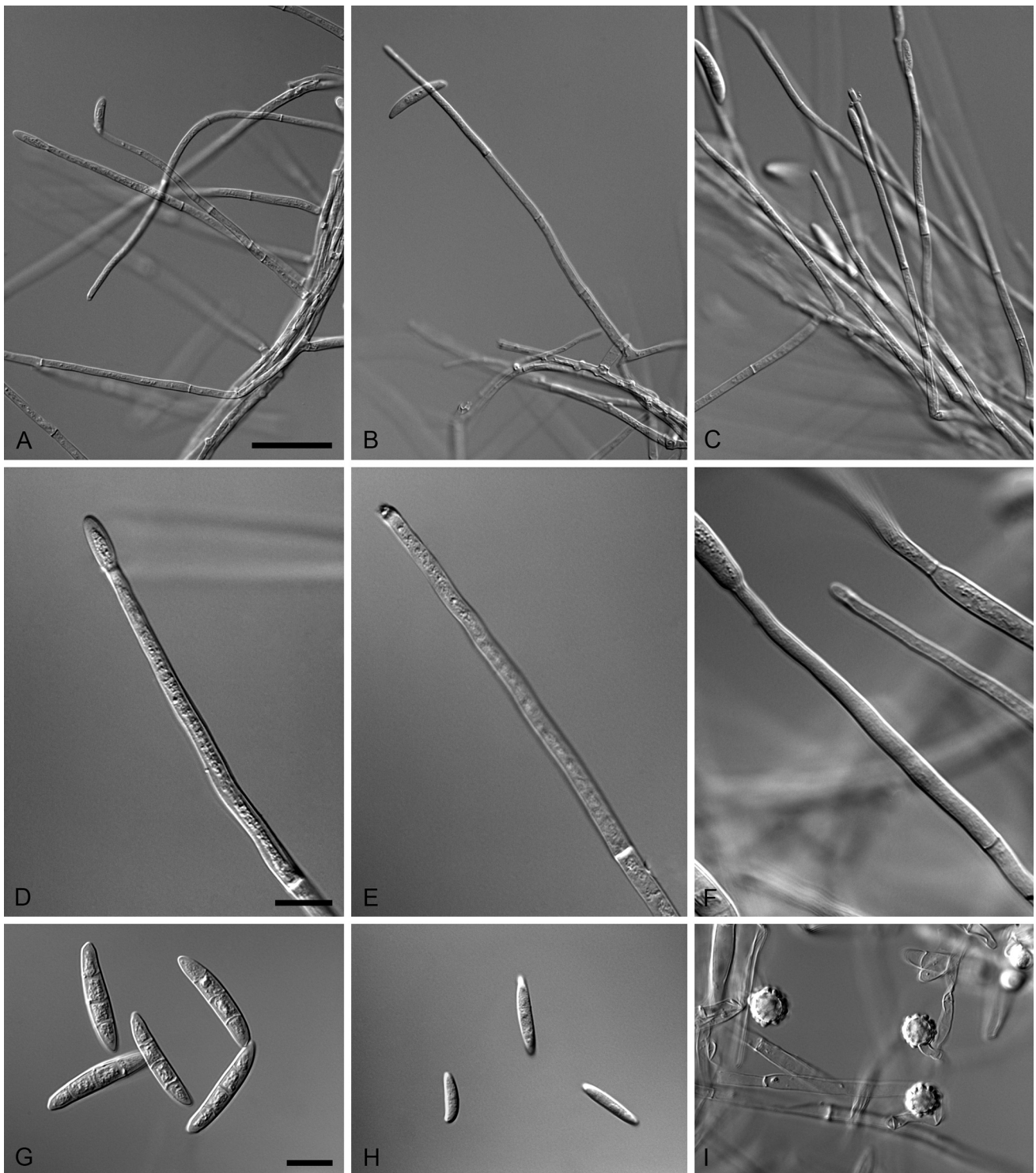


Fig. 15. *Rectifusarium robinianum* (ex-type CBS 430.91). A–F. Conidiophores. G. Macroconidia. H. Microconidia. I. Chlamydospores. Scale bars: A = 50 μm (apply to B–C); D = 10 μm (apply to E–F); G = 10 μm (apply to H–I).

Notes: Representatives of the genus *Cosmospora* formed a well-supported clade (BS \geq 75 %, PP \geq 0.95), which also included representatives of the genus *Dialonectria* (CBS 125493 & CBS 125494; Gräfenhan et al. 2011). Samuels et al. (1991) revised the genus *Dialonectria* (as *Nectria* subgen. *Dialonectria*) and assigned it to *Cosmospora sensu* Rossman. Gräfenhan et al. (2011) later resurrected the genus *Dialonectria* and restricted its generic concept around the type species, *D. episphaeria*, recognising that this species represents a species complex of at least five phylogenetic lineages. Although the phylogenetic

inference in this study supports the findings of Samuels et al. (1991) that *Dialonectria* should be seen as a synonym of *Cosmospora*, we select not to introduce new combinations at present. A monographic study for both genera is required to stabilise the taxonomy of these genera. Furthermore, isolates listed in the CBS collection as “*Acremonium cf. curvulum*” (CBS 100551) and “*Stylonectria wegeliniana*” (CBS 101915) clustered within the *Cosmospora* clade. Both isolates appear to be sterile, and therefore their taxonomic status cannot be determined at present.

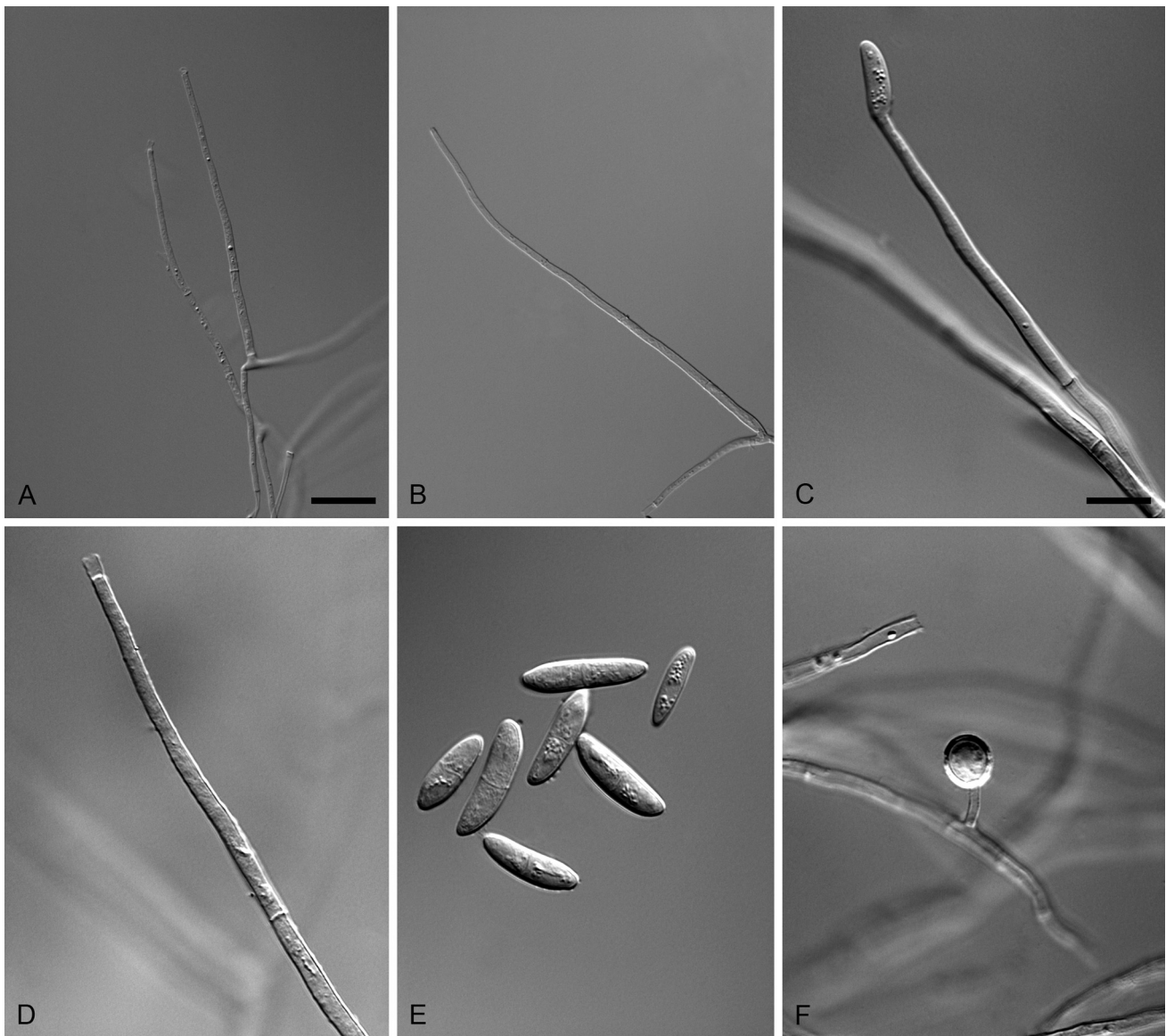


Fig. 16. *Rectifusarium ventricosum* (ex-epitype CBS 748.79). A–D. Conidiophores. E. Macroconidia. F. Chlamydospores. Scale bars: A = 50 μ m (apply to B); C = 10 μ m (apply to D–F).

Fusicolla Bonord., Handb. Allg. Mykol.: 150. 1851. MycoBank MB8294.

Ascomata perithecial, stroma erumpent, fully or partially immersed in a slimy, pale orange sheet of hyphae over the substrate, scattered to gregarious, or in small groups, globose to pyriform with a short acute or disk-like papilla, yellow, pale buff to orange, not changing in KOH, smooth walled. *Asci* cylindrical to narrowly clavate, with an apical ring, 8-spored. *Ascospores* hyaline to pale brown, 1-septate, smooth or slightly verrucose when mature. *Conidiophores* initially as lateral phialides on somatic hyphae, sometimes monochasial, verticillate or penicillate, hyaline. *Phialides* monopialidic, cylindrical to subulate, hyaline. *Microconidia* absent or sparse, ellipsoidal to allantoid, aseptate, hyaline. *Macroconidia* falcate, straight to curved, narrowing towards the ends, apical cell often hooked with a pointed tip, basal cell slightly pedicellate 1–3-septate or 3–5-septate or up to 10-septate, hyaline. *Chlamydospores* absent to abundant, globose, single, in pairs or chains, sometimes forming in macroconidia (adapted from Gerlach & Nirenberg 1982 and Gräfenhan *et al.* 2011).

Type species: Fusicolla betae (Desm.) Bonord. Handb. Allg. Mykol.: 150. 1851.

- ≡ *Fusisporium betae* Desm., Ann. Sci. Nat., Bot. 19: 436. 1830.
- ≡ *Fusarium betae* (Desm.) Sacc., Michelia 2: 132. 1880.
- ≡ *Pionnotes betae* (Desm.) Sacc., Syll. Fung. 4: 726. 1886.
- ≡ *Pionnotes rhizophila* var. *betae* (Desm.) de Wild. & Durieu, Prodrome de la flore belge 2: 367. 1898.

Descriptions and illustrations: Gerlach & Nirenberg (1982), Gräfenhan *et al.* (2011).

Notes: Representatives of the genus *Fusicolla* formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related to but separate from the clades representing the genera *Macroconia* and *Microcera*. Unfortunately, no cultures or sequences of *F. betae* were available to be included in the present study.

Macroconia (Wollenw.) Gräfenhan *et al.*, Stud. Mycol. 68: 101. 2011. MycoBank MB519441.

- ≡ *Nectria* sect. *Macroconia* Wollenw., Angew. Bot. 8: 179. 1926.

Ascomata perithecial, stroma inconspicuous or absent, solitary, subglobose with or without a small apical papilla, orange to carmine red, turning dark red to violet in KOH, sometimes with hyphal hairs arising from the outer wall. *Asci* cylindrical to narrowly clavate, with a simple apex, 8-spored. *Ascospores* yellowish, 1-septate, smooth, sometimes becoming striate when mature. *Conidiophores* initially as lateral phialides on somatic hyphae, later monochasial to verticillate, hyaline. *Phialides* monophialidic, cylindrical to subulate, hyaline. *Microconidia* rare or absent, ellipsoidal to allantoid, hyaline. *Macroconidia* sub-cylindrical to curved, apical cell conical or hooked, basal cell mostly conspicuously pedicellate, 3–7(–14)-septate, hyaline. *Chlamydospores* absent to rare, globose, single, in pairs or chains in hyphae (adapted from Gräfenhan et al. 2011).

Type species: Macroconia leptosphaeriae (Niessl.) Gräfenhan, & Schroers, Stud. Mycol. 68: 102. 2011.

- ≡ *Nectria leptosphaeriae* Niessl., Fungi Saxonici Exsiccati. Die Pilze Sachsen's: no. 165. 1886.
- ≡ *Cucurbitaria leptosphaeriae* (Niessl.) Kuntze, Rev. Gen. Plant. 3: 461. 1898.
- ≡ *Hypomyces leptosphaeriae* (Niessl.) Wollenw., Fus. Autog. Del. 1: 57. 1916.
- ≡ *Lasionectria leptosphaeriae* (Niessl.) Petch, Trans. Brit. Mycol. Soc. 21: 268. 1938.
- ≡ *Cosmospora leptosphaeriae* (Niessl.) Rossman & Samuels, Stud. Mycol. 42: 122. 1999.

Description and illustrations: Gräfenhan et al. (2011).

Notes: The genus *Macroconia* was raised from section name to genus level by Gräfenhan et al. (2011) for fusarium-like species having large macroconidia and minute perithecia. Phylogenetic inference in this study supports this decision, with representatives of this genus forming a well-supported clade (BS = 100 %, PP = 1.0) closely related to but separate from the genera *Fusicolla* and *Microcera*.

Microcera Desm., Ann. Sci. Nat. Bot. 10: 359. 1848. MycoBank MB8920.

= *Pseudomicrocera* Petch, Trans. Brit. Mycol. Soc. 7: 164. 1921.

Ascomata perithecial with stroma and/or byssus covering host, solitary or in groups, globose, with a blunt papilla, orange to dark red, turning dark red or violet in KOH, finely roughened. *Asci* cylindrical to narrowly clavate, with an apical ring, 8-spored. *Ascospores* hyaline to pale yellow-brown, 1(–3)-septate, smooth, sometimes becoming tuberculate when mature. *Conidiophores* as lateral phialides on somatic hyphae, becoming monochasial, verticillate to penicillate, hyaline, forming discrete sporodochia or synnemata on the host. *Phialides* monophialidic, cylindrical to subulate to subclavate, hyaline. *Macroconidia* pale, orange, pink or bright red in mass, sub-cylindrical, moderately or conspicuously curved, apical cell often slightly or conspicuously hooked, basal cell scarcely to conspicuously pedicellate, (0–)3–5(–12)-septate, hyaline (adapted from Gräfenhan et al. 2011).

Type species: Microcera coccophila Desm., Ann. Sci. Nat. Bot. 10: 359. 1848.

- ≡ *Tubercularia coccophila* (Desm.) Bonord., Abh. Naturf. Ges. Halle 8: 96. 1864.
- ≡ *Fusarium coccophila* (Desm.) Wollenw. & Reinking, Die Fusarien, ihre Beschreibung, Schadwirkung und Bekämpfung: 34. 1935.

≡ *Fusarium coccophilum* (Desm.) Wollenw. & Reinking, Die Fusarien, ihre Beschreibung, Schadwirkung und Bekämpfung: 34. 1935.

≡ *Nectria episphaeria* f. *coccophila* (Desm.) W.C. Snyder & H.N. Hansen, Amer. J. Bot. 32: 662. 1945.

≡ *Fusarium episphaeria* f. *coccophilum* (Desm.) W.C. Snyder & H.N. Hansen, Amer. J. Bot. 32: 662. 1945.

= *Atractium flammeum* Berk. & Ravenel, Ann. Mag. Nat. Hist. 13: 461. 1854.

= *Microcera pluriseptata* Cooke & Massee, Grevillea 17: 43. 1888.

Description and illustrations: Gräfenhan et al. (2011).

Notes: The genus *Microcera* includes fusarium-like species generally regarded as entomogenous fungi associated with scale insects, although they can also be found on other substrates (Gräfenhan et al. 2011). Gräfenhan et al. (2011) resurrected this genus based on DNA sequence data and its ecological association, after Wollenweber & Reinking (1935) placed all *Microcera* spp. in *Fusarium*. Our phylogenetic inference supports this decision, as representatives of the genus *Microcera* clustered in a well-supported clade (BS ≥ 75 %, PP ≥ 0.95) distantly related to *Fusarium* but closely related to the genera *Fusicolla* and *Macroconia*.

Stylonectria Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 124: 52. 1915. MycoBank MB5301.

Ascomata perithecial on a thin, white to yellow, hyphal or subiculum-like stroma, gregarious in groups of up to 20, subglobose, pyriform to subcylindrical, with a rounded or broad, circular, flat disc on a venter-like neck, pale yellow, orange-red, orange-brown, or pale to dark red, becoming dark red to purple in KOH, smooth. *Asci* cylindrical to clavate, apex simple or with a ring, 8-spored. *Ascospores* hyaline or yellow to pale brown, 1-septate, cylindrical to allantoid to ellipsoidal, smooth or tuberculate. *Conidiophores* initially formed as unbranched phialides on somatic hyphae, sometimes loosely branched, sometimes forming small sporodochia. *Phialides* monophialidic, cylindrical to sub-cylindrical, with a distinct collarette. *Microconidia* sparse, allantoid to lunulate, slightly or strongly curved, aseptate, in slimy heads. *Macroconidia* orange in mass, subcylindrical or moderately to strongly curved, falcate, 0–1-septate, apex narrower than base, apical cell blunt or hooked, basal cell not or scarcely pedicellate (adapted from Höhnel 1915 and Gräfenhan et al. 2011).

Type species: Stylonectria applanata Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Wien, Math.-Naturwiss. Kl., Abt. 1, 124: 52. 1915.

Descriptions and illustration: Höhnel (1915), Weese (1916), Gräfenhan et al. (2011).

Notes: Species of *Stylonectria* are host-specific fungicolous fungi, which Rossman et al. (1999) considered as a synonym of *Cosmospora*. Phylogenetic inference in this study and Gräfenhan et al. (2011) showed that the genus *Stylonectria* formed a well-supported clade (BS = 100 %, PP = 1.0) basal to the other genera included in Clade X.

Clade XI

Corallomycetella Henn., Hedwigia 43: 245. 1904. MycoBank MB1237.

= *Corallomyces* Berk & M.A. Curtis, J. Acad. Nat. Sci. Philadelphia, Ser. 2: 2: 289. 1853 [non Fr. 1849].

= *Rhizostilbella* Wolk, Mykol. Zentralbl. 4: 237. 1914.

Ascomata perithecial, solitary or gregarious, associated with reddish rhizomorphs or synnemata, obpyriform, orange-red to red, changing to purple in KOH, slightly scruffy, smooth around the ostiole. *Asci* clavate to cylindrical, with an apical ring, 8-spored. *Ascospores* ellipsoidal, 1-septate, constricted at the septum, hyaline to yellow-brown, finely striate. Asexual morph synnematos. *Synnemata* solitary or gregarious, 2–5 caespitose, arising laterally or as terminal extension of the rhizomorphs or directly from the substrate, cylindrical-capitate, subulate-capitate, cylindrical, slender to robust, straight to curved to sinuous, unbranched or branched, hirsute, pale luteous to luteous, turning red to purple in KOH. Marginal hyphae echinulate to verrucose, pale luteous, turning bright red in KOH, with clavate terminal cells, covering the entire surface of stipe. *Conidiophores* unbranched, or once simple monochasial or monoverticillate. *Phialides* cylindrical, terminal, collarettes not flared, periclinal thickening conspicuous. *Conidia* ellipsoidal, ovoidal with a truncate base, aseptate, smooth, forming white to yellow, subglobose conidial masses (adapted from Rossman *et al.* 1999 and Herrera *et al.* 2013b).

Type species: Corallomycetella repens (Berk. & Broome) Rossman & Samuels, Stud. Mycol. 42: 113. 1999.

≡ *Sphaerostilbe repens* Berk. & Broome, J. Linn. Soc., Bot. 14: 114. 1875.

= *Corallomycetella heinsenii* Henn., Hedwigia 43: 245. 1904.

≡ *Corallomyces heinsenii* Henn., Hedwigia 43: 245. 1904.

= *Corallomycetella heinsenii* Henn. Hedwigia 43: 245. 1904.

= *Nectria mauritica* Henn., Seifert & Samuels, Stud. Mycol. 27: 161. 1985.

= *Stilbum incarnatum* Wakker, Ziekten van het Suikerriet op Java, Leiden: 197. 1898.

= *Nectria coccinea* (Pers.: Fr.) Fr. var. *platyspora* Rehm, Ann. Mycol. 7: 137. 1900.

≡ *Nectria platyspora* (Rehm) Weese, Ann. Mycol. 8: 464. 1910.

= *Rhizostilbella rubra* Wolk, Mykol. Zentralbl. 4: 237. 1914.

= *Stilbum incarnatum* var. *dioscoreae* Sacc., Bull. Orto Bot. Regia Univ. Napoli 6: 63. 1918.

= *Cephalosporium kashiense* R.Y. Roy & G.N. Singh, Curr. Sci. 37: 535. 1968.

≡ *Acremonium kashiense* (R.Y. Roy & G.N. Singh) W. Gams, Cephalosporium-artige Schimmelpilze: 138. 1971.

= *Rhizostilbella hibisci* (Pat.) Seifert, Stud. Mycol. 27: 162. 1985.

≡ *Stilbum hibisci* Pat., J. Bot. (Morot): 320. 1891.

Description and illustrations: Herrera et al. (2013b).

Notes: Species of *Corallomycetella* are tropical fungi characterized by the formation of brightly coloured rhizomorphs of their rhizostilbella-like asexual morphs (Seifert 1985, Rossman *et al.* 1999, Herrera *et al.* 2013b). These fungi are associated with rotting diseases of various woody tropical plant hosts (Rossman *et al.* 1999, Herrera *et al.* 2013b). Phylogenetic inference in this study showed that the species of *Corallomycetella* formed a distinct monophyletic clade (BS = 100 %, PP = 1.0).

***Paracremonium* L. Lombard & Crous, gen. nov.** MycoBank MB810267.

Etymology: Name refers to the acremonium-like morphology of these fungi.

Ascomatal morph not observed. *Mycelium* consisting of hyaline, septate, branched hyphae, sometimes forming sterile coils with conidiophores radiating outwards, hyphal septa inconspicuously

swollen. *Conidiophores* arising laterally from somatic hyphae, erect, cylindrical to subcylindrical, unbranched or rarely branched, aseptate or septate, smooth, hyaline. *Conidiogenous cell* terminal, monophialidic, hyaline, smooth, elongate-ampulliform or subcylindrical, tapering towards the apex, with periclinal thickening and inconspicuous collarette. *Conidia* aseptate, fusiform to ellipsoidal to cylindrical, straight to slightly or strongly curved, forming slimy heads on the conidiophore.

Type species: Paracremonium inflatum L. Lombard & Crous.

Notes: The genus *Paracremonium* is established here for different strains from a group of fungi previously treated as *Acremonium recifei* (Gams 1971; also see *Xenoacremonium* below). Species of *Paracremonium* are distinguished from other acremonium-like genera by the formation of sterile coils from which conidiophores radiate and having inconspicuously swollen septa in the hyphae. All species in *Paracremonium* are associated with human infections (see below). Phylogenetic inference in this study showed that representatives of this genus formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related but separate from the clades representing *Corallomycetella* and *Xenoacremonium*.

***Paracremonium inflatum* L. Lombard & Crous, sp. nov.** MycoBank MB810268. Fig. 17.

Etymology: Name refers to the inconspicuously swollen septa of the hyphae formed by this fungus.

Ascomatal state unknown. *Mycelium* consisting of hyaline, septate, branched, 2–4 µm diam hyphae, inconspicuously swollen at the hyphal septa, sometimes forming sterile coils with conidiophores radiating outwards. *Conidiophores* arising laterally from somatic hyphae, erect, subcylindrical, unbranched or rarely branched, 0–1-septate, up to 115 µm tall, 2–3 µm diam, hyaline, smooth, terminating in one or two conidiogenous cells. *Conidiogenous cells* terminal, elongate-ampulliform, tapering towards apex, 20–85 × 2–4 µm, apex 1.5–2 µm diam, with prominent periclinal thickening and inconspicuous collarette, hyaline, smooth. *Conidia* formed in heads at apex of conidiogenous cells, aseptate, ellipsoidal to fusiform, smooth, slightly to strongly curved, 5–6 × 1–2 µm (av. 5 × 2 µm). *Chlamydospores* not seen.

Culture characteristics: Colony on PDA reaching 50–65 mm diam after 7 d at 24 °C; colony consists of semi-immersed aerial mycelium; surface with pink to salmon centre becoming white at the margins; reverse concolorous.

Materials examined: **India**, from a granulomatous lesion on the right hand of a male *Homo sapiens*, Oct. 1977, A.A. Padhye (**holotype** CBS H-21946, culture ex-type CBS 485.77 = CDC 77-043179). **Colombia**, Dep. de Meta, Municipio de Villavicencio, 25 km from road Villavicencio-Acacias, 550°m alt., from soil in maize-field, 18 Feb. 1978, O. Rangel, culture CBS 482.78.

***Paracremonium contagium* L. Lombard & Crous, sp. nov.** MycoBank MB810269. Fig. 18.

Etymology: Name refers to the ability of this fungus to cause a subcutaneous infection of humans.

Ascomatal state unknown. *Mycelium* consisting of hyaline, septate, branched, 2–4 µm diam hyphae, sometimes

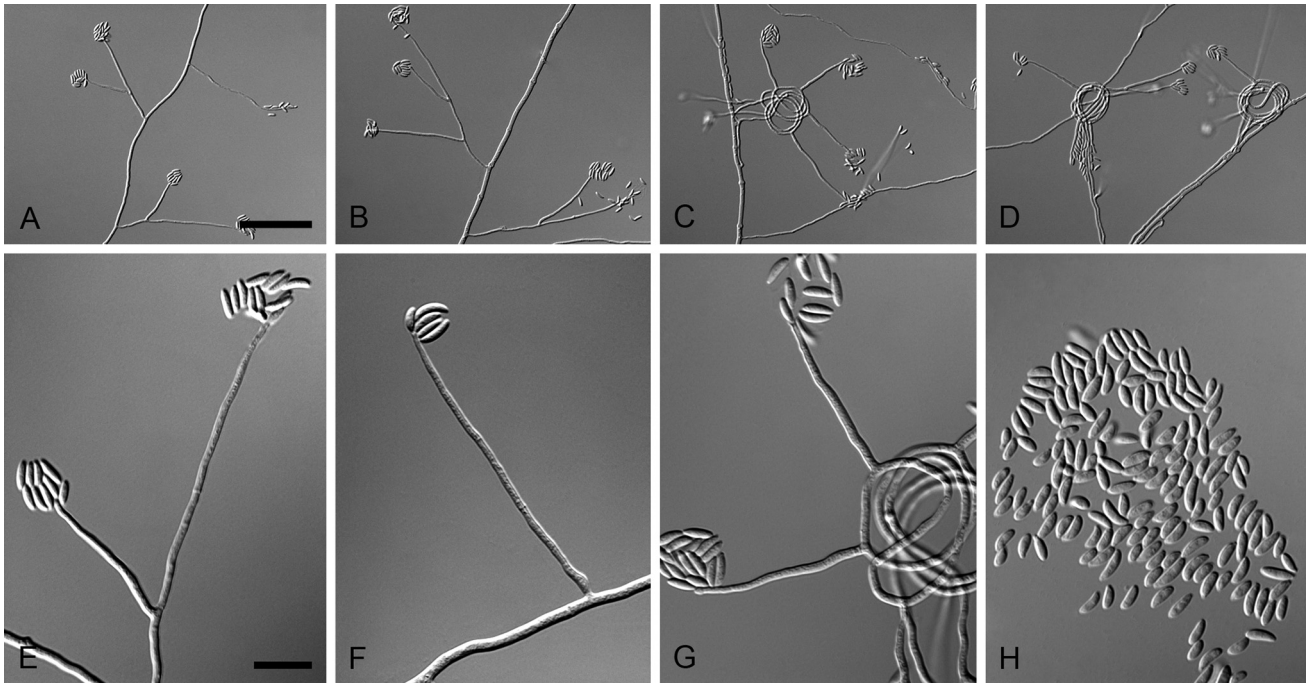


Fig. 17. *Paracremonium inflatum* (ex-type CBS 485.77). A–B, E–F. Conidiophores arising laterally from somatic hyphae with swollen hyphal septa. C–D, G. Conidiophores arising laterally from somatic hyphae in sterile coils. H. Conidia. Scale bars: A = 50 μm (apply to B–D); E = 10 μm (apply to F–H).

inconspicuously swollen at the hyphal septa. *Conidiophores* arising laterally from somatic hyphae, erect, subcylindrical, unbranched or rarely branched, 0–1-septate, up to 75 μm tall, 1–2 μm diam, hyaline, smooth, terminating in one or two conidiogenous cells. *Conidiogenous cells* terminal, elongate-ampulliform, tapering towards apex, 25–50 \times 2–3 μm , apex 1.5–2 μm diam, with prominent periclinal thickening and inconspicuous collarette, hyaline, smooth. *Conidia* formed in heads at apex of conidiogenous cells, aseptate, ellipsoidal to fusiform, smooth, slightly to strongly curved, 4–6(–7) \times 2–3 μm (av. 5 \times 2 μm). *Chlamydozoospores* not seen.

Culture characteristics: Colony on PDA reaching 45–50 mm diam after 7 d at 24 $^{\circ}\text{C}$; colony consists of semi-immersed aerial mycelium; surface with pink to salmon centre becoming white at the margins; reverse apricot in centre becoming salmon to pale pink to white towards the margin.

Material examined: Canada, Ontario, Toronto, from a subcutaneous lesion in the left thigh of a male *Homo sapiens*, S. Mohan (holotype CBS H-21945, culture ex-type CBS 110348 = UAMH 10141).

Note: *Paracremonium contagium* can be distinguished from *P. inflatum* by its shorter conidiophores and the absence of sterile coils from which conidiophores radiate.

Xenoacremonium L. Lombard & Crous, gen. nov.
Mycobank MB810270.

Etymology: Name refers to the acremonium-like morphology of these fungi.

Ascomatal state not observed. *Mycelium* consisting of hyaline, septate, branched hyphae. *Conidiophores* either as lateral phialidic pegs or arising laterally from somatic hyphae, erect, cylindrical to subcylindrical, unbranched or rarely branched, aseptate or septate, smooth, hyaline. *Conidiogenous cells* terminal, monophialidic, hyaline, smooth, elongate-ampulliform or subcylindrical, tapering towards the apex, with periclinal thickening and inconspicuous collarette. *Conidia* aseptate, fusiform to ellipsoidal to cylindrical, slightly or strongly curved, forming slimy heads on the conidiophore.

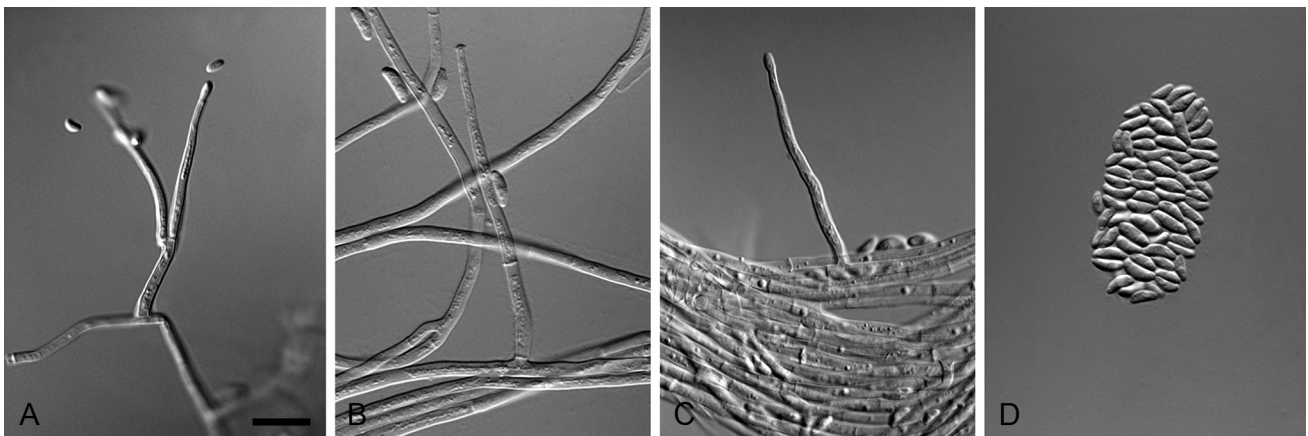


Fig. 18. *Paracremonium contagium* (ex-type CBS 110348). A–C. Conidiophores arising laterally from somatic hyphae. D. Conidia. Scale bar: A = 10 μm (apply to B–D).

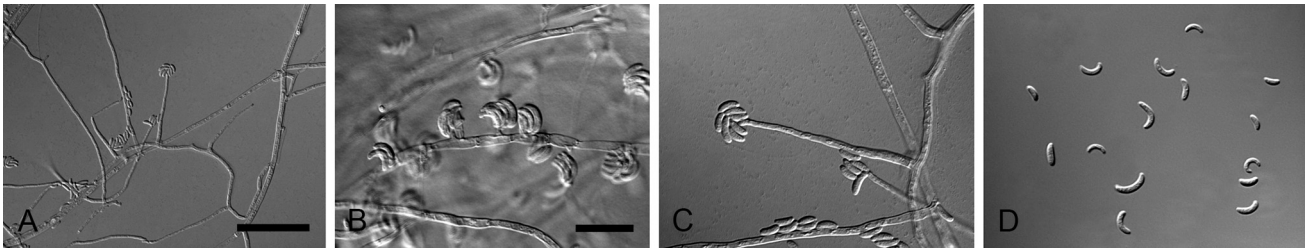


Fig. 19. *Xenoacremonium falcatus* (ex-type CBS 400.85). A, C. Conidiophores arising laterally from somatic hyphae. B. Lateral phialidic pegs. D. Conidia. Scale bars: A = 50 µm; B = 10 µm (apply to C–D).

Type species: *Xenoacremonium recifei* (Leão & Lôbo) L. Lombard & Crous.

Notes: The genus *Xenoacremonium* is established here for a group of fungi previously treated as *Acremonium recifei* (Gams 1971), which includes the ex-type of *A. recifei* (CBS 137.35). Phylogenetic inference in this study showed that representatives of this genus formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related but separate from the clades representing *Corallomycetella* and *Paracremonium*.

***Xenoacremonium falcatus* L. Lombard & Crous, sp. nov.**
MycoBank MB810271. Fig. 19.

Etymology: Name refers to the strongly curved conidia produced by this fungus.

Ascomatal morph unknown. **Mycelium** consisting of hyaline, septate, branched, 2–3 µm diam hyphae. **Conidiophores** either as lateral phialidic pegs, 2–4 × 1–2 µm, or arising laterally from somatic hyphae, erect, subcylindrical, unbranched or rarely branched, 0–1-septate, up to 80 µm tall, 2–4 µm diam, hyaline, smooth, terminating in one or two conidiogenous cells. **Conidiogenous cells** terminal, elongate-ampulliform, tapering towards apex, 25–80 × 2–3 µm, apex 1–2 µm diam, with prominent periclinal thickening and inconspicuous collarete, hyaline, smooth. **Conidia** formed in heads at apex of conidiogenous cells, aseptate, ellipsoidal to fusiform or reniform, smooth, slightly to strongly curved, 4–8(–10) × 1–2 µm (av. 6 × 2 µm). **Chlamydospores** not seen.

Culture characteristics: Colony on PDA reaching 55–60 mm diam after 7 d 24 °C; colony consists of semi-immersed aerial mycelium; surface with pale luteous to luteous centre becoming white towards the margins; reverse pale luteous with pale luteous or luteous pigment throughout the medium.

Material examined: **New Zealand**, North Island, Woodhill Forest, Compartment 75, on *Pinus radiata*, 14 May 1982, J. Reid (**holotype** CBS H-21944, culture ex-type CBS 400.85).

Notes: The conidia of *Xenoacremonium falcatus* [4–8(–10) × 1–2 µm (av. 6 × 2 µm)] are slightly larger than those of *X. recifei* [4–6(–7.5) × 1–2 µm; Gams 1971]. Furthermore, *X. falcatus* produces lateral phialidic pegs on its somatic hyphae, a feature not observed in this study or reported for *X. recifei* by Gams (1971).

***Xenoacremonium recifei* (Leão & Lôbo) L. Lombard & Crous, comb. nov.** MycoBank MB810272. Fig. 20.

Basionym: *Cephalosporium recifei* Leão & Lôbo, C.R. Soc. Biol. R. Janeiro: 205. 1934.

≡ *Hyalopus recifei* (Leão & Lôbo) Leão & M.A.J. Barbosa, Sub. Stud. Parasitol. Genero Hyalopus Corda 1838: 39. 1941.

≡ *Acremonium recifei* (Leão & Lôbo) W. Gams, Cephalosporium-artige Schimmelpilze: 133. 1971.

= *Hyalopus furcatus* Bat. & C. Ram., Atas Inst. Micol. Univ. Recife 4: 290. 1967.

= *Hyalopus furcatum* Bat. & C. Ram., Atas Inst. Micol. Univ. Recife 4: 290. 1967.

Material examined: **Brazil**, from mycetoma on *Homo sapiens*, 1934, A.E. de Area Leão (culture ex-type CBS 137.35).

Clade XII

***Nalanthamala* Subram., J. Indian Bot. Soc. 35: 478. 1956.**

= *Rubrinectria* Rossman & Samuels, Stud. Mycol. 42. 1999.

Ascomata perithecial on an erumpent stroma, aggregated in groups, superficial, globose to broadly ovate or broadly pyriform, with a short, rounded, obtuse papilla, orange-red with orange, rarely green scales, turning dark red in KOH. **Asci** cylindrical, apex simple or with a small, refractive ring, 8-spored. **Ascospores** broadly ellipsoidal to fusiform, 1-septate, slightly constricted at the septum, pale brown to golden-brown, coarsely striate. **Conidiophores** sporodochial or penicillate, stalked, mononematous. **Sporodochia** hyaline, erumpent, hemispherical or flat; cells of well-developed sporodochia angular to globose, forming pseudoparenchymatous tissue, evenly thin-walled. **Phialides** formed singly or in whorls on cylindrical cells that arise from pseudoparenchymatous tissue of sporodochia or in whorls on penicillately branched conidiophores, elongate, widest

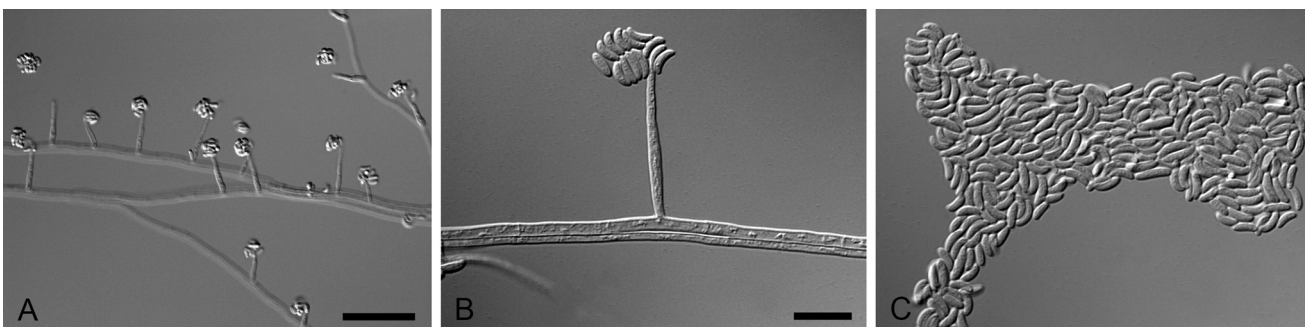


Fig. 20. *Xenoacremonium recifei* (ex-type CBS 137.35). A–B. Conidiophores arising laterally from somatic hyphae. C. Conidia. Scale bars: A = 50 µm; B = 10 µm (apply to C).

at the base or in the lower third, narrowing towards the apex or cylindrical and narrowing below the apex. *Conidia* ovoid, frequently with somewhat truncated ends, hyaline, aseptate, smooth, held in dry chains (adapted from Rossman *et al.* 1999 and Schroers *et al.* 2005).

Type species: Nalanthamala madreeya Subram., J. Indian Bot. Soc. 35: 478. 1956.

Descriptions and illustrations: Rossman et al. (1999), Schroers et al. (2005).

Notes: Species of *Nalanthamala* are tropical fungi associated with wilt and blight diseases of various economically important tropical crops (Schroers *et al.* 2005, Rossman *et al.* 2013). Representatives of this genus formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related to the clade representing the genus *Nectria*. Unfortunately cultures or sequences of *N. madreeya* were not available for the molecular phylogeny.

Nectria (Fr.) Fr., Summa Veg. Scand. 2: 387. 1849. MycoBank MB3431.

- ≡ *Hypocrea* sect. *Nectria* Fr., Syst. Orbis Veg.: 105. 1825.
- = *Ephodrosphaera* Dumort., Commentat. Bot.: 90. 1822.
- = *Sphaerostilbe* Tul. & C. Tul., Sel. Fung. Carpol. 1: 130. 1861.
- = *Megalonectria* Speg., Anales Soc. Ci. Argent. 12: 217. 1881.
- = *Stilbonectria* P. Karst., Hedwigia 28: 194. 1889.
- = *Creonectria* Seaver, Mycologia 1: 183. 1909.
- = *Rhodotrinx* Vain., Ann. Acad. Sci. Fenn. 15: 31. 1921.
- = *Styloletendreae* Weese, Mitt. Bot. Inst. Techn. Hochsch. Wien 1: 60. 1924.
- = *Ochraceospora* Fiore, Boll. Soc. Naturalisti Napoli 41: 90. 1930.

Ascomata perithecial on or nearly or completely immersed in an erumpent stroma, aggregated in groups, red to bay to sienna, turning bright red to blood red to purple in KOH, subglobose to globose, surface smooth to warted. *Asci* cylindrical to narrowly clavate or clavate, with an inconspicuous ring, 8-spored. *Ascospores* ellipsoidal, oblong, fusiform, pyriform or allantoid, rounded at both ends, smooth or spinulose, hyaline, straight to slightly curved, up to 4-septate. *Conidiophores* pycnidial, sporodochial, lateral phialidic pegs or acropleurogenous. *Microconidia* hyaline, ellipsoid to fusoid, rarely curved, aseptate. *Macroconidia* hyaline, ellipsoidal, oblong, cylindrical to allantoid or subglobose to ellipsoidal, 0–1-septate, smooth, straight to slightly curved, rounded at both ends. *Chlamydospores* rare (adapted from Hirooka *et al.* 2012).

Type species: Nectria cinnabarina (Tode: Fr.) Fr., Summa Veg. Scand. 2: 388. 1849.

- ≡ *Sphaeria cinnabarina* Tode: Fr., Tode, Fungi Mecklenburg. Selecti. 2: 9. 1791: Fries, Syst. Mycol. 2: 412. 1823.
- ≡ *Cucurbitaria cinnabarina* (Tode: Fr) Grev., Scot. Crypt. Fl. 3: 135. 1825.
- = *Sphaeria tremelloides* Weigel, Observ. Bot.: 46. 1772.
- = *Tubercularia vulgaris* Tode: Fr., Tode, Fungi Mecklenburg. Selecti. 1: 18. 1790: Fries, Syst. Mycol. 3: 464. 1832.
- = *Sphaeria decolorans* Pers.: Fr., Persoon, Neues Mag. Bot. 1: 83. 1794: Fries, Syst. Mycol. 2: 412. 1823.
- = *Sphaeria celsi* Fr., Elenchus Fung. 2: 81. 1827.
- = *Nectria russellii* Berk. & M.A. Curtis, Grevillea 4: 45. 1875.
- = *Nectria offuscata* Berk. & M.A. Curtis, Grevillea 4: 45. 1875.
- = *Creonectria purpurea* (L.) Seaver, Mycologia 1: 183. 1909.
- ≡ *Tremella purpurea* L., Species Pl.: 1158. 1753.

Description and illustration: Hirooka et al. (2012).

Notes: Hirooka et al. (2012) recently revised *Nectria*, recognising 29 species within the genus. Representatives of this genus included in this study formed a monophyletic clade (BS \geq 75 %, PP \geq 0.95) closely related to the genus *Nalanthamala*.

Clade XIII

Allantonectria Earle, In: Greene, Pl. Baker. 2: 11. 1901. MycoBank MB128.

Ascomata perithecial on a well-developed, erumpent stroma, superficial, scattered to aggregated, subglobose to globose, sometimes with a depressed apical region, bay to scarlet, turning blood-red in KOH, sometimes surface scruffy or scaly, slightly orange. *Asci* narrowly clavate with an inconspicuous ring at the apex, 8-spored. *Ascospores* allantoid to cylindrical with rounded corners, straight to slightly curved, aseptate, hyaline, smooth. *Lateral phialidic pegs* abundant, enteroblastic, monophialidic, flask-shaped. *Conidiophores* abundant, unbranched, sometimes trichoderma-like. *Conidiogenous cells* monophialidic, cylindrical, tapering towards the apex or slightly flask-shaped. *Conidia* oblong or ellipsoidal with strongly constricted centre, hyaline, straight or slightly curved, rounded at both ends (adapted from Hirooka *et al.* 2012).

Type species: Allantonectria miltina (Mont.) Weese, Ann. Mycol. 8: 464. 1910.

- ≡ *Sphaeria miltina* Mont., Explor. Sci. Algérie, Bot. I, 1: 477. 1848.
- ≡ *Nectria miltina* (Mont.) Mont., Syll. Gen. Sp. Pl. Cryptog.: 225. 1856.
- ≡ *Nectriella miltina* (Mont.) Sacc., Michelia 1: 278. 1878.
- = *Allantonectria yuccae* Earle, In: Greene, Pl. Baker. 2: 11. 1901.
- = *Nectriella bacillisporea* Traverso & Spessa, Bol. Soc. Brot. 25: 172. 1910.

Description and illustrations: Hirooka et al. (2012).

Notes: The genus *Allantonectria* is monotypic based on *A. miltina*, recently resurrected to generic level by Hirooka *et al.* (2012) after Rossman *et al.* (1999) placed the type species in *Nectria*. Isolates of *A. miltina* formed a monophyletic clade (BS \geq 75 %, PP \geq 0.95), distinct from the *Nectria* clade, but closely related to the clade representing the genus *Thyronectria*.

Thyronectria Sacc., Grevillea 4 (no. 29): 21. 1875. MycoBank MB5469.

- = *Pleonectria* Sacc., Nuovo Giom. Bot. Ital. 8: 78. 1876.
- = *Chilonectria* Sacc., Michelia 1: 279. 1878.
- = *Nectria* subgenus *Aponectria* Sacc., Michelia 1: 296. 1878.
- ≡ *Aponectria* (Sacc.) Sacc., Syll. Fung. 2: 516. 1883.
- = *Mattiolia* Berl. & Bres., Annuario Soc. Alpinisti Tridentini 14: 55. 1889.
- = *Scoleconectria* Seaver, Mycologia 1: 197. 1909.
- = *Thyronectroidea* Seaver, Mycologia 1: 206. 1909.

Ascomata perithecial, immersed in a stroma or superficial, densely aggregated, subglobose to globose to flask-shaped, apex obtuse, red to umber, turning slightly purple in KOH. *Asci* oblong or clavate, with undifferentiated apex or with an inconspicuous ring, 8-spored. *Ascospores* ellipsoidal, fusiform, long-cylindrical to filiform, hyaline, (0–)1-septate, multiseptate to muriform, smooth or striate, sometimes budding in the ascus to produce oblong to allantoid, aseptate, hyaline, ascoconidia. On natural substrate asexual morph sometimes pycnidial. *Pycnidia* co-occurring with ascomata, solitary or aggregated in groups, superficial, subglobose to irregularly discoid to cupulate or

elongate and erect, rosy, orange, red, violaceous brown to nearly black. *Conidiophores* densely packed, simple, irregularly or verticillately branched. Conidia formed on lateral phialidic pegs or cylindrical to subulate phialides, conidial formation enteroblastic. *Conidia* hyaline, oblong, ellipsoid or allantoid, aseptate. In culture, asexual morph forming verticillate conidiophores or pycnidia. *Conidiophores* unbranched or branched, but sometimes densely branched to form sporodochia. *Conidiogenous cells* monophialidic, cylindrical, slightly curved towards the apex. *Conidia* oblong, ellipsoidal, cylindrical or allantoid, hyaline (0–) 1–2-septate, smooth (adapted from Hirooka *et al.* 2012 and Jaklitsch & Voglmayr 2014).

Type species: Thyronectria rhodochlora (Mont.) Seeler, J. Arnold Arbor. 21: 455. 1940.

- ≡ *Sphaeria rhodochlora* Mont., Ann. Sci. Nat., Bot. 1: 307. 1834.
- ≡ *Mattirolia rhodochlora* (Mont.) Berl. (as "*rhodochlora*"), Atti Congr. Bot. Int., (Genova): 574. 1892.
- ≡ *Pleosphaeria rhodochlora* (Mont.) Sacc., Syll. Fung. (Abellini) 2: 306. 1883.
- ≡ *Trichosphaeria rhodochlora* (Mont.) Sacc., Syll. Fung. (Abellini) 1: 454. 1882.
- = *Pleosphaeria mutabilis* Sacc., Syll. Fung. 2: 306. 1883.
- ≡ *Mattirolia mutabilis* (Sacc.) Checa, M.N. Blanco & G. Moreno, Mycotaxon 125: 153. 2013.
- ≡ *Strickeria mutabilis* (Sacc.) G. Winter, Rabenh. Krypt.-Fl., ed. 2, 1: 288. 1885.
- = *Thyronectria patavina* Sacc., Atti Soc. Veneto-Trentino Sci. Nat. 4: 123. 1875.
- ≡ *Nectria patavina* (Sacc.) Rossman, Mem. New York Bot. Gard. 49: 260. 1989.
- ≡ *Valsonectria patavina* (Sacc.) Cooke, Grevillea 12: 105. 1884.
- = *Nectria pyrrochlora* Auersw., (as "*pyrrochlora*") in Rabenhorst, Hedwigia 8: 88. 1869.
- ≡ *Calonectria pyrrochlora* (Auersw.) Sacc., (as "*pyrrochlora*") *Michelia* 1: 251. 1878.
- ≡ *Thyronectria pyrrochlora* (Auersw.) Sacc., *Michelia* 2: 325. 1881.
- ≡ *Valsonectria pyrrochlora* (Auersw.) Cooke, Grevillea 12: 105. 1884.
- ≡ *Pleonectria pyrrochlora* (Auersw.) G. Winter, Rabenh. Krypt.-Fl. Ed. 2, 1, II. Abt.: Ascomyc.: Gymnoasceen: 108. 1884.
- ≡ *Mattirolia pyrrochlora* (Auersw.) Starbäck, Bih. Kungl. Svenska Vetenskapsakad. Handl. 19: 43. 1894.

Descriptions and illustrations: Hirooka *et al.* (2012), Jaklitsch & Voglmayr (2014).

Notes: Recently, Hirooka *et al.* (2012) revised this group of fungi, placing them in the genus *Pleonectria*, with *P. lamyi* as type, stating that this generic name was the oldest available name for these fungi. Jaklitsch & Voglmayr (2014), however, argued that the generic name *Thyronectria* represents the oldest name for these fungi based on phylogenetic inference. Previously, these fungi were incorrectly placed in the fungal family *Thyridiaceae* due to the presence of paraphyses, but have now been shown to belong to the *Nectriaceae* (Jaklitsch & Voglmayr 2014). Phylogenetic inference in the present study supports this conclusion with representatives of *Thyronectria* forming a monophyletic clade (BS \geq 75 %, PP \geq 0.95) closely related to but separate from the clade representing *Allantonectria*.

Clade XIV

Tilachlidiaceae L. Lombard & Crous, **fam. nov.** MycoBank MB810273.

Ascomatal state unknown. *Conidiophores* synnematosus or acremonium-like. *Synnemata* terete, simple to branched,

cylindrical, narrowing towards the apex, consisting of bundles of parallel longitudinal, closely compacted hyphae with 1–4 scattered phialides terminating the hyphae of the synnema. *Phialides* cymbiform to cylindrical, hyaline, aseptate, with obvious collarettes, narrowing towards the apex. *Conidia* hyaline, fusiform to ellipsoid to subcylindrical, aseptate becoming 1–3-septate in culture, smooth to finely ornamented, with or without mucoid sheath, formed in chains or agglutinating into large spherical or irregular white clumps. Parasitic or saprobic on living or dead foliicolous or entomogenous fungi.

Type genus: Tilachlidium Preuss.

Type species: Tilachlidium brachiatum (Batsch) Petch.

Notes: The fungal family *Tilachlidiaceae* is introduced here to include species of the synnematosus genera *Septofusidium* and *Tilachlidium*. Gams (1971) placed the genus *Septofusidium* in the family *Nectriaceae* based on morphological characters, whereas the genus *Tilachlidium* was classified as *incertae sedis* in the order *Hypocreales* (Gams 1971). No records could be located where *Septofusidium* has been treated in a molecular or phylogenetic analysis and neither are there any DNA sequence records available for this genus on NCBI's GenBank sequence database. Only one record for *T. brachiatum* (CBS 506.67; HQ232177) could be found on GenBank. Therefore, this study represents the first molecular phylogenetic inference to include *Septofusidium*. Representatives of both genera clustered together in a well-supported clade (BS \geq 75 %, PP \geq 0.95) basal to the clades (Clades I–XIII) representing the family *Nectriaceae*, supporting the introduction of the new family *Tilachlidiaceae*.

Tilachlidium Preuss, *Linnaea* 24: 126. 1851. MycoBank MB10236. Fig. 21.

Ascomatal state unknown. *Synnemata* cylindrical, simple or branched, narrowing towards the apex, consisting of bundles of parallel, longitudinal, usually closely compacted hyphae. *Phialides* scattered, hyaline, subulate, gradually narrowing to an acute apex, usually terminating hyphae of the synnema, or as lateral cells of the hyphae, single or in groups. *Conidia* oblong to ellipsoidal, aseptate, hyaline, smooth, covered by a mucoid layer, aggregating into large spherical or irregular masses.

Type species: Tilachlidium brachiatum (Batsch) Petch, Trans. Brit. Mycol. Soc. 21: 66. 1937.

- ≡ *Clavaria brachiata* Batsch., Elenchus Fung. 1: 233. 1786.
- ≡ *Isaria brachiata* (Batsch) Schum., Enum. Fl. Saell. 2: 443. 1803.
- = *Isaria agaricina* Pers., Disp. Meth. Fung.: 111. 1794.
- = *Isaria citrine* Pers., Icon. Descr. Fung. Minus Cognit., Lipsiae: 9. 1798.
- = *Isaria intricata* Fr., Syst. Mycol. 3: 278. 1829.
- = *Isaria filiformis* Wallr., Fl. Cryptog. German. 2: 307. 1833.
- = *Tilachlidium pinnatum* Preuss, *Linnaea* 24: 127. 1851.
- = *Corethrospis epimyces* Masee, J. R. Microbiol. Soc. 5: 759. 1885.
- = *Tilachlidium subulatum* A.L. Smith, Trans. Brit. Mycol. Soc. 3: 122. 1908.
- = *Hirsutella ramosa* Mains, Mycologia 41: 308. 1949.
- = *Tilachlidium ramosum* (Mains) Mains, Mycologia 43: 714. 1952.
- = *Tilachlidium setigerum* Malençon, Bull. Soc. Hist. Nat. Afr. N. 44: 148. 1953.

Descriptions and illustrations: Mains (1951), Gams (1971).

Notes: Species of *Tilachlidium* are saprophytic fungi growing on dried fungi or entomogenous on lepidopterous insects (Petch

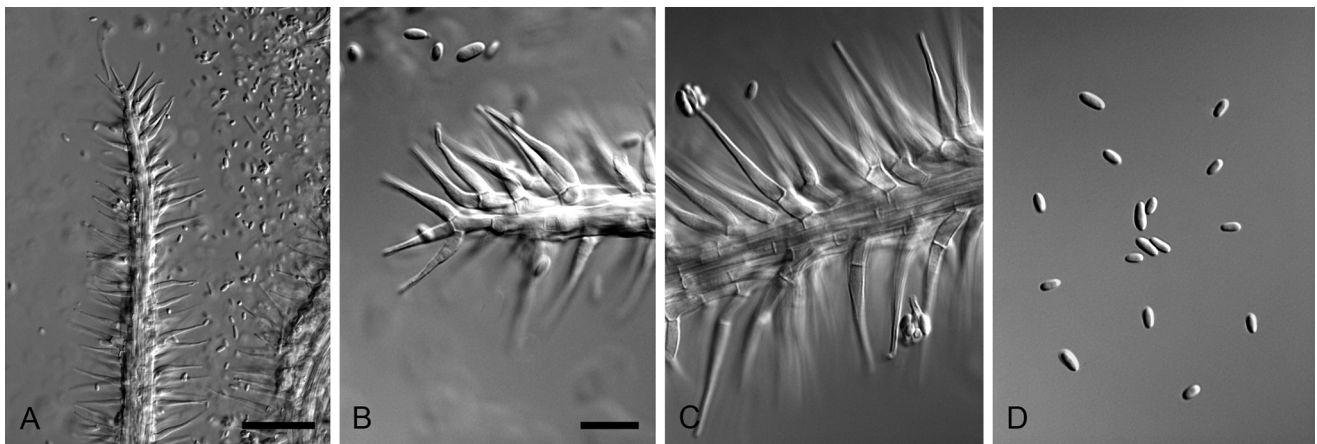


Fig. 21. *Tilachlidium brachiatum* (CBS 505.67). A. Synnema of bundled, parallel, compacted hyphae with lateral and terminal phialides. B. Phialides terminating hyphae of synnema. C. Lateral phialides extending from synnema. D. Conidia. Scale bars: A = 50 µm; B = 10 µm (apply to C–D).

1931, Mains 1951). Representatives of the genus *Tilachlidium* formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related to but separate from the clade representing the genus *Septofusidium*.

Septofusidium W. Gams, *Cephalosporium-artige Schimmelpilze*: 147. 1971. MycoBank MB9882. [Fig. 22](#).

Ascomatal state unknown. *Conidiophores* basitonously verticillate, arising laterally from submerged hyphae. *Phialides* sometimes integrated in septate branches, cylindrical to allantoid, smooth, becoming verrucose, hyaline to yellow. *Conidia* formed in long divergent chains, cylindrical to fusiform, 0–7-septate, hyaline to yellow, smooth or roughened to verrucose, sometimes with distinct hilum at both ends.

Type species: *Septofusidium elegantulum* (Pidopl.) W. Gams, *Cephalosporium-artige Schimmelpilze*: 147. 1971.

≡ *Fusidium elegantulum* Pidopl., *Mykrobiol. Zh.* Kiev 9: 53. 1948.

Descriptions and illustrations: [Gams \(1971\)](#), [Samson \(1974\)](#).

Notes: Species of *Septofusidium* are regarded as parasitic on foliicolous fungi ([Gams 1971](#), [Samson 1974](#)). Representatives of this genus formed a monophyletic clade (BS ≥ 75 %, PP ≥ 0.95) within the larger clade representing the new family *Tilachlidiaceae*. Unfortunately sequences or cultures of *S. elegantulum* were not available for study. One isolate (CBS 696.93) listed as “*Pseudonectria coronata*” in the CBS collection also clustered within the *Tilachlidiaceae* clade. However, this isolate was sterile and analyses of the DNA sequences were inconclusive. Therefore this isolate cannot be identified at present and might be a contaminant of the original culture.

Clade XV

This weakly-supported clade includes representatives of the hypocrealean families *Clavicipitaceae* and *Niessliaceae*. The family *Clavicipitaceae* is represented here by isolates previously treated as *Aphanocladium album* (CBS 401.70, CBS 892.72 & CBS 634.75; [Gams 1971](#)) which formed a well-supported clade (BS = 100 %, PP = 1.0). Based on the illustration provided by [Gams \(1971\)](#) for CBS 401.70 and confirmed by comparisons of

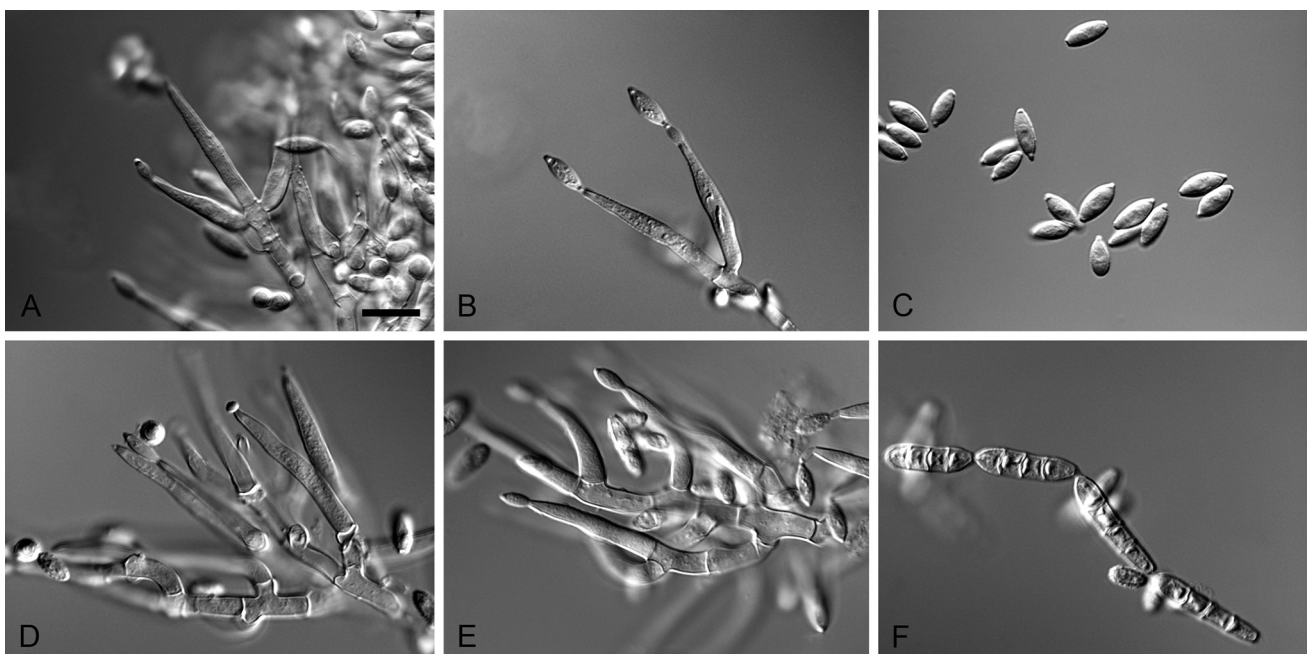


Fig. 22. *Septofusidium*. A–C. *S. herbarum*. A–B. Conidiophores. C. Conidia. D–F. *S. berolinense*. D–E. Conidiophores. F. Conidia. Scale bar: A = 10 µm (apply to B–F).

DNA sequences on NCBI's GenBank sequence database, these isolates represent unknown species in the genus *Pochonia*. Unfortunately, all three isolates appear to be sterile and are therefore tentatively treated as undetermined species of *Pochonia* pending further investigation. The family *Niessliaceae* is represented by *Hyaloseta nolinae* (CBS 109837) and *Trichosphaerella ceratophora* (CBS 130.82). An isolate listed in the CBS collection as "*Nectria dacryocarpa*" (CBS 113532) also clustered within this clade, but is also sterile and no conclusive identification could be made based on DNA sequence comparisons, and is therefore not treated further here.

Clade XVI

This weakly-supported clade includes the ex-type of *Rodentomyces reticulatus* (CBS 128675; [Doveri et al. 2010](#)) and an authentic strain of *Sarocladium kiliense* (CBS 400.52; [Herrera et al. 2013b](#)). The monotypic genus *Rodentomyces* was initially placed in the *Nectriaceae* based on ITS and LSU sequence data ([Doveri et al. 2010](#)). However, this was not supported in the phylogenetic inference in this study. Analyses of the individual gene regions used here clustered both *R. reticulatus* and *S. kiliense* as a weakly-supported clade in the *Nectriaceae* (Clades I–XIII) using the *tub2*, ITS, LSU and *tef1* gene regions (results not shown) basal to the *Nectria* clade (Clade XII). The remaining six genes regions used here, however, placed both these isolates at the basal position represented in [Figs 1 and 2](#). At present, the genus *Sarocladium* is classified as *incertae sedis* in the order *Hypocreales* ([Summerbell et al. 2011](#), [Giraldo et al. 2014](#)), and therefore based on the weak relationship between *R. reticulatus* and *S. kiliense* in this study, both are considered *incertae sedis* pending further investigation. An isolate listed in the CBS collection as "*Nectria dacryocarpa*" (CBS 121.87) also clustered within this clade, but is also sterile and no conclusive identification could be made based on DNA sequence comparisons, and is therefore not treated further here.

Clade XVII

Falcocladium S.F. Silveira et al., Mycotaxon 50: 447. 1994. MycoBank MB25800.

Ascomatal state unknown. *Conidiophores* sporodochial, synnematal, or penicillate when formed on aerial mycelium, hyaline, solitary or aggregated in groups, arising laterally from somatic hyphae, or from a stroma of thick-walled, red-brown chlamydospores. *Stipe extensions* hyaline to pale brown, straight to flexuous, aseptate, thick-walled, originating from any position on a conidiophore branch, or in the position of a phialide, frequently with more than one occurring in the same conidiogenous apparatus, terminating in an ellipsoidal, sphaeropedunculate or turbinate vesicle. *Conidiogenous apparatus* hyaline, aseptate to multi-septate, consisting of up to three series of branches. *Phialides* hyaline, arising from ends of each terminal branch in groups of 2–6, ampulliform or lageniform to subulate, with inconspicuous collarettes. *Conidia* hyaline, 0(–1)-septate, falcate with acute, short apical and basal appendages (adapted from [Crous et al. 1994](#)).

Type species: *Falcocladium multivesiculatum* S.F. Silveira et al., Mycotaxon 50: 448. 1994.

Descriptions and illustrations: [Crous et al. \(1994, 1997, 2007\)](#), [Somrithipol et al. \(2007\)](#).

Notes: The family *Falcocladiaceae* was recently introduced for the genus *Falcocladium* ([Jones et al. 2014](#)), which includes four species, namely *F. multivesiculatum* ([Crous et al. 1994](#)), *F. sphaeropedunculatum* ([Crous et al. 1997](#)), *F. thailandicum* ([Crous et al. 2007](#)) and *F. turbinatum* ([Somrithipol et al. 2007](#)). [Crous et al. \(2007\)](#) judged the genus to be polyphyletic (but allied with the *Hypocreales*) after the ITS sequence of *F. thailandicum* was included in a phylogenetic analysis of this species with *F. multivesiculatum*, *F. sphaeropedunculatum* and other related sequences downloaded from GenBank. Phylogenetic inference in the present study showed that the ex-type of *F. thailandicum* (CBS 121717) clustered within the monophyletic clade (BS $\geq 75\%$, PP ≥ 0.95) representing the genus *Falcocladium*, but distinct from the *Nectriaceae* clade (Clade I–XIII), therefore supporting the introduction of the family *Falcocladiaceae*.

Clade XVIII

This unsupported clade includes *Lectera colletotrichoides* (CBS 109728) of the *Plectosphaerellaceae* (*Hypocreomycetidae*, *incertae sedis*, *Sordariomycetes*), representatives of the genera *Cylindrium* and *Ciliciopodium*, and a single isolate (CBS 122.39) listed as "*Calostilbe striispora*" in the CBS collection. Both *Cylindrium* and *Ciliciopodium* are classified in the family *Nectriaceae* by Index Fungorum and MycoBank and limited literature is available for both genera. Phylogenetic inference in this study excluded both genera from *Nectriaceae* and they are therefore considered as *incertae sedis*.

Untreated or excluded genera

Bacillispora Sv. Nilsson, Bot. Not. 115: 77. 1962. MycoBank MB7304.

Type species: *Bacillispora aquatica* Sv. Nilsson, Botaniska Notiser 115: 77. 1962.

Descriptions and illustrations: Nilsson (1962), Iqbal & Bhatti (1980).

Notes: *Bacillospora* is an aquatic asexual genus established by Nilsson (1962) with *B. aquatica* as type. Based on the descriptions provided by Nilsson (1962) and Iqbal & Bhatti (1980) (for *B. inflata*), members of this genus closely resemble the asexual morphs of the genera *Neonectria* and *Thelonectria*. However, no cultures were available at this time to determine the phylogenetic position of *Bacillospora* in the *Nectriaceae*.

Peziotrichum (Sacc.) Lindau, In: Engler & Prantl, Natürl. Pflanzenfam. 1(1): 467. 1900. MycoBank MB9285.

≡ *Botryotrichum* subgenus *Peziotrichum* Sacc., Hedwigia 32: 58. 1893.

Type species: *Peziotrichum lachnella* (Sacc.) Lindau, In: Engler & Prantl, Natürl. Pflanzenfam. 1(1): 467. 1900.

≡ *Botryotrichum lachnella* Sacc., Hedwigia 32: 58. 1893.

Description and illustration: [Subramanian \(1971\)](#).

Notes: *Peziotrichum* is an entomogenous asexual genus, based on *P. lachnella*, which was initially linked to *Ophionectria coccorum* (Petch 1927, Subramanian 1971). Rossman (1977) synonymised *O. coccorum* under *Podonectria coccorum*, which belongs to the *Tubeufiaceae* (*Pleosporales*, *Pleosporomycetidae*, *Dothideomycetes*; Rossman 1987), a genus also linked to the asexual genus *Tetracrium* (*Tubeufiaceae*, *Pleosporales*, *Pleosporomycetidae*, *Dothideomycetes*; Kodsueb et al. 2006). Since there are no living cultures available representing *Peziotrichum* that would allow for molecular studies, the link of this genus to *Podonectria* and *Tetracrium* cannot be confirmed. *Peziotrichum* could be considered as a member of the *Tubeufiaceae*, based on the descriptions and illustrations provided by Petch (1927) and Subramanian (1971).

Pleogibberella Sacc., In: Berl. & Voglino, Syll. Fung. Addit. 1–4: 217. 1886. MycoBank MB4211.

Type species: *Pleogibberella calami* (Cooke) Berl. & Voglino, Syll. Fung. Addit. 1–4: 217. 1886 (as “*calamia*”).
≡ *Gibberella calami* Cooke, Grevillea 13: 8. 1884.

Description and illustration: Rossman et al. (1999).

Notes: Rossman et al. (1999) studied the type specimen of *Pleogibberella calami*, the only species in this genus, and concluded that this genus is most similar to members of the genus *Nectria* based on the ascomatal wall structure, well-developed stroma and large, muriform ascospores. The type specimen also did not include asexual structures. No living cultures are available to allow this genus to be included in molecular studies.

Pleurocolla Petr., Ann. Mycol. 22: 15. 1924. MycoBank MB9458.

Type species: *Pleurocolla tiliae* Petr. Ann. Mycol. 22: 15. 1924.

Description and illustration: Diehl (1933).

Notes: No living cultures were available for molecular studies.

Pseudocosmospora C. Herrera & P. Chaverri, Mycologia 105: 1291. 2013. MycoBank MB802432.

Type species: *Pseudocosmospora eutypellae* C. Herrera & P. Chaverri, Mycologia 105: 1293. 2013.

Description and illustration: Herrera et al. (2013a).

Notes: Representatives of *Pseudocosmospora* have not been included in this study as no cultures were available to us. Herrera et al. (2013a), however, clearly indicated this sexual genus to form a monophyletic lineage sister to *Dialonectria* and *Cosmospora*.

Stalagmites Thiess. & Syd., Ann. Mycol. 12: 189. 1914. MycoBank MB5182.

Type species: *Stalagmites tumefaciens* (Syd. & P. Syd.) Thiess. & Syd., Ann. Mycol. 12: 189. 1914.

Description and illustration: Rossman et al. (1999).

Notes: This monotypic genus, based on *Stalagmites tumefaciens*, is associated with galls on branches of a *Serjania* sp. Rossman et al. (1999) concluded that this genus belongs in the *Nectriaceae* based on morphological similarities to the sexual morphs of *Fusarium* (as *Gibberella*) and *Pleogibberella*. No living cultures were available for molecular studies.

DISCUSSION

To our knowledge, this study represents the largest sampling of nectriaceous fungi subjected to multi-locus sequence analyses to date. It provides a broad phylogenetic backbone and framework for future studies of the *Nectriaceae*. Members of this family are commonly found in various environments, where they play important socio-economic roles in human endeavours in agriculture, industry and medicine. The phylogenetic foundation set in this study will form the basis for further investigation of several genera, and will allow identification of novel taxa in existing and new fungal groups in this family. Although taxonomic issues have been clarified in some genera in this study, it also highlights some taxonomic problems in the *Nectriaceae*.

Members of the *Nectriaceae* are pleomorphic fungi, displaying both asexual and sexual morphs during their life cycles. This originally resulted in the separate naming of each fungal morph, providing a considerable challenge to fungal systematics (Cannon & Kirk 2000). The implementation of The International Code of Nomenclature for algae, fungi and plants (ICN; McNeill et al. 2012), stipulating that only one scientific name should be used for a fungal species, resulted in the abolishment of dual nomenclature (ICN Art. 59; McNeill et al. 2006, Hawksworth et al. 2011) for pleomorphic fungi. Although selecting the correct generic name for a group of fungi should be based on priority of the oldest generic name, several fungal groups are considered exceptions to this principle based on the need for reasonable nomenclatural stability in fungi of economic or health significance (Rossman et al. 2013). Therefore, Hawksworth (2011, 2012) proposed several criteria to be applied for determining the status of a generic name. These criteria include (1) the number of name changes required, (2) the clarity of the generic concept, (3) the frequency of use of each generic name and (4) the vote of interested members of the scientific community. Applying these criteria, Rossman et al. (2013) proposed the conservation or protection of several generic names in the *Nectriaceae*. Also following this approach, we propose the conservation or protection of the generic names *Penicillifer* (= *Viridispora*), *Sarcopodium* (= *Actinostilbe* = *Lanatonectria*) and *Xenocyliandrocladium* (= *Xenocalonectria*) based on priority of the generic name and the number of name changes required if the alternative generic name is applied. However, the implementation of ICN has already sparked intensive debate, especially where well-established generic names in literature, such as *Fusarium* s. lat. (Geiser et al. 2013, O'Donnell et al. 2013, Aoki et al. 2014), have now been segregated into more narrowly defined genera, with newly introduced and older generic names being applied for these newly segregated fungal groups (Gräfenhan et al. 2011, Schroers et al. 2011).

The generic name *Fusarium* is well-embedded in mycological literature, representing the fourth most commonly published fungal name (see Geiser *et al.* 2013). The segregation of the genus *Fusarium* by Gräfenhan *et al.* (2011) and Schroers *et al.* (2011) was therefore met by strong opposition from the general *Fusarium* working community (Geiser *et al.* 2013, O'Donnell *et al.* 2013, Aoki *et al.* 2014), although the genus *Fusarium* s. *lat.* clearly has internal phylogenetic structure supporting these divisions. A similar debate within the general plant pathological community surrounded the segregation of *Cylindrocarpon* and *Neonectria* into several genera by Chaverri *et al.* (2011). These changes have ultimately been widely accepted (Cabral *et al.* 2012a, b, c, Lombard *et al.* 2013). We therefore choose to retain the generic names *Albonectria*, *Cyanonectria*, *Geejayessia* and *Neocosmospora* as proposed by Gräfenhan *et al.* (2011), Nalim *et al.* (2011) and Schroers *et al.* (2011) for fungal groups previously treated in the genus *Fusarium*. This approach allows for consistency in the taxonomic treatment of genera in the *Nectriaceae*, as several clades, which include important plant pathogens (e.g. Clade III & IV) are shown here to display a similar genetic structure and ecology (e.g. *Campylocarpon*, *Dactylonectria*, *Ilyonectria* and *Neonectria* on *Vitis vinifera*; Cabral *et al.* 2012a, b, c, Lombard *et al.* 2013, 2014a, b).

In this study, we were able to resolve 47 genera in the *Nectriaceae*, of which three genera, namely *Calostilbe*, *Corallonectria* and *Dematiocladium*, are represented by single lineages due to the paucity of cultures. For several of these genera there has been little or no DNA sequence data available prior to this study. These genera include *Aquanectria*, *Curviadiella*, *Cylindrocarpostylus*, *Cylindrodendrum*, *Ophionectria*, *Paracremonium*, *Penicillifer*, *Sarcopodium*, *Septofusidium*, *Tilachlidium*, *Xenoacremonium*, *Xenocylindrocladium*, and *Xenogliocladopsis*. All these genera were shown to form monophyletic clades. New studies will be needed on these groups, especially since two of them, *Paracremonium* and *Xenoacremonium*, represent important human pathogens (Gams 1971). The remaining genera are for the most part regarded as either foliicolous or entomogenous fungi or endophytes and saprobes of mostly woody plant hosts (Ranzoni 1956, Gams 1971, Crous & Kendrick 1994, Kirschner & Oberwinkler 1999, Rossman *et al.* 1999) which might play an important role in industrial applications in future.

Six new genera, which were previously treated as members of the genera *Acremonium*, *Flagellospora*, *Fusarium* and *Pseudonectria*, are introduced here in the family *Nectriaceae*. Species in the new genus *Coccinonectria* were initially regarded as members of the genus *Pseudonectria* mostly based on plant host association (Rossman *et al.* 1999, Gräfenhan *et al.* 2011, Crous *et al.* 2014). Morphologically, *Coccinonectria* species can be distinguished from *Pseudonectria* by their scarlet ascomata, although their asexual morphs share several morphological features. Phylogenetic inference in this study also supported segregation of *Coccinonectria* from *Pseudonectria*, and therefore two new combinations are made in *Coccinonectria*.

Bisifusarium, *Neocosmospora* and *Rectifusarium* were previously treated as members of the genus *Fusarium*. Phylogenetic inference in this study showed that these genera are monophyletic and distinct from each other and *Fusarium*. *Bisifusarium* includes fusarium-like species previously treated as the "*Fusarium dimerum* species complex" (Schroers *et al.* 2005, Geiser *et al.* 2013, O'Donnell *et al.* 2013). They are distinguished by the formation of lateral phialidic pegs, which are not commonly

found in *Fusarium*, and by producing 1–2-septate macroconidia. These fungi are mostly isolated from clinical samples (Schroers *et al.* 2009). Species of *Rectifusarium* are soil-borne fungi and have been isolated from various agricultural crops, but are not regarded as important pathogens or post-harvest pathogens of these crops (Wollenweber 1913, Gerlach & Nirenberg 1982). This genus is distinguished from *Fusarium* by its simple, erect, almost cylindrocarpon-like conidiophores, and the absence of sporodochia. Members of the new genera *Paracremonium* and *Xenoacremonium* were previously treated as *Acremonium recifei* (Gams 1971, Summerbell *et al.* 2011), which have been shown to be paraphyletic (Summerbell *et al.* 2011). Both genera include important human subcutaneous and opportunistic pathogens (Gams 1971, de Hoog *et al.* 2011). Phylogenetic inference guided the recognition of subtle morphological distinctions between the genera. Species of *Paracremonium* can be distinguished by the formation of sterile coils in culture and their pink to salmon coloured colonies on PDA. *Xenoacremonium* species do not form sterile coils in culture, but readily release a pale luteous to luteous pigment into the growth medium, a phenomenon that is not observed in *Paracremonium*.

A new family, *Tilachliaceae*, is introduced here in the order *Hypocreales* for two genera, *Septofusidium* and *Tilachlidium*, previous classified in the family *Nectriaceae*. These genera share several morphological characters and are known to be saprobic or parasitic on other fungi (Petch 1931, Mains 1951, Gams 1971, Samson 1974). Some species of *Tilachlidium* have been shown to produce important antibiotics (Gottshall *et al.* 1951, Roberts 1952) as well as novel compounds that are cytotoxic to leukemia cells (Feng *et al.* 2004), discoveries highlighting the potential for exploitation of these fungi in medical applications.

Comparisons of the phenotypic and ecological characters of genera in the *Nectriaceae* included in this study showed marginal correlations with some of the clades identified in the phylogenetic tree. Genera in Clade I are characterised by their penicillate arrangement of fertile branches but do not all share the same ecological niche. Clade III includes genera that also have a penicillate arrangement of fertile branches but have a sterile stipe extension extending beyond the conidiogenous apparatus and are generally regarded as soil-borne fungi. Clade IV and VI include genera, with the exception of *Cylindrocarpostylus* and *Mariannaea*, having soil-borne cylindrocarpon-like asexual morphs. They are associated with basal rot and canker diseases of their plant hosts. Genera in Clade VII are characterised by their sporodochial asexual morphs with characteristic straight to circinate setae surrounding the sporodochia. They are associated mostly with leaf and stem blight diseases of plant hosts in the *Buxaceae*. Clade X includes genera with fusarium-like asexual morphs. They are generally pathogens of other fungi or of insects.

The ten gene regions used in this study were chosen based on their extensive use in molecular mycology. They have proved suitable to explore phylogenetic relationships within and between genera in the *Nectriaceae* (Chaverri *et al.* 2011, Gräfenhan *et al.* 2011, Hirooka *et al.* 2012, Lombard *et al.* 2010a, b, 2012, 2014a, b, Lombard & Crous 2012, Herrera *et al.* 2013a, b, O'Donnell *et al.* 2013). Although phylogenetic analyses of the individual gene regions (results not shown) were able to resolve all the genera in the *Nectriaceae* with varying statistical support, none of these gene regions can be considered as the "silver bullet" for the *Nectriaceae*. An illustration of the unreliability of individual

genes is found in the placement of *Rodentomyces reticulatus* and *Sarocladium kiliense* within the *Nectriaceae* clade by *tub2*, ITS, LSU and *tef1*, but not by the other six genes studied. The best statistical support for each genus was obtained using *rpb1* and *rpb2*, and therefore these loci should be further studied in attempts to determine phylogenetic relationships in the *Nectriaceae*. However, the ability of these two loci to serve as barcodes for species in these genera still needs to be determined for each genus on an individual basis.

The present study, as mentioned previously, should serve as backbone for future taxonomic studies of genera in the *Nectriaceae*. More loci need to be identified and screened with an eye to finding a more robust single locus – a process that might be expedited by using whole genome sequences. Presently there is an under-representation of *Nectriaceae* in the available whole genome sequences (nine genomes; <http://genome.jgi.doe.gov>). More genomic studies are urgently needed in the *Nectriaceae*. Our study also highlights the importance of maintaining living cultures in public culture collections, as many of the genera included in this study were subjected to molecular analysis for the first time based on cultures collected at various times in history, while, on the other hand, several recently described taxa were unavailable for inclusion.

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APPENDIX

Recently Rossman *et al.* (2013) proposed generic names for acceptance or rejection in the families *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae*. In this treatment, *Clonostachys* was recommended above *Bionectria* in the *Bionectriaceae*. Within the *Hypocreaceae*, *Hypomyces* was recommended over *Cladobotryum*, *Sphaerostilbella* over *Gliocladium*, and *Trichoderma* over *Hypocrea*. In keeping with these proposals and in line with the *International Code of Nomenclature for algae, fungi and plants* (ICN; McNeill *et al.* 2012), new combinations are required in the genera *Clonostachys*, *Hydropisphaera*, *Nectriopsis* (*Bionectriaceae*), and *Sphaerostilbella* (*Hypocreaceae*), which are provided here.

BIONECTRIACEAE

Clonostachys apocyni (Peck) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810968.

Basionym: *Nectria apocyni* Peck, Bull. Buffalo Soc. Nat. Sci. 1: 71. 1873.

≡ *Cucurbitaria apocyni* (Peck) Kuntze, Rev. Gen. Plant. 3: 460. 1898.

≡ *Bionectria apocyni* (Peck) Schroers & Samuels, Z. Mykol. 63: 153. 1997.

= *Nectria rugispora* Pat., Bull. Trimestriell Soc. Mycol. France 8: 133. 1892.

≡ *Cucurbitaria rugispora* (Pat.) Kuntze, Rev. Gen. Plant. 3: 461. 1898.

= *Nectria carneoflavida* Penz. & Sacc., Malpighia 11: 511. 1897.

= *Dendrodochium macrosporum* Sacc. & Ellis, Michelia 2: 580. 1882.

≡ *Clonostachys macrospora* (Sacc. & Ellis) Schroers & W. Gams, Stud. Mycol. 46: 62. 2001.

= *Dendrodochium roseomucosum* Matsush., Matsush. Mycol. Mem. 8: 17. 1995.

Clonostachys aurantia (Penz. & Sacc.) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810969.

Basionym: *Nectriella aurantia* Penz. & Sacc., Malpighia 11: 509. 1897.

≡ *Bionectria aurantia* (Penz. & Sacc.) Rossman, Samuels & Lowen, Mycologia 85: 698. 1993.

Clonostachys blumenaviae (Rehm) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810970.

Basionym: *Nectria blumenaviae* Rehm, Hedwigia 37: 192. 1898.

Clonostachys gibberosa (Schroers) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810971.

Basionym: *Bionectria gibberosa* Schroers, Stud. Mycol. 46: 198. 2001.

Clonostachys manihotis (Rick) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810972.

Basionym: *Nectria manihotis* Rick, Ann. Mycol. 8: 458. 1910.

Clonostachys parva (Schroers) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810973.

Basionym: *Bionectria parva* Schroers, Stud. Mycol. 46: 143. 2001.

Clonostachys tonduzii (Speg.) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810974.

Basionym: *Bionectria tonduzii* Speg., Bol. Acad. Nac. Ci. 579: 563. 1919.

≡ *Nectria tonduzii* (Speg.) Samuels, Mem. New York Bot. Gard. 48: 22. 1988.

Clonostachys tornata (Höhn.) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810975.

Basionym: *Pseudonectria tornata* Höhn., Sitzungsber. Akad. Wiss. Wien, Mat.-Naturwiss. Kl. 118: 1470. 1909.

≡ *Bionectria tornata* (Höhn.) Schroers, Stud. Mycol. 46: 184. 2001.

= *Nectria sesquiphialis* Samuels, Mem. New York Bot. Gard. 49: 276. 1989.

= *Sesquicillium asymmetricum* Samuels, Mem. New York Bot. Gard. 49: 276. 1989.

≡ *Clonostachys asymmetrica* (Samuels) Schroers, Stud. Mycol. 46: 184. 2001.

Note: The sexual-asexual morph connections for these species in *Clonostachys* are based on the monograph of *Bionectria* by Schroers (2001).

Hydropisphaera fusigera (Berk. & Broome) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810976.

Basionym: *Monotospora fusigera* Berk. & Broome, J. Linn. Soc., Bot. 14: 99. 1873.

≡ *Gliomastix fusigera* (Berk. & Broome) C.H. Dickinson, Mycol. Pap. 115: 7. 1968.

≡ *Acremonium fusigera* (Berk. & Broome) W. Gams, *Cephalosporium-artige Schimmelpilze*: 94. 1971.

= *Hydropisphaera bambusicola* Lechat, Mycotaxon 111: 96. 2010.

Notes: Lechat *et al.* (2010) linked the sexual morph *Hydropisphaera bambusicola* to the asexual morph *Gliomastix fusigera*.

The epithet of *G. fusigera* (\equiv *Monotospora fusigera* (1973) is older, therefore takes priority, and the new combination is provided.

***Nectriopsis rexiana* (Sacc.) Rossman, L. Lombard & Crous, comb. nov.** MycoBank MB810977.

Basionym: *Verticillium nanum* subsp. *rexianum* Sacc., *Michelia* 2: 577. 1882.

\equiv *Verticillium rexianum* (Sacc.) Sacc., *Syll. Fung.* 4: 153. 1886.

=*Verticillium niveostratosum* Lindau, *Rabenh. Kryptogam.-Fl., Pilze – Fungi imperfecti* 1: 316. 1905.

= *Hypomyces exiguus* Pat., *Bull. Soc. Mycol. France* 18: 180. 1902.

\equiv *Nectriopsis exigua* (Pat.) W. Gams, *Netherlands J. Pl. Pathol.* 88: 73. 1982.

=*Nectria myxomyceticola* Samuels, *Mem. New York. Bot. Gard.* 48: 48. 1988.

HYPOCREACEAE

***Sphaerostilbella aurifila* (W.R. Gerard) Rossman, L. Lombard & Crous, comb. nov.** MycoBank MB810979.

Basionym: *Stilbum aurifilum* W.R. Gerard, *Bull. Torrey Bot. Club.* 5: 39. 1874.

\equiv *Ciliciodium aurifilum* (W.R. Gerard) Cooke, *Grevillea* 19: 14. 1890.

\equiv *Dendrostilbella aurifilia* (W.R. Gerard) Seifert & J.A. Mackinnon, *Mycologia* 75: 324. 1983.

= *Sphaerostilbe lutea* Henn., *Bot. Jahrb. Syst.* 30:40. 1901.

\equiv *Sphaerostilbella lutea* (Henn.) Sacc., *Syll. Fung.* 17: 778. 1905.

= *Stilbum zacaloxanthum* R.T. Moore, *Amer. Naturalist* 93: 41. 1959.

= *Stilbum mycetophilum* S. Ahmad, *Biologia (Lahore)* 6: 136. 1961.

***Sphaerostilbella penicillioides* (Corda) Rossman, L. Lombard & Crous, comb. nov.** MycoBank MB810978.

Basionym: *Gliocladium penicillioides* Corda, *Icon. Fungorum hucusque Cogn.* 4: 31. 1840.

= *Hypomyces aureonitens* Tul. & C. Tul., *Selecta Fungorum Carpologia: Nectriei-Phacidiei- Pezizei* 3: 64. 1865.

\equiv *Hypolyssus aureonitens* (Tul. & C. Tul.) Kuntze, *Rev. Gen. Plant.* 3: 488. 1898.

\equiv *Nectriopsis aureonitens* (Tul. & C. Tul.) Maire, *Ann. Mycol.* 9: 323. 1911.

\equiv *Hyphonectria aureonitens* (Tul. & C. Tul.) Petch, *J. Bot.* 74: 220. 1937.

\equiv *Sphaerostilbella aureonitens* (Tul. & C. Tul.) Seifert, Samuels & W. Gams, *Stud. Mycol.* 27: 145. 1985.

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