



Phylogenetic relationships and morphological reappraisal of Chaetothyriales

Tian Q^{1,2}, Chomnunti P^{1,2}, Lumyong S³, Liu JK⁴ and Hyde KD^{1,3,5}

¹Center of Excellence in Fungal Research, Mae Fah Luang University, Chiang Rai 57100, Thailand

²School of Science, Mae Fah Luang University, Chiang Rai 57100, Thailand

³Research Center of Microbial Diversity and Sustainable Utilization, Chiang Mai University, Chiang Mai 50200, Thailand

⁴School of Life Science and Technology, Center for Informational Biology, University of Electronic Science and Technology of China, Chengdu 611731, People's Republic of China

⁵Innovative Institute of Plant Health, Zhongkai University of Agriculture and Engineering, Haizhu District, Guangzhou, Guangdong 510225, People's Republic of China

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Abstract

The order Chaetothyriales, are mainly epiphytes, often with the appearance of sooty moulds and are found addressed to the surface of leaves and stems, gaining nutrients from sugary exudates. Others can be saprobes growing on decaying wood or pathogens on plants, mushrooms and animals, including humans. This group has other ecologies, such as being associated with ants, rocks and lichens. Most species of Chaetothyriales are delimited exclusively by morphology. There has been very little molecular reassessment of the group. We revisit the recently listed genera in Chaetothyriales as in the *Outline of the Fungi 2020*. Currently, the families, Chaetothyriaceae, Coccodiniaceae, Cyphellophoraceae, Epibryaceae, Herpotrichiellaceae, Lyrommataceae, Microtheliopsidaceae, Paracladophialophoraceae, Pyrenotrichaceae and Trichomeriaceae, with 55 genera are accepted in Chaetothyriales. Four genera have not been resolved and are placed in Chaetothyriales genera *incertae sedis*. A checklist and a backbone tree of Chaetothyriales based on ITS and LSU sequence data are provided. Illustrations, line drawings, and descriptions are provided based on the examination of types and the literature.

Key words – Checklist – Phylogeny – Revision – Taxonomy – Types

Introduction

Chaetothyriales M.E. Barr was introduced by Barr (1987) and is characterized by erumpent to superficial ascomata with periphysate ostioles formed on a subiculum (Kirk et al. 2008). The unique character of this group is bitunicate asci with an ocular thickening in the apical region. They share similarities characteristic of bitunicate asci with taxa in Dothideomycetes O.E. Erikss. & Winka, and thus, Eriksson (1982), placed Chaetothyriaceae Hansf. ex M.E. Barr with Herpotrichiellaceae Munk in Dothideales Lindau. Barr (1987) placed Chaetothyriaceae in Chaetothyriales and incorporated eight families. However, the relationships of poorly studied Chaetothyriaceae in the order is unclear due to lack of molecular data. Phylogenetically, Chaetothyriales is closely related to Eurotiales and was therefore transferred to Eurotiomycetes O.E. Erikss. & Winka (Spatafora et al. 1995, Berbee 1996, Winka et al. 1998, Haase et al. 1999). The taxonomic placement of Chaetothyriales has been confirmed

in recent molecular studies (Lutzoni et al. 2004, Miadlikowska & Lutzoni 2004, Reeb et al. 2004, Schoch et al. 2006, Chen et al. 2015, Liu et al. 2015, Quan et al. 2020).

Chaetothyriales, presently comprises Chaetothyriaceae Hansf. ex M.E. Barr, Coccodiniaceae Höhn. ex O.E. Erikss., Cyphellophoraceae Réblová & Unter., Epibryaceae S. Stenroos & Gueidan, Herpotrichiellaceae Munk, Lyrommataceae Lücking, Microtheliopsidaceae O.E. Erikss., Paracladophialophoraceae Crous, Pyrenotrichaceae Zahlbr. and Trichomeriaceae Chomnunti & K.D. Hyde (Geiser et al. 2006, Kirk et al. 2008, Chomnunti et al. 2012a, 2014, Flakus & Farkas 2013, Réblová et al. 2013, Gueidan et al. 2014, Wijayawardene et al. 2020). The inclusion of Herpotrichiellaceae was clarified by Haase et al. (1999), while *Cladophialophora* Borelli is unclear, despite having similar, long coherent, conidial chains. Chaetothyriaceae is also poorly understood since genera in this family have rarely been investigated (Winka et al. 1998, Liu & Hall 2004, Lumbsch et al. 2005, Badali et al. 2008, Gueidan et al. 2008, Chomnunti et al. 2012b). Collections of Trichomeriaceae from Thailand revealed a monophyletic group of foliar epiphytes, similar to sooty molds, confirming their placement within Chaetothyriales (Chomnunti et al. 2012a). Recent phylogenetic delimitations of Trichomeriaceae resulted in many paraphyletic, undetermined taxa. We therefore, broaden the delimitation of the family to comprise taxa of *Bradomyces* Hubka et al., *Knufia* L.J. Hutchison & Unter., and *Metulocladosporiella* Crous et al. (Crous et al. 2006, Tsuneda et al. 2011, Hubka et al. 2014). Epibryaceae with a single genus is thought to be phylogenetically distinct from other families in Chaetothyriales (Réblová et al. 2013, Gueidan et al. 2014).

Ecological habitats of species of Chaetothyriales are highly diverse. Typically, Chaetothyriaceae, Coccodiniaceae, Trichomeriaceae are epiphytes having the appearance of sooty moulds and mostly grow on the surface of living leaves, apparently gaining nutrients from sugary exudates of insects in the Order Hemitera (Barr 1987, Chomnunti et al. 2014). Species are characterized by dark mycelium adpressed to the surface of leaves and stems, but not penetrating the host tissues (Batista & Ciferri 1962, 1963, Eriksson 1981, Chomnunti et al. 2012a, 2014). Species of Cyphellophoraceae are known from individual reports from plants, but are mostly endophytes on plants and animals, including human pathogens (Vries 1962, de Hoog et al. 1999, 2000, Lopez et al. 2007, Li et al. 2011, Feng et al. 2012, Gao et al. 2015, Yang et al. 2018, Phookamsak et al. 2019, Rashmi et al. 2019, Vu et al. 2019). Inconspicuous immersed mycelium is found in the asexual morphs of Herpotrichiellaceae which mostly grow on decayed wood or mushrooms (Barr 1987, Untereiner & Naveau 1999, Untereiner 2000, Sun et al. 2019). Both sexual and asexual morphs of Herpotrichiellaceae have been reported, while most of the asexual morphs are opportunistic animal or human pathogens (Haase et al. 1999, Prenafeta-Boldú et al. 2006, Crous et al. 2007, Réblová et al. 2013). However, this group also occupies other habitats, such as being symbiotic ant-associated (Little & Currie 2007, Defosse et al. 2009, Mayer & Voglmayr 2009, Untereiner et al. 2011, Nepel et al. 2014), lichenicolous (Untereiner et al. 2011, Diederich et al. 2013) and rock-inhabiting (Sterflinger et al. 1999, Ruibal et al. 2005, 2008, Gueidan et al. 2008). Species in Epibryaceae include saprobes on plants and biotrophic parasites of algae, mosses, or asymptomatic on lichens (Döbbeler 1978, U'Ren et al. 2010, Gueidan et al. 2014, Döbbeler, 2016, Muggia et al. 2016, Darmostuk & Khodosovtsev 2019). Members of Lyrommataceae, Microtheliopsidaceae and Pyrenotrichaceae are known as lichenicolous fungi (Riddle 1917, Engler & Prantl 1926, Eriksson 1981, 2006, Eriksson et al. 2004, Herrera-Campos et al. 2005, Lücking 2008, Flakus & Farkas 2013) Members of Trichomeriaceae are mostly rock colonizers or epiphytes as sooty moulds on plants (Chomnunti et al. 2012a, 2014, Zakharova et al. 2013).

Species of Chaetothyriales are exclusively delimited by morphology and have generally not been reassessed using molecular data and are normally highly homoplastic (Staiger 2002, Miller & Huhndorf 2004, 2005). Therefore, molecular data is needed to verify their natural classification.

The life cycles of taxa of Chaetothyriaceae, Coccodiniaceae and Trichomeriaceae are similar to sooty moulds. Spores are usually spread by wind or raindrops and insects probably serve as vectors (Nelson 2008, He et al. 2013). After germination on honeydew, the mycelium grows on the surface (Hughes 1976, Reynolds 1999, Nelson 2008). Colonies develop and often amass with the same or other species and form biofilms covering entire leaves or stems, even whole plants (Hughes 1983, Laemmlen 2011). Asexual morphs appear first, while sexual morphs may also develop in mature colonies. Asexual

and sexual morphs may not appear at the same time, and only 70 % were found to produce asexual states by Chomnunti et al. (2014).

This study aims to reappraise the placement of genera in Chaetothyriales based on phylogenetic analyses and morphological characteristics and provides a backbone tree for these taxa, as well as a checklist. This will enhance the future study of species in the group.

Material & Methods

Herbarium Examination

Herbarium specimens, including type specimens, were loaned from B, BPI, BR, E, FH, G, GZU, H, HIRO, IMI, K, M, MA, NY, PC, PDD, S and W fungaria (see <http://sweetgum.nybg.org/ih/index.php> for full names). Ascomata were rehydrated in 5% KOH and stained with cotton blue or India ink if necessary before examination. The cotton blue stain was used to verify the septation of ascospores and internal elements of the hamathecium. India ink was added to water mounts to visualize gelatinous sheaths and ascospore appendages. Permanent slides were prepared by mounting material in lactoglycerol and sealing the coverslips with clear nail polish. Fruiting bodies were examined with a stereomicroscope (Olympus SZH10), micro-morphology was determined with a Nikon ECLIPSE 80i compound microscope and images were captured with a Canon EOS 600D digital camera. Measurements were made with Tarosoft (R) Image FrameWork version 0.9.7. Photographic plates were prepared in Adobe Photoshop version CS6 (Adobe Systems, The United States).

Terminologies mainly follow Ulloa & Hanlin (2000) and Zhang et al. (2009, 2012). In addition, ascomata size is defined as small: < 300 µm diam., medium: from 300 µm to 600 µm diam., large: > 600 µm diam.

Phylogenetic Analyses

The taxa of Eurotiomycetes and aligned strains used in the analyses were obtained from GenBank (Table 1). The multiple alignments were made by MAFFT v. 7.036 (Kato & Standley 2013) and adjusted manually for improvement where necessary using BioEdit v. 7.2 (Hall 1999) and ClustalX v. 1.83 (Thompson et al. 1997).

MODELTEST v. 2.0 (Nylander 2004) following Akaike Information Criterion was used to determine the best-fit model of evolution for each data set for Bayesian and Maximum likelihood analyses.

Maximum-likelihood (ML) analysis was performed in RAxML (Stamatakis 2008) implemented in raxmlGUI v.0.9b2 (Silvestro & Michalak 2011). One thousand non-parametric bootstrap iterations were employed with the available models of generalized time-reversible (GTR model) and a discrete gamma distribution (Stamatakis et al. 2008, Liu et al. 2011). Maximum likelihood bootstrap values equal to or greater than 70 % were given as the first set of numbers above the nodes.

A Bayesian analysis was conducted with MrBayes v. 3.1.2 (Huelsenbeck & Ronqvist 2001) to evaluate Posterior probabilities (PP) (Rannala & Yang 1996, Zhaxybayeva & Gogarten 2002) by Markov Chain Monte Carlo sampling (BMCMC). Six simultaneous Markov chains were run for 1,000,000 generations and trees were sampled every 100th generation and 10,000 trees were obtained. The first 2,000 trees, representing the burn-in phase of the analyses, were discarded, while the remaining 8,000 trees were used for calculating posterior probabilities in the majority rule consensus tree (critical value for the topological convergence diagnostic is 0.01) (Cai et al. 2006). Bayesian Posterior Probabilities (BYPP) equal to or greater than 0.90 were given below or above each node.

Table 1 Taxa used in the phylogenetic analysis and their corresponding GenBank numbers

Species	Voucher/Strain	GenBank accession numbers	
		LSU	ITS
<i>'Anthracinomyces petraeus'</i>	CGMCC:3.17315	KP174924	KP174843
<i>Aculeata aquatica</i>	MFLUCC 11-0529	MG922575	MG922571

Table 1 Continued.

Species	Voucher/Strain	GenBank accession numbers	
		LSU	ITS
<i>Adautomilanezia caesalpiniae</i>	HUEFS 216632	NG_058594	NR_153560
<i>Aequabiliella effusa</i>	CBS 120883	NG_056966	NR_132005
<i>Agonimia tristicula</i>	Palice 5651	AY300828	/
<i>Aleuria aurantia</i>	AFTOL-ID 65	AY544654	DQ491495
<i>Amaurascopsis perforata</i>	FMR 388	/	AJ390377
<i>Amauroascus verrucosus</i>	CBS 181.70	MH871325	MH859546
<i>Anthopsis catenata</i>	CBS 492.81	MF479749	MH861371
<i>Anthopsis deltoidea</i>	CBS 263.77	KX447683	KX447684
<i>Anthracocarpon virescens</i>	M. Prieto 530	GU228948	/
<i>Anthracothecium nanum</i>	AFTOL-ID 1649	FJ358271	KT232207
<i>Anzia colpodes</i>	Lumbsch 4.VI.04	DQ923651	DQ980000
<i>Aphanoascus mephitalis</i>	ATCC 22144	NG_056949	NR_154665
<i>Aphanophora eugeniae</i>	CBS 124105	FJ839652	FJ839617
<i>Apinisia graminicola</i>	CBS 721.68	NG_056945	/
<i>Apiospora bambusae</i>	ICMP 6889	DQ368630	/
<i>Arachniotus ruber</i>	CBS 352.90	MH873901	MH862216
<i>Arachnomyces nitidus</i>	IFO 32048	AB075351	/
<i>Arachnotheca glomerata</i>	CBS 349.71	MH871926	MH860158
<i>Armillaria mellea</i>	AFTOL-ID 449	AY700194	AY789081
<i>Arthrocladium caudatum</i>	CBS 457.67	KT337443	MH859032
<i>Arthroderma curreyi</i>	CBS 353.66	MH870459	MH858822
<i>Arthrophiale arthrospora</i>	CPC 19480	KX447144	KY173474
<i>Arthropisia cirrhata</i>	CBS 628.83	HG004549	/
<i>Arthropisia hispanica</i>	UTHSC 10-2389	HE965763	HE965762
<i>Arthropisia truncata</i>	CBS 584.82	NG_056973	NR_159641
<i>Ascobolus crenulatus</i>	AFTOL-ID 181	AY544678	DQ491504
<i>Ascocalvatia alveolata</i>	ATCC 22147	NG_056946	/
<i>Ascocoryne sarcoides</i>	AFTOL-ID 1834	FJ176886	/
<i>Ascodesmis sphaerospora</i>	AFTOL-ID 920	FJ176858	/
<i>Ascosphaera apis</i>	CBS 402.96	/	MH862580
<i>Aspergillus bisporus</i>	NRRL 3693	NG_057328	NR_135377
<i>Aspergillus nidulans</i>	NRRL 187	EF652427	EF652427
<i>Aspicilia caesiocinerea</i>	AFTOL-ID 653	DQ986778	HQ650636
<i>Atla alpina</i>	SS193	EU697732	EU697725
<i>Atrokylindriopsis setulosa</i>	HMAS245592	KP337329	KP337330
<i>Auxarthron californiense</i>	ATCC 15600	NG_056947	NR_121259
<i>Auxarthronopsis bandhavgarhensis</i>	NFCCI 2185	NG_057012	NR_153515
<i>Baeomyces placophyllus</i>	T1364	KU844631	KU844777
<i>Bagliettoa limborioides</i>	CG1750	/	KM371454
<i>Betisia fastidia</i>	CBS 493.91	MH873953	MH862271
<i>Blastomyces dermatitidis</i>	CBS 673.68	KT155306	KT155961
<i>Botryolepraria lesdainii</i>	Spribille17964	GU181264	GU181263
<i>Botrytis cinerea</i>	AFTOL-ID 59	AY544651	DQ491491
<i>Bradomyces oncorhynchi</i>	CCF 4369	HG426063	NR_132843
<i>Brunneocarpos banksiae</i>	CPC 29841	KX228352	NR_147648
<i>Brycekendrickomyces acaciae</i>	CBS 124104	FJ839641	FJ839606
<i>Buellia frigida</i>	AFTOL-ID 889	DQ883695	HQ650628
<i>Bulgaria inquinans</i>	AFTOL-ID 916	DQ470960	/
<i>Byssoonygena ceratinophila</i>	ATCC 64724	NG_058608	/
<i>Caliciopsis pinea</i>	CBS 139.64	DQ678097	KP881691
<i>Calicium salicinum</i>	CBS 100898	KF157982	/
<i>Calicium viride</i>	Soechting 7475	AF356670	/
<i>Calycina herbarum</i>	KUS-F51458	JN086693	JN033390
<i>Calypトロzyma arxii</i>	CBS 354.92	/	NR_137141
<i>Camptophora hylomeconis</i>	CBS 113311	EU035415	KC455241
<i>Candelaria concolor</i>	AFTOL-ID 1706	DQ986791	/
<i>Candelariella aurella</i>	Hermansson 10056	AY853361	/

Table 1 Continued.

Species	Voucher/Strain	GenBank accession numbers	
		LSU	ITS
<i>Canoparmelia caroliniana</i>	AFTOL-ID 6	AY584634	DQ782833
<i>Capnodium coffeae</i>	CBS 147.52	DQ247800	MH856967
<i>Capronia pilosella</i>	AFTOL-ID 657	DQ823099	DQ826737
<i>Castanedomyces australiensis</i>	FMR 5484	/	AJ131785
<i>Catapyrenium cinereum</i>	MA16301	GQ344587	GQ344598
<i>Celerioriella dura</i>	CBS 120882	NG_058775	NR_132004
<i>Celothelium cinchonarum</i>	F 17105 f	DQ329020	/
<i>Ceramothyrium ficus</i>	MFLUCC 15-0228	KT588599	KT588601
<i>Ceramothyrium thailandicum</i>	MFLUCC 10-0008	HQ895835	HQ895838
<i>Chaenotheca brachypoda</i>	CBS 100900	KF157983	/
<i>Chaenotheca phaeocephala</i>	CBS 100906	KF157984	/
<i>Chaenotheca trichialis</i>	CBS 113986	KF157985	/
<i>Chaenotheca xyloxena</i>	CBS 100907	KF157986	/
<i>Chaenothecopsis khayensis</i>	H:JR 04G058	HQ172895	JX122785
<i>Chaenothecopsis resinophila</i>	H:JR 000424	JX122782	JX122780
<i>Chaetomium globosum</i>	AFTOL-ID 217	AY545729	DQ518179
Chaetothyriales sp.	Trii4	KX822551	KX822551
Chaetothyriales sp.	CBS 128963	KX822328	/
Chaetothyriales sp.	CBS 128959	KX822542	KX822542
Chaetothyriales sp.	T9	KF614780	KF614780
Chaetothyriales sp.	CBS 128943	KX822485	KX822485
Chaetothyriales sp.	CBS 129047	KX822533	KX822533
Chaetothyriales sp.	A933	KT270641	/
<i>Chaetothyrium agathis</i>	MFLUCC 12-0113	KP744480	KP744437
<i>Cheilymenia stercorea</i>	AFTOL-ID 148	AY544661	DQ491500
<i>Chlamydosauromyces punctatus</i>	UAMH 9990	/	NR_165613
<i>Chlorociboria aeruginosa</i>	AFTOL-ID 151	AY544669	DQ491501
<i>Chrysosporium echinulatum</i>	CBS 141178	MH878205	/
<i>Chrysosporium submersum</i>	CBS 101575	MH874348	KT155673
<i>Cirrosporium novae-zelandiae</i>	CBS 125236	HQ878612	/
<i>Cladophialophora carrionii</i>	CBS 160.54	NG_055741	EU137266
<i>Cladosporium herbarum</i>	CBS 121621	MH874676	MH863124
<i>Clavascidium umbrinum</i>	AFTOL-ID 2274	EF643749	/
<i>Coccidioides immitis</i>	CBS 120936	MH874654	MH863096
<i>Coccoliniium bartschii</i>	CPC 13861	EU019265	EU019265
<i>Cordyceps militaris</i>	OSC 93623	AY184966	JN049825
<i>Corynelia uberata</i>	PREM 61207	/	NR_153903
<i>Ctenomyces serratus</i>	CBS 187.61	NG_058765	NR_144890
<i>Cudoniella clavus</i>	AFTOL-ID 166	DQ470944	DQ491502
<i>Cylindroconidiis aquaticus</i>	MFLUCC 11-0294	MH236579	MH236576
<i>Cyphellophora guyanensis</i>	CBS 129342	KC455253	KC455240
<i>Cyphellophora laciniata</i>	CBS 190.61	FJ358239	JQ766423
<i>Cyphellophoriella pruni</i>	CPC 25120	/	KR611878
<i>Dendrographa minor</i>	AFTOL-ID 355	AF279382	DQ842015
<i>Dermatocarpon miniatum</i>	Sohrabi 4609	KY773247	KY697126
<i>Dermea acerina</i>	AFTOL-ID 941	DQ247801	AF141164
<i>Diaporthe eres</i>	AFTOL-ID 935	AF408350	DQ491514
<i>Diatrype disciformis</i>	AFTOL-ID 927	DQ470964	/
<i>Disciotis venosa</i>	AFTOL-ID 179	AY544667	DQ491503
<i>Dissoconium aciculare</i>	CBS 204.89	GU214419	AY725520
<i>Dolabra nepheliae</i>	CBS 122120	GU332517	/
<i>Dothidea hippophaes</i>	CBS 188.58	DQ678048	MH857750
<i>Dothidea insculpta</i>	CBS 189.58	DQ247802	AF027764
<i>Dothiora cannabinae</i>	AFTOL-ID 1359	DQ470984	/
<i>Elaphomyces aculeatus</i>	IC10041103	KX238880	KX238844
<i>Elaphomyces cyanosporus</i>	LIP-0001137	KX238874	KX238826
<i>Eleutherascus lectardii</i>	AFTOL-ID 933	DQ470966	/
<i>Emergomyces pasteurianus</i>	CBS 101426	KT154983	KT155671

Table 1 Continued.

Species	Voucher/Strain	GenBank accession numbers	
		LSU	ITS
<i>Emmonsia crescens</i>	UAMH 3008	/	NR_132795
<i>Emmonsiiellopsis terrestris</i>	UAMH 2304	/	NR_153965
<i>Endocarpon pusillum</i>	CG470	/	KY769556
<i>Endothia gyrosa</i>	AFTOL-ID 1223	DQ470972	KT225530
<i>Epibryon bryophilum</i>	M2	EU940090	/
<i>Epibryon plagiochilae</i>	M187	EU940124	/
<i>Epidermophyton floccosum</i>	CBS 457.65	MH870307	MH858667
<i>Eremascus albus</i>	CBS 975.69	FJ358283	MH859498
<i>Exophiala salmonis</i>	CBS 157.67	AY213702	JF747137
<i>Extremus antarcticus</i>	CCFEE 451	GU250360	KF309978
<i>Flakea papillata</i>	AFTOL-ID 1041	KT232216	KT232210
<i>Fonsecaea pedrosoi</i>	CBS 271.37	KJ930166	AB114127
<i>Fumagopsis stellae</i>	CBS 145078	NG_066293	NR_161138
<i>Geoglossum nigrinum</i>	AFTOL-ID 56	AY544650	DQ491490
<i>Gnomonia gnomon</i>	AFTOL-ID 952	AF408361	DQ491518
<i>Granulopyrenis seawardii</i>	CBS 109025	EF411062	/
<i>Guarromyces ceretanicus</i>	CBS 269.89	MF893224	MF926403
<i>Gymnascella aurantiaca</i>	ATCC 22394	AY176747	HM991267
<i>Gymnoascus reesii</i>	CBS 409.72	MH872223	MH860506
<i>Gyromitra californica</i>	AFTOL-ID 176	AY544673	/
<i>Hamigera avellanea</i>	CBS 295.48	/	NR_156333
<i>Henrica melaspora</i>	AA62248	/	KY769557
<i>Heteropladidium imbricatum</i>	AFTOL-ID 2281	EF643756	/
<i>Histoplasma capsulatum</i>	CBS 287.54	MH868877	MH857336
<i>Hyaloscypha hepaticola</i>	M339	EU940150	EU940226
<i>Hydropunctaria maura</i>	AMNH:LA31903	KY773249	KY697129
<i>Involucropyrenium waltheri</i>	JH59126	KF959809	KF959781
<i>Knufia cryptophialidica</i>	DAOM 216555	JN040500	JN040501
<i>Kraurogymnocarpa trochleospora</i>	CBS 591.71	MH872035	MH860277
<i>Lacazia loboi</i>	human skin	/	MN403304
<i>Lachnum virgineum</i>	AFTOL-ID 49	AY544646	DQ491485
<i>Lagenulopsis bispora</i>	PREM 57232	NG_060325	NR_154120
<i>Lasallia pustulata</i>	AFTOL-ID 554	DQ883690	HM161456
<i>Lasiobolidium spirale</i>	AFTOL-ID 1321	FJ176873	/
<i>Lasiochaeria ovina</i>	SMH4605	AY436413	AY587923
<i>Lecanactis abietina</i>	Ertz 5068	AY548812	AY548804
<i>Lecidea fuscoatra</i>	AFTOL-ID 589	DQ912332	HQ650707
<i>Lecophagus</i> sp	AFTOL-ID 183	DQ273799	AY997058
<i>Leiothecium ellipsoideum</i>	CBS 607.74	FJ358285	NR_144922
<i>Leptoxylum fumago</i>	CBS 123.26	MH866361	MH854862
<i>Letrouitia domingensis</i>	AFTOL-ID 102	AY584648	HQ650700
<i>Leucothecium emdenii</i>	CBS 576.73	NG_057812	/
<i>Lichenodiplis lecanorae</i>	L	KT285909	/
<i>Lindra thalassiae</i>	AFTOL-ID 413	DQ470947	DQ491508
<i>Lithophila guttulata</i>	CCFEE 5907	KR781061	KP791773
<i>Lithothelium immersum</i>	AA11919	KT808556	KT820111
<i>Lobaria scrobiculata</i>	AFTOL-ID 128	AY584655	AF524913
<i>Lophophyton gallinae</i>	CBS 244.66	MH870427	MH858789
<i>Loramycetes macrosporus</i>	AFTOL-ID 913	DQ470957	/
<i>Lulworthia fucicola</i>	ATCC 64288	AY878965	/
<i>Malbranchea pulchella</i>	IFM 41308	AB359426	AB361638
<i>Mallochhia echinulata</i>	CBS 168.73	MH878316	/
<i>Marcelleina persoonii</i>	AFTOL-ID 164	DQ470943	/
<i>Marinophialophora garethjonesii</i>	MFLUCC 16-1449	KY305176	NR_164246
<i>Mastodia tessellata</i>	Schultz 16853	/	MN952977
<i>Megalospora tuberculosa</i>	AFTOL-ID 107	AY584650	HQ650701
<i>Melanconis marginalis</i>	AR3442	AF408373	/
<i>Melanoctona tectonae</i>	MFLUCC 12-0389	KX258779	KX258778

Table 1 Continued.

Species	Voucher/Strain	GenBank accession numbers	
		LSU	ITS
<i>Melnikomyces vietnamensis</i>	CBS 136209	NG_058087	NR_164227
<i>Meria laricis</i>	AFTOL-ID 907	DQ470954	/
<i>Metulocladosporiella musae</i>	CBS 161.74	DQ008161	DQ008137
<i>Microsporium audouinii</i>	CBS 332.68	MH870861	MH859149
<i>Microxiphium purpuraefaciens</i>	CBS 201.30	MH866560	MH855112
<i>Microxiphium theae</i>	CBS 202.30	MH866561	MH855113
<i>Minimelanolocus rousselianus</i>	CBS 126086	/	MH863784
<i>Minutiella tardicola</i>	CBS 121757	NG_057826	NR_132006
<i>Mollisia cinerea</i>	AFTOL-ID 76	DQ470942	DQ491498
<i>Monascus ruber</i>	CBS 135.60	MH869468	MH857924
<i>Moristroma japonicum</i>	BN1674	AY254052	AY254052
<i>Moristroma quercinum</i>	BN1678	AY254051	AY254051
<i>Muellerella erratica</i>	Ertz 20485	MN241079	/
<i>Mycocalicium americanum</i>	Kalb & Nash	/	AY795879
<i>Mycocalicium hyaloparvicellulum</i>	MFLUCC 14-0169	KR920005	KR920004
<i>Mycosphaerella graminicola</i>	AFTOL-ID 1615	DQ678084	/
<i>Myriodontium keratinophilum</i>	CBS 947.73	NG_063938	NR_157454
<i>Nadsoniella nigra</i>	CBS 535.94	NG_059253	NR_154974
<i>Nannizzia incurvata</i>	CBS 174.64	NG_057715	NR_155473
<i>Nannizziopsis chlamydospora</i>	strain 1824	KR063660	KR349444
<i>Nannizziopsis crocodili</i>	UAMH 9666	/	KF477204
<i>Nannizziopsis pluriseptata</i>	UTHSC 10-1045	NG_042532	NR_111524
<i>Neocatapyrenium rhizinosum</i>	AFTOL-ID 2282	EF643757	/
<i>Neocladothialophora quercina</i>	CBS 138874	MH877670	KP004470
<i>Neogymnomycetes virgineus</i>	DCDSL7716	JN038186	JN038187
<i>Neophaeococcomyces aloes</i>	CPC 21873	KF777234	KF777182
<i>Neophaeomoniella eucalypti</i>	CBS 139919	NG_058174	NR_138001
<i>Neostrelitziana acaciigena</i>	CBS:139903	NG_058165	NR_137987
<i>Normandina pulchella</i>	TNS:Ohmura 7853	KF972457	/
<i>Norrlinia peltigericola</i>	Palice 4369	AY300845	/
<i>Nullicomyces eucalypti</i>	CPC 32942	MH327843	MH327807
<i>Onychocola glareosa</i>	UAMH 10000	/	AY624315
<i>Onygena equina</i>	ATCC 22731	AY176717	/
<i>Ophidiomyces ophiodiicola</i>	UAMH 11295	/	KF477237
<i>Ophiocordyceps gracilis</i>	OSC 151906	KJ878890	/
<i>Ophiocordyceps sinensis</i>	YN09-64	JX968033	JQ325141
<i>Ophiocordyceps variabilis</i>	OSC 111003	EF468839	/
<i>Ophiodiaporthe cyatheae</i>	YMJ 1364	JX570891	JX570889
<i>Orbilina vinosa</i>	AFTOL-ID 905	DQ470952	DQ491511
<i>Ovadendron sulphureoochraceum</i>	CBS 125.81	KT155095	KT155767
<i>Paecilomyces divaricatus</i>	CBS 284.48	MH867896	MH856344
<i>Parabagliettoa dufourii</i>	CG579	/	KM371425
<i>Paracladophialophora carceris</i>	CPC 27596	/	NR_154360
<i>Paracladophialophora cyperacearum</i>	CPC 33046	MH327844	NR_160625
<i>Paracoccidioides brasiliensis</i>	CBS 372.73	MH872413	MH860706
<i>Paranannizziopsis australasiensis</i>	UAMH 11645	/	KF477220
<i>Paraphaeomoniella capensis</i>	CPC 15416	NG_057814	NR_137711
<i>Paraphyton cookei</i>	CBS 228.58	NG_058188	NR_155665
<i>Pectinotrichum llanense</i>	CBS 882.71	NG_057620	NR_119467
<i>Peltula auriculata</i>	AFTOL-ID 892	DQ832330	DQ832329
<i>Peltula umbilicata</i>	AFTOL-ID 891	DQ832334	DQ832333
<i>Penicilliopsis clavariiformis</i>	CBS 257.33	MH866881	MH855432
<i>Penicillium euglaucum</i>	CBS 323.71	NG_067394	NR_121517
<i>Penicillium hennbertii</i>	CBS 334.68	NG_057625	NR_160113
<i>Peziza vesiculosa</i>	AFTOL-ID 507	DQ470948	DQ491509
<i>Phacidium lacerum</i>	AFTOL-ID 1253	DQ470976	/
<i>Phaeoannellomyces elegans</i>	CBS 122.95	KY115194	NR_155687
<i>Phaeocalicium curtisii</i>	BIOUG24047-F02	/	KT695401

Table 1 Continued.

Species	Voucher/Strain	GenBank accession numbers	
		LSU	ITS
<i>Phaeocalicium populneum</i>	Tibell 19286	AY796009	AY795874
<i>Phaeococcomyces nigricans</i>	CBS 652.72	AF361048	AF050278
<i>Phaeosaccardinula ficus</i>	MFLUCC 10-0009	HQ895837	HQ895840
<i>Phialomyces macrosporus</i>	CBS 430.64	MH870110	MH858478
<i>Phialophora verrucosa</i>	CBS 140325	/	NR_146242
<i>Phyllobaeis imbricate</i>	AFTOL-ID 852	DQ986781	HQ650635
<i>Piedraia hortae</i>	CBS 480.64	GU214466	GU214647
<i>Placidiopsis custmani</i>	MA16310	GQ344578	GQ344604
<i>Placidium michelii</i>	M. Prieto 1356	GU228909	/
<i>Placocarpus schaeferi</i>	C. Gueidan 588	/	EU006532
<i>Plagiostoma euphorbiae</i>	CBS 340.78	AF408382	DQ323532
<i>Pleostigma jungermannicola</i>	M174	EU940119	/
<i>Plicaria leiocarpa</i>	AFTOL-ID 1345	DQ842029	/
<i>Polyblastia cupularis</i>	AFTOL-ID 2239	EF643769	/
<i>Polytolypa hystricis</i>	UAMH 7299	NG_042396	NR_111161
<i>Potebniamyces pyri</i>	AFTOL-ID 744	DQ470949	DQ491510
<i>Pseudoamauroascus australiensis</i>	FMR 5482	/	AJ131787
<i>Pseudobactrodesmium aquaticum</i>	MFLUCC 18-1015	MN335230	MN335228
<i>Pseudophaeomoniella oleae</i>	CBS 139191	NG_060141	NR_137966
<i>Pseudospiromastix tentaculata</i>	CBS 184.92	NG_042397	NR_111162
<i>Pseudotulostoma volvatum</i>	AMV1956	/	KT724084
<i>Pyrenula nitida</i>	F 5929	DQ329023	JQ927458
<i>Pyronema domesticum</i>	AFTOL-ID 949	DQ247805	DQ491517
<i>Pyxidiophora arvernensis</i>	AFTOL-ID 2197	FJ176894	/
<i>Pyxine subcinerea</i>	AFTOL-ID 686	DQ883802	HQ650705
<i>Racodium rupestre</i>	L346	EU048583	GU067666
<i>Rasamsonia emersonii</i>	CBS 266.71	MH871885	MH860109
<i>Renispora flavissima</i>	CBS 708.79	KC989737	AF299348
<i>Rhinocladiella atrovirens</i>	CBS 264.49	EU041869	MH856518
<i>Rhizina undulata</i>	AFTOL-ID 918	DQ470961	/
<i>Rhopalophora clavispora</i>	CBS 637.73	NG_058262	KX537753
<i>Rhynchostoma proteae</i>	CBS 112051	EU552154	NR_132824
<i>Roccella fuciformis</i>	AFTOL-ID 126	AY584654	DQ782840
<i>Roccellographa cretacea</i>	AFTOL-ID 93	DQ883696	/
<i>Rutstroemia firma</i>	AFTOL-ID 923	DQ470963	/
<i>Sagenomella diversispora</i>	CBS 354.36	MH867323	MH855819
<i>Sarcinomyces crustaceus</i>	CBS 156.89	GU250893	AJ244258
<i>Sarcoscypha coccinea</i>	AFTOL-ID 50	AY544647	DQ491486
<i>Sarcosoma latahense</i>	AFTOL-ID 954	FJ176860	/
<i>Schaereria fuscocinerea</i>	T1291	KR017225	KR017085
<i>Schismatomma decolorans</i>	Ertz 5003	AY548815	AY548808
<i>Sclerocleista ornata</i>	NRRL4735	AF433095	EF669703
<i>Sclerococcum sphaerale</i>	Ertz 17425	JX081674	/
<i>Sclerophora farinacea</i>	Wedin 6414	JX000095	JX000113
<i>Sclerotinia sclerotiorum</i>	AFTOL-ID 928	DQ470965	/
<i>Scutellinia scutellata</i>	AFTOL-ID 62	DQ247806	DQ491492
<i>Shanorella spirotricha</i>	CBS 304.56	FJ358288	MH857651
<i>Sigleria carmichaelii</i>	CBS 138264	KP119638	KP119626
<i>Sordaria fimicola</i>	AFTOL-ID 216	AY545728	DQ518178
<i>Sphaerosporium equinum</i>	MUCL 46080	JQ434642	JQ434578
<i>Sphaerosporium lignatile</i>	D. Haelew. F-1614a	MN749494	MN749372
<i>Sphinctrina turbinata</i>	Tibell 23093	DQ009001	AY795877
<i>Sporendonema casei</i>	CBS 543.75	MH872720	MH860952
<i>Sporodictyon schaeferianum</i>	AMNH:LA31905	KY773252	KY697132
<i>Staurothele clopima</i>	W1235	JN573792	/
<i>Stenocybe pullatula</i>	Tibell 17117	AY796008	AY795878
<i>Strelitziana africana</i>	ICMP_21760	MK210501	MK210540
<i>Strelitziana australiensis</i>	CBS 124778	GQ303326	GQ303295

Table 1 Continued.

Species	Voucher/Strain	GenBank accession numbers	
		LSU	ITS
<i>Talaromyces macrosporus</i>	CBS 317.63	MH869909	MH858299
<i>Testudomyces verrucosus</i>	CBS 500.86	/	AJ315841
<i>Thelidium pertusatii</i>	JN1541	/	EU249472
<i>Thermoascus aurantiacus</i>	CBS 398.64	MH870100	MH858464
<i>Thysanorea papuana</i>	CBS 212.96	MH874198	MH862572
<i>Trichocoma paradoxa</i>	CBS 103.73	MH872339	MH860643
<i>Trichoderma viride</i>	DAOM JBT1003	JN938865	JN942883
<i>Trichoglossum hirsutum</i>	AFTOL-ID 64	AY544653	DQ491494
<i>Trichomerium foliicola</i>	MFLUCC 10-0078	JX313661	JX313655
<i>Trichophyton tonsurans</i>	CBS 496.48	MH867992	MH856446
<i>Trimmatothele perquisita</i>	T560	EU598695	EU559742
<i>Tripospora tripos</i>	PREM 61202	/	NR_164231
<i>Umbilicaria mammulata</i>	AFTOL-ID 645	DQ782912	DQ782851
<i>Uncinocarpus reesii</i>	CBS 121.77	MH872807	MH861035
<i>Uncispora sinensis</i>	YMF1.03683	KU558914	KU173860
<i>Usnea antarctica</i>	AFTOL-ID 813	DQ883692	HQ650616
<i>Veronaea botryosa</i>	CBS 254.57	EU041873	MH857711
<i>Verrucaria rupestris</i>	SS043	EU598724	EU553501
<i>Verruculopsis poeltiana</i>	AFTOL-ID 2298	EF643822	EU010257
<i>Vibrissea truncorum</i>	AFTOL-ID 1322	FJ176874	/
<i>Vonarxia vagans</i>	CBS 123533	FJ839672	FJ839636
<i>Wahlenbergiella mucosa</i>	A. Orange 16305	FJ664875	FJ664875
<i>Willeya diffractella</i>	Harris 44093	/	KM371613
<i>Xanthothecium peruvianum</i>	CBS 112.54	NG_057623	MH857258
<i>Xenocylindrosporium kirstenboschense</i>	CBS 125545	NG_057857	NR_132841
<i>Xerochrysum dermatitidis</i>	CBS 132.31	NG_058454	KY635853
<i>Xeromyces bisporus</i>	CBS 236.71	NG_057813	NR_154540
<i>Xylaria hypoxylon</i>	AFTOL-ID 51	AY544648	DQ491487
<i>Zodiomyces vorticellarius</i>	MG003	KT800022	/

Results

Outline of Chaetothyriales, as of July 2021, updated data as compared with Wijayawardene et al. (2020) are marked with an asterisk (*)

Eurotiomycetes Tehler ex O.E. Eriksson & K. Winka

Chaetothyriomycetidae Doweld

Chaetothyriales M.E. Barr

Chaetothyriaceae Hansf. ex M.E. Barr

Actinocymbe Höhn. (3)

Aithaloderma Syd. & P. Syd. (13)

Aphanophora Réblová & Unter. (1)

Arthrophia (D.J. Soares, R.W. Barreto & U. Braun) W.S. Lisboa, Meir. Silva & R.W.

Barreto (1)*

Beelia F. Stevens & R.W. Ryan (3)

Camptophora Réblová & Unter. (2)

Ceramothyrium Bat. & H. Maia (36)*

Ceratocarpia Rolland (2)

Chaetothyriomyces Pereira-Carv., Inácio & Dianese (1)

Chaetothyrium Speg. (45) *

Cyphellophoriella Crous & A.J. Sm. (1)

Longihyalospora D.S. Tennakoon, C.H. Kuo & K.D. Hyde (2)

Nullicomyces Crous (1)

Phaeosaccardinula P. Henn. (27)

Stanhughesia Constant. (1)
Treubiomyces Höhn. (7)
Vonarxia Bat. (2)

Coccodiniaceae Höhn. ex O.E. Erikss.

Coccodinium A. Massal. (4)
Dennisiella Bat. & Cif. (7)
= *Microxiphium* (Harv. ex Berk. & Desm.) Thüm. (14)*
Limacinula Höhn. (12) *

Cyphellophoraceae Réblová & Unter.

Anthopsis Fil. March., A. Fontana & Luppi Mosca (2)
Cyphellophora G.A. de Vries (26)*

Epibryaceae S. Stenroos & Gueidan

Epibryon Döbbeler (46) *

Herpotrichiellaceae Munk

Aculeata W. Dong, H. Zhang & K.D. Hyde (1)
Atrokyliandriopsis Y.R. Ma & X.G. Zhang (1)
Brycekendrickomyces Crous & M.J. Wingf. (1)
Capronia Sacc. (79)*
Cladophialophora Borelli (38)*
Exophiala J.W. Carmich. (51)*
Fonsecaea Negroni (8)*
Marinophialophora J.F. Li, Phook. & K.D. Hyde (1)
Melanoctona Qing Tian, Doilom & K.D. Hyde (1)
Metulocladosporiella Crous, Schroers, J.Z. Groenew., U. Braun & K. Schub. (6)
Minimelanolocus R.F. Castañeda & Heredia (34)*
Phialophora Medlar (41)*
Pleomelogramma Speg. (2)
Rhinocladiella Nannf. (17)
Sorocybe Fr. (3)
Thysanorea Arzanlou, W. Gams & Crous (14)*
Uncispora R.C. Sinclair & Morgan-Jones (4)*
Veronaea Cif. & Montemart. (19)*

Lyrommataceae Lücking

Lyromma Bat. (8)*

Microtheliopsidaceae O.E. Erikss.

Microtheliopsis Müll. Arg. (4)

Paracladophialophoraceae Crous

Paracladophialophora Crous (2)

Pyrenotrichaceae Zahlbr

Pyrenothrix Riddle (2)
Neophaeococcomyces Crous & M.J. Wingf. (4) *

Trichomeriaceae Chomnunti & K.D. Hyde (= *Strelitzianaceae* Crous & M.J. Wingf.)

Arthrocladium Papendorf (4)

Bradomyces Hubka, Réblová, Selbmann & M. Kolařík (3)
Knufia L.J. Hutchison & Unter. (139)*
Lithohypha Selbmann & Isola (3)*
Neostrelitziana Crous & M.J. Wingf. (1)
Strelitziana Arzanlou & Crous (8)
Trichomerium Speg. (29)*

Chaetothyriales genera *incertae sedis*

Bacillicladium Hubka, Réblová & Thureborn (2)*
Euceramia Bat. & Cif. (1)*
Lichenodiplis Dyko & D. Hawksw. (= *Laeviomycetes* D. Hawksw.) (13)
Melanina Grube, Muggia & de Hoog (1)*

Genera excluded from Chaetothyriales

Microcallis Syd. (10)*
Yatesula Syd. & P. Syd. (2)*

Phylogeny

The phylogenetic tree in Fig. 1 was constructed to verify the relationships of Eurotiomycetes in Ascomycota. The combined ITS and LSU gene analysis comprised 320 taxa with *Armillaria mellea* AFTOL-ID 449 as the outgroup taxon. The best scoring RAxML tree with a likelihood value is shown in Fig. 1.

The best-fit models of evolution obtained for the different datasets were ITS = TVM+I+G, LSU = GTR+I+G, combined sequences = TIM2+I+G. No topological conflicts between the datasets were detected. Three hundred and twenty taxa were included in the combined ITS and LSU sequence analyses which comprised 1,916 characters including gaps (ITS = 1-574, LSU= 575-1916). The best scoring RAxML tree with a final likelihood value of -106670.289774 was presented. The matrix had 1693 distinct alignment patterns, with 31.37% of undetermined characters or gaps. Estimated base frequencies were as follows, A = 0.247262, C = 0.233934, G = 0.291391, T = 0.227413, substitution rates AC = 1.293417, AG = 2.574842, AT = 1.517180, CG = 0.928081, CT = 5.845223, GT = 1.000000, gamma distribution shape parameter α = 0.491701.

The phylogenetic tree was obtained from both RAxML and Bayesian analyses, the Chaetothyriales clade comprises Trichomeriaceae, Coccodiniaceae, Chaetothyriaceae, Herpotrichiellaceae, Cyphellophoraceae, Paracladophialophoraceae and Epibryaceae. The Chaetothyriaceae clade was relatively heterogeneous with 82% ML BS, 0.93 BY PP support. The Herpotrichiellaceae clade was clearly distinct from Chaetothyriaceae, Trichomeriaceae and Coccodiniaceae. The Herpotrichiellaceae clade had 96% ML BS, 1.00 BY PP support in both analyses. Species of this family are polyphyletic and divided into two groups. The other families, i.e. Coccodiniaceae was distinct (96% ML BS and 1.00 BY PP) with one taxon; *Coccodinium brtschii* CPC13861. Cyphellophoraceae was a single, 82% ML BS, 0.93 BY PP supported clade with Paracladophialophoraceae as a sister group.

Cyphellophoraceae comprises *Cyphellophora guyanensis* Decock & G. Delgado (CBS 129342), *Cy. laciniata* G.A. de Vries (CBS 190.61), *Anthopsis deltoidei* Fil. March. et al. (CBS 263.77) and Chaetothyriales sp. (CBS 128959). *Cyphellophora* G.A. de Vries resembles *Phialophora* Medlar, but differs in conidial shape, while the type species *Phialophora verrucosa*, is a member of the 'carrionii-clade' in Herpotrichiellaceae (de Hoog et al. 2011). In the present study, Strelitzianaceae is excluded from Chaetothyriales, and synonymized in Trichomeriaceae.

Epibryaceae comprised two strains, *Epibryon plagiophilae* (Gonz. Frag.) Döbbeler (ex-type strain, M187) and *E. bryophilum* (Fuckel) Döbbeler (M2), clustering with 100% ML BS, 0.90 BY PP support. Forty-seven species are accepted in Index Fungorum (2021), but only seven have sequence data in GenBank.

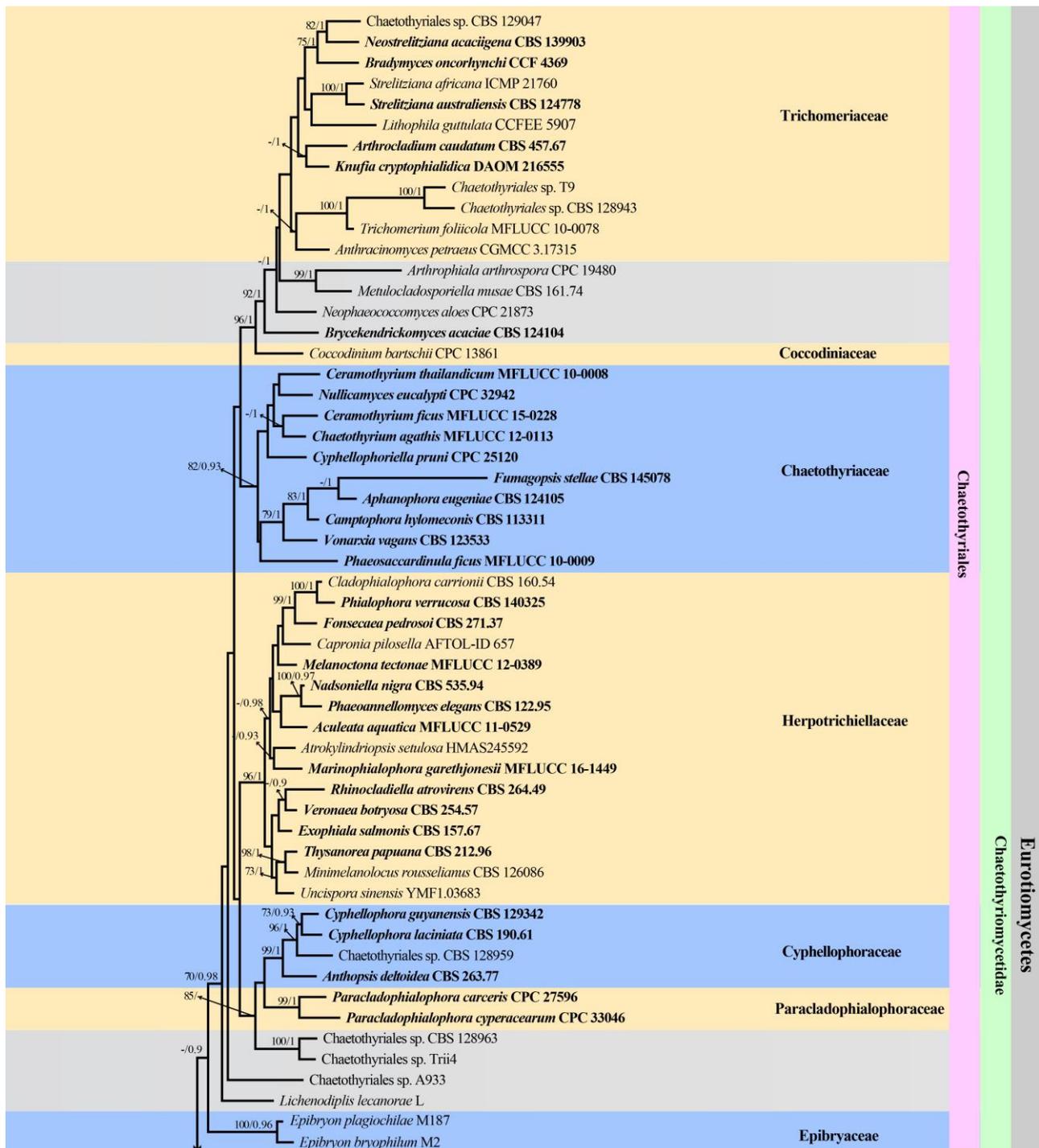


Figure 1 – Phylogenetic tree generated from maximum likelihood analysis based on combined ITS and LSU sequence data for species of Eurotiomycetes. Sequences were obtained from GenBank. Single gene analyses are carried out and compared with each species, the topology of the tree and clade stability. *Armillaria mellea* AFTOL-ID 449 is used as the outgroup taxon. The tree topology of the maximum-likelihood analysis is similar to the maximum parsimony analysis and the Bayesian analysis. Bootstrap support values for maximum likelihood (ML, first set) equal to or greater than 70% are given above or below the nodes. Branches with Bayesian posterior probabilities (BPP, second set) equal to or higher than 0.90 are given above or below the nodes. The hyphen (“–”) indicates a value lower than 70% for ML BS or 0.90 for BY PP. Ex-type and ex-epitype strains are in bold.

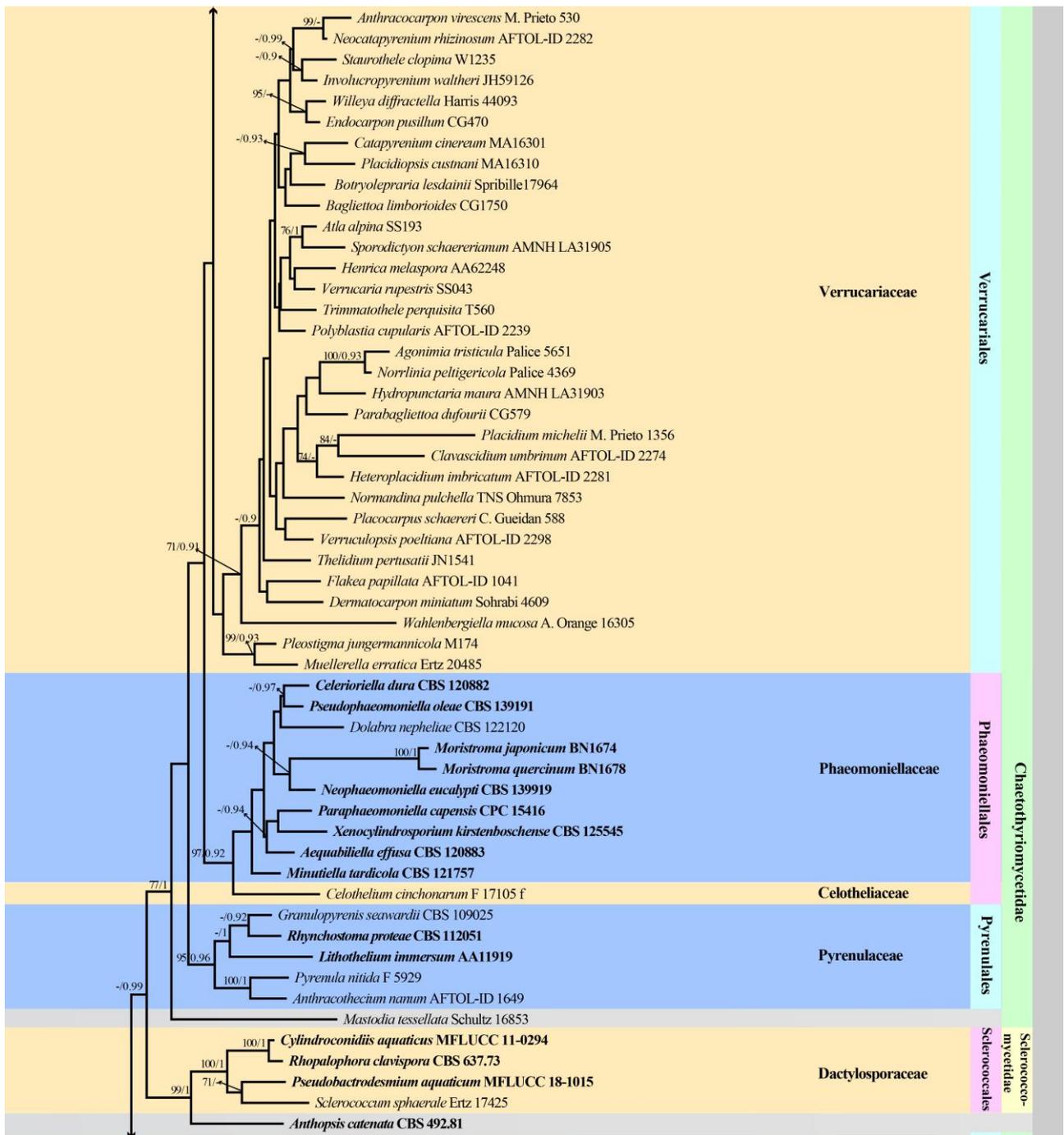


Figure 1 – Continued.

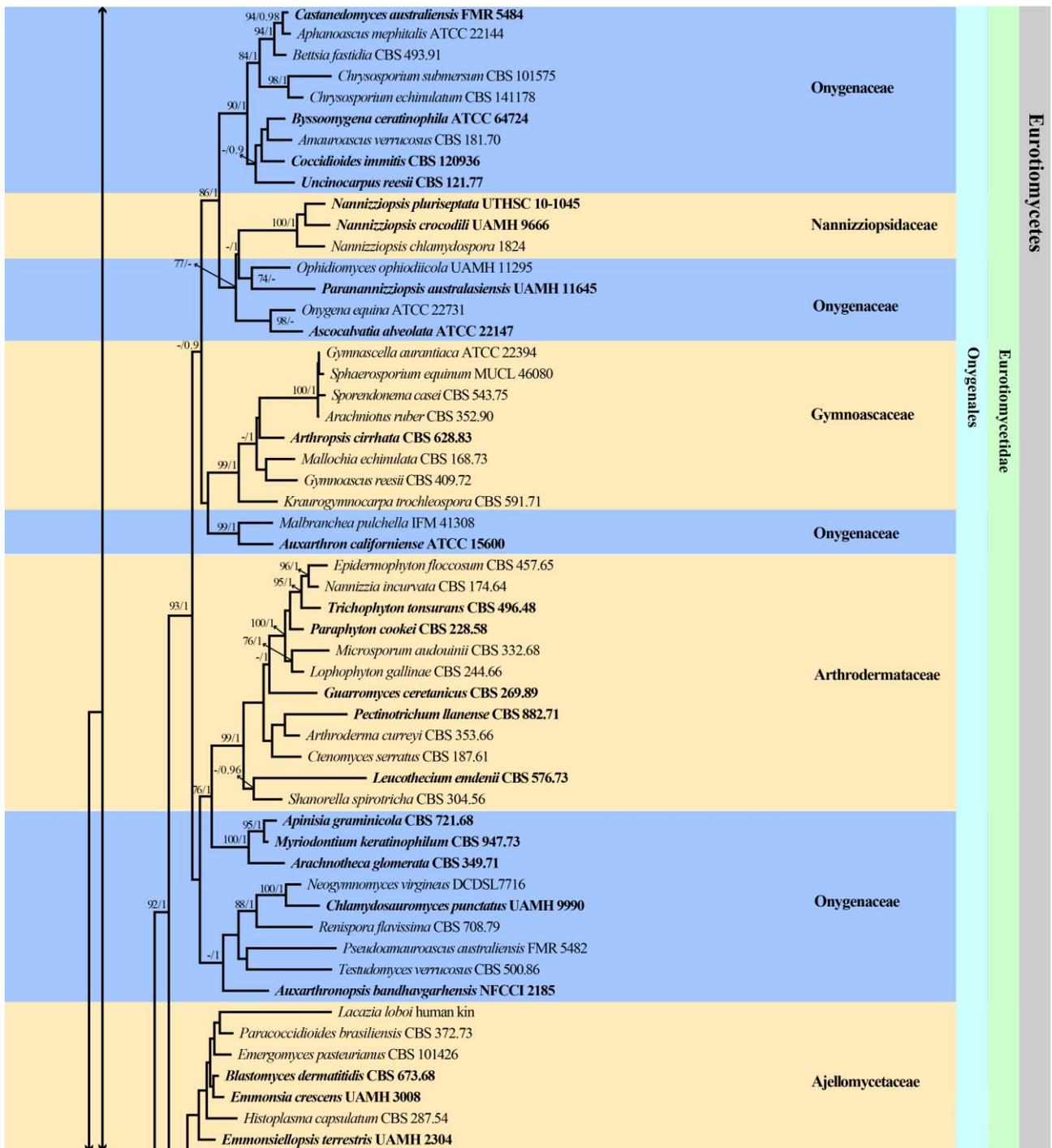


Figure 1 – Continued.

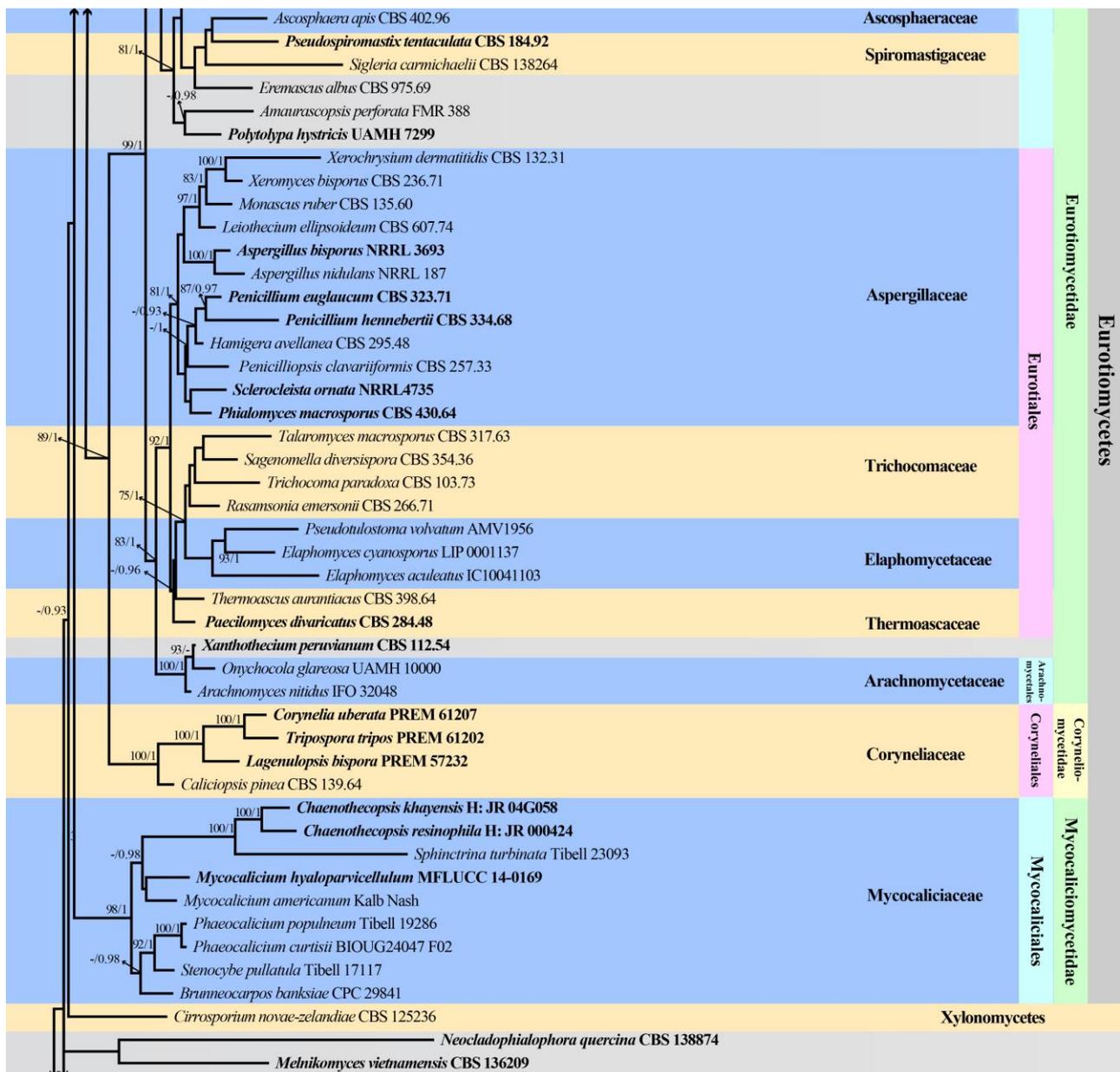


Figure 1 – Continued.

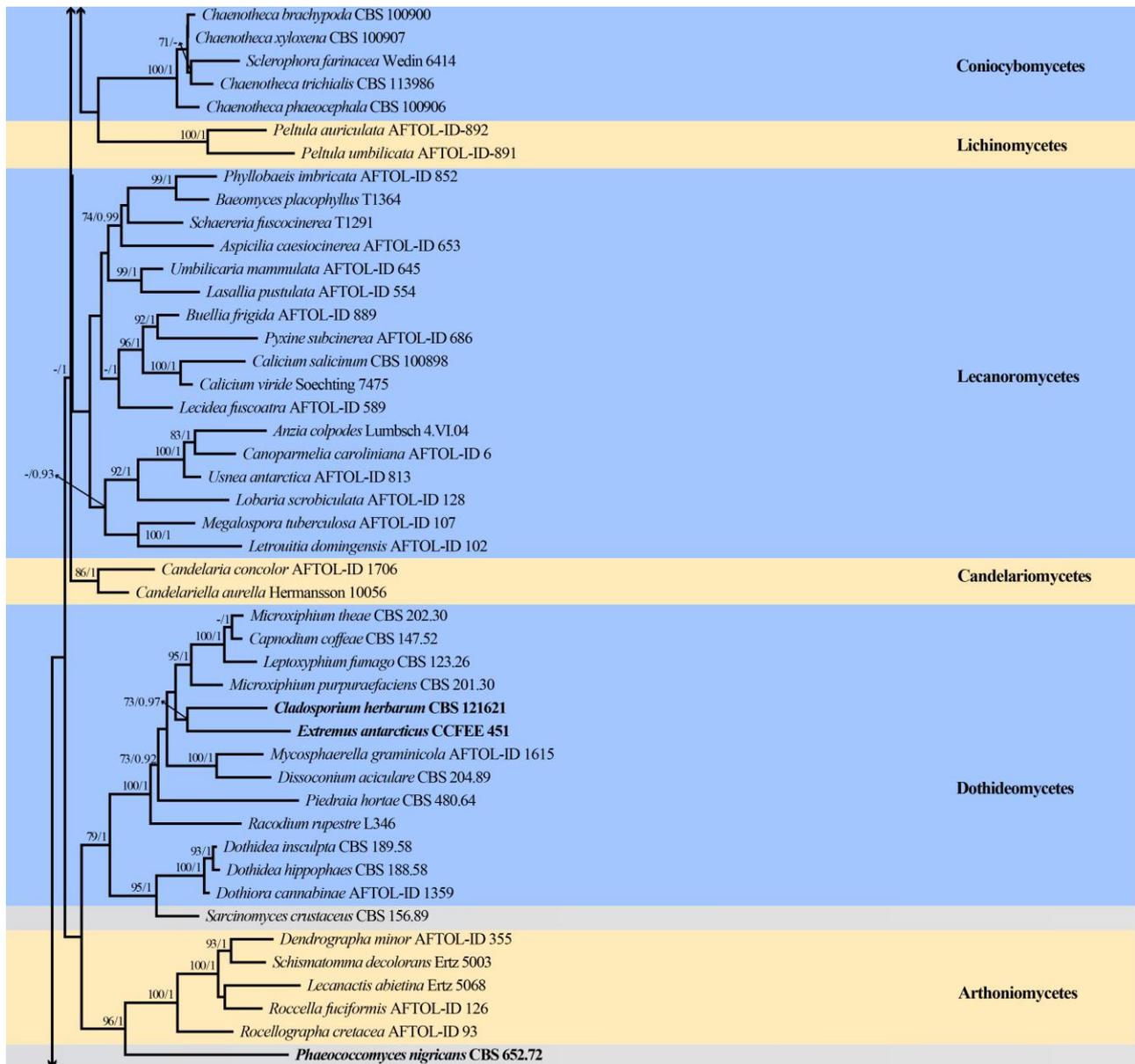


Figure 1 – Continued.

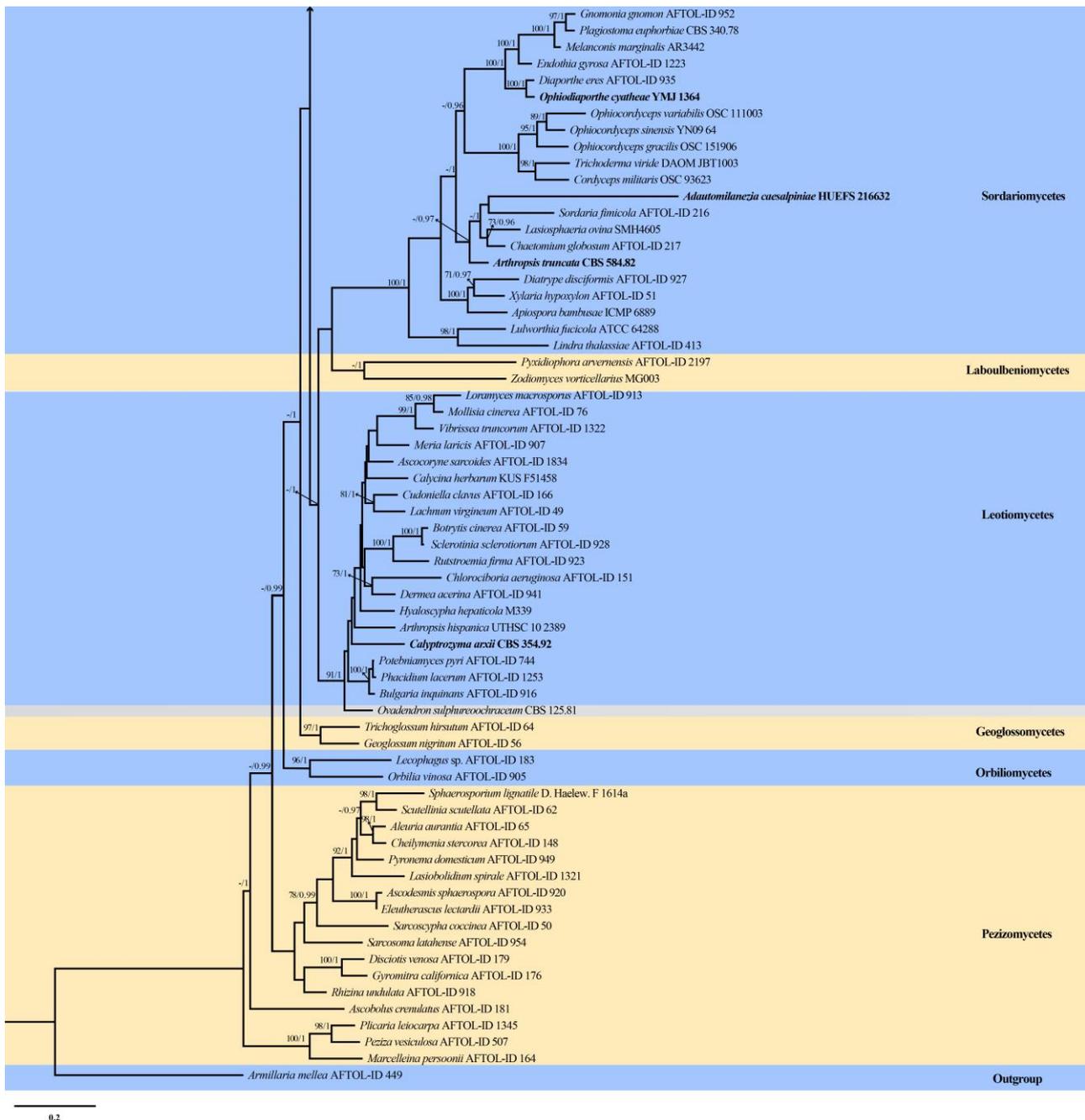


Figure 1 – Continued.

Descriptions and notes on families and genera

Chaetothyriomycetidae Doweld

Chaetothyriales M.E. Barr

Chaetothyriaceae Hansf. ex M.E. Barr, Mycologia 71(5): 943 (1979)

Index Fungorum number: IF80584; Facesoffungi number: FoF 10323

Epiphytic or *saprobic* on leaves and stems of various plants in terrestrial habitats. Sexual morph: *Ascomata* superficial, immersed to erumpent through cracking or splitting of the host tissue, solitary to gregarious, with periphysate ostioles, with or without papilla. *Wall of ascoma* composed of several layers, outer layers of dark brown cells, inner layers of hyaline to light brown flattened cells. *Hamathecium* lacking or comprising filiform, hyaline, septate paraphyses. *Asci* 4–8-spored, bitunicate, fissitunicate, oblong, clavate to nearly cylindrical, oval, sessile or short pedicellate, with or without an ocular chamber, forming in a basal layer, often interspersed with and covered by cellular remnants of

interthecial tissues. *Ascospores* overlapping 1-multi-seriate, irregularly arranged, ellipsoid to broadly obovoid, fusiform to cylindrical, hyaline or lightly pigmented, yellowish to brownish, aseptate or 1–2-trans-septate, or muriform, thin-walled, with or without a gelatinous sheath or appendages, guttulate or eguttulate. Asexual morph: coelomycetous and hyphomycetous.

Type – *Chaetothyrium* Speg.

Notes – Chaetothyriaceae was established by Hansford (1946) with *Chaetothyrium* Speg. as the type genus (type species: *C. guaraniticum* Speg. *vide* Spegazzini 1888). The family is characterized by superficial ascomata produced beneath a mycelial pellicle, with or without setae and mainly bitunicate asci (Batista et al. 1960, Batista & Ciferri 1962, von Arx & Müller 1975, Hughes 1976, Pereira-Carvalho et al. 2009, Chomnunti et al. 2012, 2014, Tian et al. 2014, Zeng et al. 2016, Yang et al. 2018). Species of Chaetothyriaceae are mostly epiphytes, and resemble other sooty mould families, such as Capnodiaceae Höhn. ex Theiss. because of their similar morphology and habitat preferences. Species in both families are associated with insects and isolated from the same hosts (Hansford 1946, Batista & Ciferri 1962, Chomnunti et al. 2012a, b, 2014). Most of the previous work included only brief descriptions and indistinct illustrations or simple line drawings, which not been a reliable guide to current research (Hansford 1946, Batista & Ciferri 1962, von Arx & Müller 1975, Hughes 1976). The placement of this family in Eurotiomycetes was clarified with high support in phylogenetic analysis (Winka et al. 1998, Chomnunti et al. 2012a, b, 2014). However, the family is still poorly circumscribed because: (1) the brief descriptions and some illustrations are not a reliable guide to current research; (2) previous studies for the arrangement of genera based on subjective morphology are hard to follow (For example, with or without setae, spore septation *vide* Batista & Ciferri 1962, Hughes 1976); (3) lacking DNA sequence data. Wijayawardene et al. (2020) accepted 20 genera in Chaetothyriaceae, but only ten genera have molecular data in GenBank. Therefore, it is essential to re-examine the type species of each genus of Chaetothyriaceae and provide detailed morphological information and focus on collecting more taxa of Chaetothyriaceae to obtain molecular data towards resolving a natural classification.

Chaetothyrium Speg., Anal. Soc. cient. argent. 26(1): 46 (1888)

Index Fungorum number: IF978; Facesoffungi number: FoF 10324, 45 morphological species (Species Fungorum 2021), 2 species with molecular data.

Saprobic on leaves. Sexual morph: *Ascomata* appearing as black dots scattered on the upper surface, developing beneath a brown layer attached to the leaf surface, scattered, subglobose to circular, cupulate on drying, brown to dark brown, ostiole or papilla not apparent. *Setae* scattered, dark brown to black at the apex, erect. *Wall of ascoma* thicker at the apex, multi-layered, pseudoparenchymatous, comprising pigmented, thick-walled cells of *textura angularis*, with inner layer thinner, flattened, lightly pigmented to hyaline, thin-walled cells. *Hamathecium* lacking paraphyses. *Asci* 8-spored, bitunicate, clavate to ellipsoid, shortly pedicellate or sessile. *Ascospores* overlapping uni-seriate or bi-seriate, oblong-ellipsoid, obovoid, hyaline, septate or muriform, slightly constricted at the septa, smooth and thick-walled, lacking a gelatinous sheath or appendages. Asexual morph: Undetermined.

Type species – *Chaetothyrium guaraniticum* Speg. [as ‘guaranticum’]

Notes – *Chaetothyrium* is the type genus of Chaetothyriaceae. Species in *Chaetothyrium* are referred to as sooty moulds because of the similarity of appearance and ecology to capnodiaceous sooty moulds. The black mycelia reduce photosynthesis rates in the host. Some species in *Chaetothyrium*, such as *C. vermisporum* Hansf., are fly-speck taxa (forming thyriothecia on darkly pigmented blemishes and smudges on stems or leaves of living or dead hosts) which can be identified by their pellicle structures that press the thyriothecia close to the leaf (Hofmann & Piepenbring 2006). However, other species in *Chaetothyrium* have perithecia on the surface of host organs (Hofmann & Piepenbring 2006). *Merismella* Syd. (*M. concinna* Sydow, type species) has been reported as the asexual morph of *Chaetothyrium* (*C. vermisporum*) due to its similar fruiting body characters when they examined the same host specimen, while *C. vermisporum* has setae with a ring around the thyriothecia (Hofmann & Piepenbring 2006). The sexual / asexual connection was accepted by Hyde et al. (2011), Chomnunti et al. (2012a) and Wijayawardene et al. (2012). However, *Merismella* has not yet been formally synonymized under *Chaetothyrium*. Presently, 45 species are referred to *Chaetothyrium*

(Species Fungorum 2021). There is few sequence data for *Chaetothyrium* in GenBank (July, 2021). Winka et al. (1998) showed that *Ceramothyrium linnaeae* (Dearn.) S. Hughes is closely related to *Chaetothyrium* based on SSU rDNA sequence analysis. Chomnunti et al. (2012a) introduced a new species, *C. bischofiicola* Chomnunti et al., and included LSU and ITS rDNA sequence data for this genus and verified the position of *Chaetothyrium* in Chaetothyriaceae (Chaetothyriales, Eurotiomycetes). Liu et al. (2015) introduced *C. agathidis* Hongsanan & K.D. Hyde and provided further sequence data for this genus. Nevertheless, further studies with more taxon sampling are needed for a better understanding of *Chaetothyrium* and to verify whether the genus is monophyletic (Badali et al. 2008, Gueidan et al. 2008, Untereiner et al. 2011, Chomnunti et al. 2012a). Quan et al. (2020) proposed *C. agathidis* (Liu et al. 2015) as the neotype of *Chaetothyrium*, however, *Chaetothyrium agathidis* resembles *C. guaraniticum* in having long setae but ascospores of *C. agathidis* are cylindrical with 3–7 septa, while in *C. guaraniticum* they are oblong-ellipsoid with 1–3-septa. Therefore, we herewith proposed to designate *C. agathidis* as a representative type of *Chaetothyrium*. Our combined LSU and ITS sequence data demonstrate a close relationship between *C. agathidis* and the sooty mould species *Ceramothyrium ficus* (66% ML BS and 1.00 BY PP support, Fig. 1). We also provide an appropriate description and photo-plate of the type species *C. guaraniticum* Speg. from an Indian collection.

Chaetothyrium guaraniticum Speg. [as ‘guaranticum’], Anal. Soc. cient. argent. 26(1): 46 (1888)

Fig. 2

Index Fungorum number: IF569945; Facesoffungi number: FoF 10325

Saprobic on *Aegle marmelos*. Sexual morph: *Ascomata* 95–185 µm high × 80–110 µm diam. (\bar{x} = 111 × 90 µm, n = 10), perithecial, solitary, scattered, superficial, subglobose to circular, brown to dark brown, lacking an ostiole or papilla, appearing as black dots scattered on the upper surface of leaves. *Setae* 45–100 × 1.8–3.6 µm (\bar{x} = 78 × 2.4 µm, n = 10), scattered, dark brown to black at the apex, erect, rounded at the base and wider than the apex. *Wall of ascoma* 18–32 µm (\bar{x} = 25 µm, n = 10), thicker at the apex, multi-layered, externally comprising pigmented, dark brown, thick-walled cells of *textura angularis*, with inner layer thinner, composed of irregularly-shaped, flattened, lightly pigmented to hyaline, thin-walled cells of *textura angularis*. *Hamathecium* lacking paraphyses. *Asci* 48–52 × 13–17 µm (\bar{x} = 48 × 15.8 µm, n = 10), 8-spored, bitunicate, fissitunicate, clavate to ellipsoid, short pedicellate or sessile, with an ocular chamber. *Ascospores* 18–27 × 3–5 µm (\bar{x} = 24 × 4.2 µm, n = 10), overlapping uni-seriate or bi-seriate, oblong-ellipsoid, hyaline, 1–3 septate, constricted at the septa, smooth and thick-walled, lacking a gelatinous sheath or appendages. Asexual morph: Undetermined.

Material examined – India, Uttar Pradesh, on leaves of *Aegle marmelos* (L.) Corrêa (Rutaceae), 16 February 1962, Dwivedi R.S. (IMI 91630).

Ecological and economic significance of Chaetothyriaceae

Chaetothyriaceae species are known as epiphytes with the appearance of sooty moulds and mostly grow on the surface of living leaves apparently gaining nutrients from sugary exudates. They are characterized by dark mycelium adpressed to the surface of leaves and stems, but do not penetrate the host tissues (Batista & Ciferri 1962, Chomnunti et al. 2012a, 2014). Sooty moulds are treated as a plant disease, growing on the surface of the plant tissues, as they can block sunlight from leaf chloroplasts and cause lower growth rates of plants and reduce yield (Nelson 2008, Laemmlen 2011). *Chaetothyrium vermisporum* looks like a fly-speck fungus which is identified by the pellicle structures that can press the perithecia close to the leaf (Hofmann & Piepenbring 2006).

Genera included in Chaetothyriaceae

Actinocybbe Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 120: 416 (1911)

Index Fungorum number: IF60, Facesoffungi number: FoF 10326, 3 morphological species (Species Fungorum 2021), molecular data unavailable.

Type species – *Actinocybbe separato-setosa* (Henn.) Höhn.

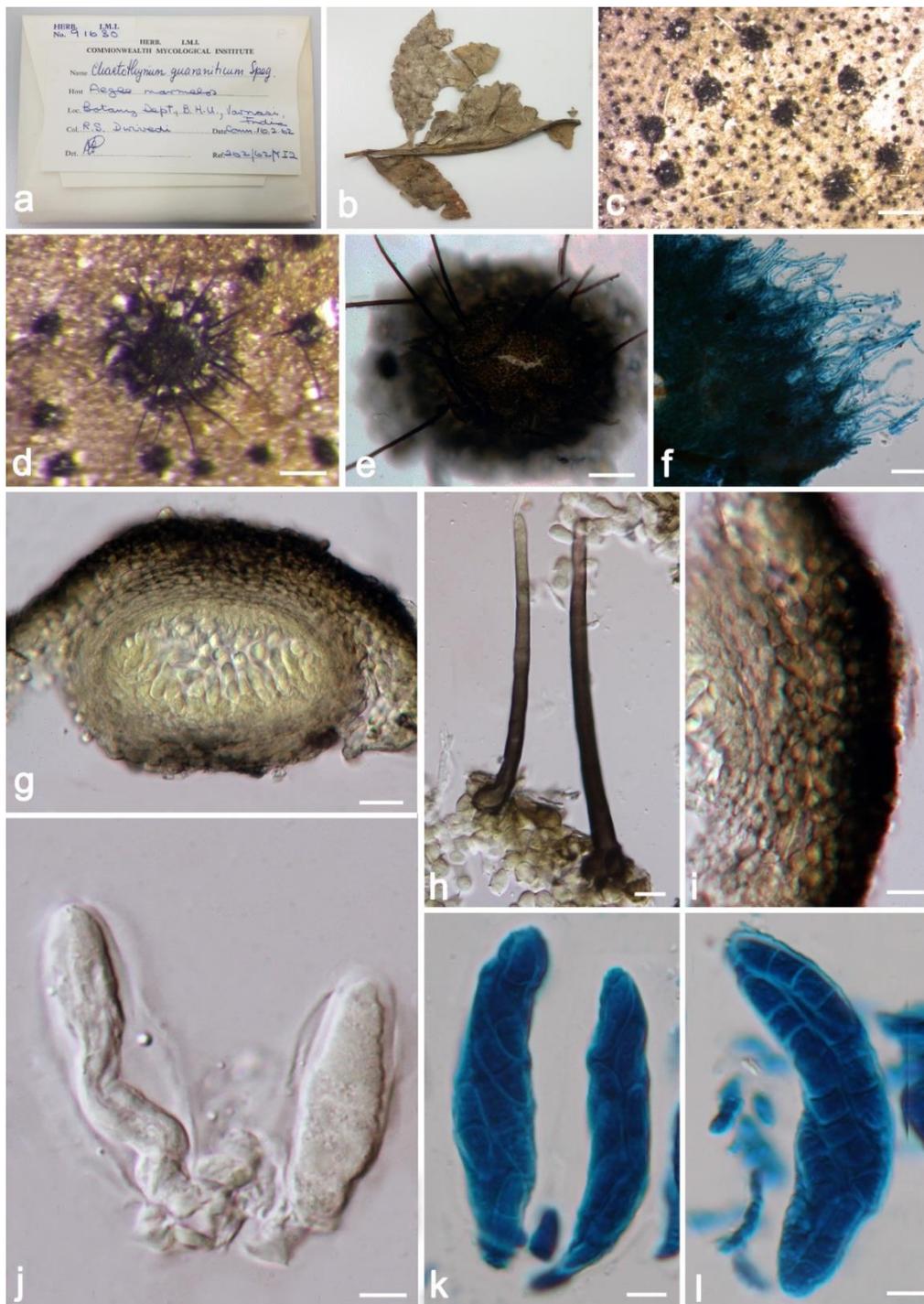


Figure 2 – *Chaetothyrium guaraniticum* (IMI 91630). a Envelop and collection information of *Chaetothyrium guaraniticum*. b Herbarium material. c Appearance of ascomata on the leaves of *Aegle marmelos*. d Globose ascoma with black setae. e Squash mount of ascoma. f Mycelial network attaching ascoma to the leaf surface. g Vertical sections of ascoma. h Ascumatal setae. i Vertical sections through ascoma wall. j Immature asci. k, l Asci with ascospores, stained in lactophenol cotton blue. Scale bars: c = 500 µm, d = 100 µm, e, g = 50 µm, f = 20 µm, i = 10 µm, h, j-l = 5 µm.

Epiphytic on the surface of leaves. Sexual morph: *Mycelium* branched, septate, greyish brown, appressed to the cuticle. *Ascomata* perithecial, solitary, scattered, superficial to erumpent, subglobose to circular, brown to dark brown, ostiolate. *Ostiole* open, periphysate. *Setae* scattered to clustered, dark brown to black, erect, rounded at the base and wider than the apex. *Wall of ascoma* multi-layered, externally comprising pigmented, dark brown, thick-walled cells of *textura angularis*, with inner layer

thinner, composed of irregularly-shaped, lightly pigmented to hyaline, thin-walled cells. *Hamathecium* paraphysate. *Asci* 8-spored, bitunicate, fissitunicate, clavate, long pedicellate, straight to slightly curved. *Ascospores* overlapping multi-seriate, oblong-ellipsoid, tapering at the ends, hyaline, usually 9-septate, without constriction at the septa, smooth and thick-walled, lacking a gelatinous sheath or appendages. Asexual morph: Undetermined.

Notes – *Actinocymbe separato-setosa* (Henn.) Höhn, *A. congensis* (Henn.) Hansf. and *A. indica* R.K. Verma & Kamal were added to this genus which is characterized by setose ascomata, periphysate ostioles and oblong-ellipsoid ascospores (Höhn 1911, von Arx & Müller 1975, Verma & Kamal 1987). Periphyses have been illustrated as an important character to identify species in Chaetothyriaceae (von Arx & Müller 1975). There is no culture or molecular data available in GenBank (July, 2021). We re-examined the holotype of *A. separato-setosa* to provide an updated morphology. Based on the setiferous ascomata, periphysate ostioles and oblong-ellipsoid, multi-septate ascospores, we maintain *Actinocymbe* in Chaetothyriaceae.

Actinocymbe separato-setosa (Henn.) Höhn., Sber. Akad. Wiss. Wien, Math. -naturw. Kl., Abt. 1 120: 416 (1911) Fig. 3

= *Actiniopsis separato-setosa* Henn., Hedwigia 47: 269 (1908)

Index Fungorum number: IF811417; Facesoffungi number: FoF 10327

Epiphytic on the surface of leaves, epiphyllous or sometimes hypophyllous. *Mycelium* 4–6 µm wide, branched, septate, greyish brown, appressed to the cuticle. Sexual morph: *Ascomata* 470–680 µm diam. (\bar{x} = 590 µm, n = 10), perithecial, solitary, scattered, superficial to erumpent, subglobose to circular, brown to dark brown, ostiolate. *Ostiole* open, periphysate. *Setae* 140–180 × 4–6 µm (\bar{x} = 168 × 5 µm, n = 10), scattered to clustered, dark brown to black, erect, rounded at the base and wider than the apex. *Wall of ascoma* 26–50 µm (\bar{x} = 42 µm, n = 10), multi-layered, externally comprising pigmented, dark brown, thick-walled cells of *textura angularis*, with inner layer thinner, composed of irregularly-shaped, flattened, lightly pigmented to hyaline, thin-walled cells of *textura prismatica*. *Hamathecium* composed of long, 2.5–3 µm wide, septate, paraphyses, with hyaline, guttulate cells. *Asci* 42–58 × 13–19 µm (\bar{x} = 46 × 15 µm, n = 10), 8-spored, bitunicate, fissitunicate, clavate to ellipsoid, long pedicellate, straight to slightly curved. *Ascospores* 24–33 × 4–7 µm (\bar{x} = 28 × 6 µm, n = 10), overlapping multi-seriate, oblong-ellipsoid, tapering at the ends, hyaline, usually 9-septate, without constrictions at the septa, smooth and thick-walled, lacking a gelatinous sheath or appendages. Asexual morph: Undetermined.

Material examined – Brazil, Amazonas, Rio Juruá, on leaves, May 1905, E. Ule (S-F12588, holotype).

Aphanophora Réblová & Unter., PLoS ONE 8(5): e63547, 14 (2013)

Index Fungorum number: IF803677, Facesoffungi number: FoF 10328, 1 species with molecular data.

Type species – *Aphanophora eugeniae* (Crous & Alfenas) Réblová & Unter.

Epiphytic on the surface of living leaves. Sexual morph: Undetermined. Asexual morph: *Mycelium* composed of branched, septate, greenish-brown hyphae on PDA. *Conidiophores* lacking, reduced to conidiogenous cell. *Conidiogenous cells* phialidic, intercalary, hyaline, with the inconspicuous collarette, with aggregated loci. *Conidia* subcylindrical to cylindrical, hyaline to sub-hyaline, 4–6-septate, constricted at the septa, curved, smooth-walled, guttulate, each segment divided by a secondary median septum (Crous et al. 2009, Réblová et al. 2013).

Notes – Réblová et al. (2013) introduced *Aphanophora* Réblová & Unter. to accommodate the type species *Aphanophora eugeniae* (Crous & Alfenas) Réblová & Unter. (Basionym: *Cyphellophora eugeniae* Crous & Alfenas) with evidence from phylogenetic analysis and the morphological distinction between *Aphanophora* and *Cyphellophora*. Species of *Aphanophora* produce intercalary phialides and the cylindrical-elongate conidia are divided into septate segments. *Aphanophora* resembles *Camptophora* and they cluster together with high support (Réblová et al. 2013). However, the collarettes in *Aphanophora* are inconspicuous, and the multiple conidiogenous loci become swollen,

while *C. hylomeconis* (Crous, de Hoog & H.D. Shin) Réblová & Unter. produces conspicuous phialides and has a single conidiogenous locus. In our phylogenetic analysis based on combined LSU and ITS sequence data, *A. eugeniae* clustered with *Fumagopsis stellae* Crous & A.J. Carnegie and formed a sister group with *C. hylomeconis* (Fig. 1). However, *F. stellae* is distinctly based on its star-shaped conidia. Currently, no sexual morphs are linked to *Aphanophora*. Thus, the hyphomycetous genus *Aphanophora* is accepted in Chaetothyriaceae primarily based on phylogenetic analysis.



Figure 3 – *Actinocymbe separato-setosa* (S-F12588, holotype). a Appearance of superficial ascomata on the host. b, e Squash mount of ascoma. c Globose ascoma with black setae. d Vertical section through ascoma wall. f Vertical section of ascoma. g, i Asci with ascospores, stained in lactophenol cotton blue reagent. j Erect, septate, dark brown setae. Scale bars: b, f = 100 μ m, c–e = 50 μ m, g–j = 20 μ m.

Aphanophora eugeniae (Crous & Alfenas) Réblová & Unter., PLoS ONE 8(5): e63547, 14 (2013)

Fig. 4

= *Cyphellophora eugeniae* Crous & Alfenas, Persoonia 22: 147 (2009)

Index Fungorum number: IF803678; Facesoffungi number: FoF 10329

Description: see Réblová et al. (2013).

Type material – Brazil, Rio Grande do Sul, Guaíba, living leaves of *Eugenia uniflora* L. (Myrtaceae), 1 April 2008, leg. A.C. Alfenas, isol. P.W. Crous (CPC 15172 = CBS 124105, ex-type).

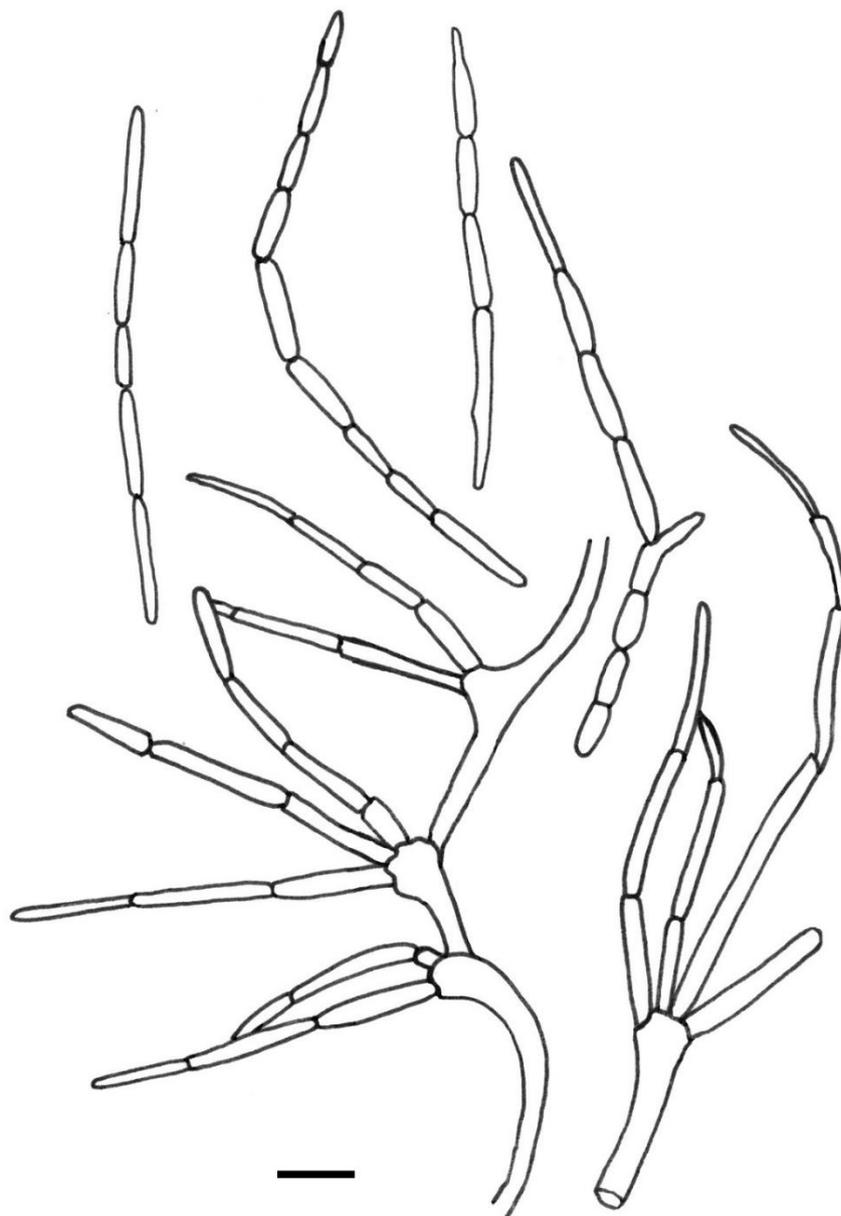


Figure 4 – *Aphanophora eugeniae* (CBS 124105, ex-type, redrawn from Crous et al. 2009). Conidiogenous cells with conidia. Scale bar: 10 μ m.

Beelia F. Stevens & R.W. Ryan, in Stevens, Bulletin of the Bernice P. Bishop Museum, Honolulu, Hawaii 19: 71 (1925)

Index Fungorum number: IF530, Facesoffungi number: FoF 10330, 3 morphological species (Species Fungorum 2021), molecular data unavailable.

Type species – ***Beelia suttoniae*** F. Stevens & R.W. Ryan

Saprobic on the surface of leaves. Sexual morph: *Ascomata* superficial, immersed in darkened mycelium, globose to subglobose, black, ostiolate, periphysate. *Wall of ascoma* comprising two cell types, externally comprising pigmented, dark brown, thick-walled cells, with inner layer thinner and composed of hyaline, thin-walled cells. *Hamathecium* lacking paraphyses. *Asci* 8-spored, bitunicate, broadly ellipsoidal, obovate to saccate, pedicellate, with an ocular chamber. *Ascospores* cylindrical,

hyaline, 5-septate, strongly constricted at each septum, smooth-walled, with a narrow mucilage sheath. Asexual morph: Undetermined.

Notes – *Beelia* was introduced by Stevens (1925) and typified by *B. philippinensis* Bat. & C.A.A (Batista & Costa 1959). Subsequently, *B. plumeria* Bat. & Cavalc. was added to the genus (Batista et al. 1967). *Beelia* was accommodated in Microthyriaceae based on morphology by Stevens (1925) and confirmed by Petrak (1953). According to the dimidiate ascomata and long, brown ascospores, von Arx & Müller (1975) transferred *Beelia* to Myriangiaceae. Recently, *Beelia* was regarded as a genus in Elsinoaceae (Hawksworth et al. 1995, Lumbsch & Huhndorf 2007, Kirk et al. 2008). Li et al. (2011) and Hyde et al. (2013) suggested to transfer *Beelia* to Chaetothyriaceae because the taxon was a superficial biotroph on leaf surfaces, which fit the characters of Chaetothyriaceae. *Beelia* differs from other genera in this family as the ascospores are distoseptate, with a deep central constriction. Combined with important diagnostic characters of periphysate ostioles (von Arx & Müller 1975), we retain *Beelia* in Chaetothyriaceae. DNA sequence data are needed to clarify the placement of *Beelia*.

Beelia suttoniae F. Stevens & R.W. Ryan, Bulletin of the Bernice P. Bishop Museum, Honolulu, Hawaii 19: 71 (1925) Fig. 5

Index Fungorum number: IF200511; Facesoffungi number: FoF 10331

Saprobic on the surface of leaves of *Suttonia lanaiensis*. Sexual morph: *Ascomata* 190–210 µm wide, 115–133 µm high, scattered, superficial, immersed in the darkened mycelial substrate, globose to subglobose, black, easily removed, ostiolate. *Ostiole* open, periphysate. *Wall of ascoma* 25–30 µm wide, up to 39 µm wide at the apex, 20 µm wide at the base, comprising multi-layers, externally comprising pigmented, dark brown, thick-walled cells of *textura globulosa*, with inner layer thinner, composed of lightly pigmented to hyaline, thin-walled cells of *textura angularis*. *Hamathecium* lacking paraphyses. *Asci* 70–89 × 45–55 µm (\bar{x} = 84.3 × 51.2 µm, n = 20), 8-spored, bitunicate, broadly ellipsoidal, obovate to saccate, thick-walled, with a small pointed pedicle, with an ocular chamber. *Ascospores* 38–45 × 13–18 µm (\bar{x} = 42.8 × 14.6 µm, n = 20), irregularly arranged, cylindrical, hyaline, 5-septate, slightly constricted at each septum, central septum strongly constricted and upper part wider, smooth-walled, with a narrow mucilage sheath. Asexual morph: Undetermined.

Material examined – USA, Hawaii, on leaves of *Suttonia lanaiensis* Mez (Myrsinaceae), 1925, Lanai, no. 421, leg. Munro (BISH 499845, syntype).

Camptophora Réblová & Unter., PLoS ONE 8(5): e63547, 14 (2013)

Index Fungorum number: IF803679, Facesoffungi number: FoF 10332, 2 species with molecular data.

Type species – ***Camptophora hylomeconis*** (Crous, de Hoog & H.D. Shin) Réblová & Unter.

Saprobic on sugar exudates from insects or *foliar epiphytes* on the upper surface of living leaves. Sexual morph: *Mycelium* superficial, black, composed of dark brown, reticulate-branched, hyphae, constricted at the septa. *Ascomata* scattered, superficial, subglobose to globose, black, with short stalk. *Wall of ascoma* multi-layered, inwardly hyaline of *textura prismatica*, dark brown towards the outside, comprised *textura angularis*. *Asci* 8-spored, bitunicate, ovoid to obpyriform, short pedicellate. *Ascospores* biserial, fusiform, hyaline, phragmospores or muriform, with 3–5 transverse septa and 1–4 longitudinal septa, constricted at the septum, with guttules, narrow at the ends (Yang et al. 2018). Asexual morph: *Mycelium* composed of branched, septate, greenish-brown hyphae. *Conidiophores* lacking, reduced to a conidiogenous cell. *Conidiogenous cells* phialidic, intercalary, hyaline, with inconspicuous collarette, or sometimes proliferating percurrently. *Conidia* sickle-shaped, light brown, usually 3-septate, constricted at the septa, curved, widest in middle, apex rounded, base subtruncate, with a foot cell for germination, smooth-walled, guttulate (Crous et al. 2007, Réblová et al. 2013).

Notes – *Camptophora* Réblová & Unter. was established to accommodate *Camptophora hylomeconis* (Crous, de Hoog & H.D. Shin) Réblová & Unter. transferred from *Cyphellophora* (Réblová et al. 2013). The genus is characterized by phialidic, intercalary, conidiogenous cells, with an inconspicuous collarette, or sometimes proliferating percurrently, and sickle-shaped conidia (Crous et

al. 2007, Réblová et al. 2013). Phylogenetically, *C. hylomeconis*, *Aphanophora eugeniae* (Crous & Alfenas) Réblová & Unter. and *Fumagopsis stellae* Crous & A.J. Carnegie group together within Chaetothyriaceae (Réblová et al. 2013, this study, Fig. 1). However, *Camptophora* has conspicuous phialides, with a single conidiogenous locus and sickle-shaped conidia, while *A. eugeniae* has inconspicuous collarettes, with aggregated loci and subcylindrical to cylindrical conidia, and it is apparently differentiated from *F. stellae* based on star-like conidia (Crous et al. 2007, 2018, Réblová et al. 2013). Yang et al. (2018) reported a sexual morph of *C. schimae* H. Yang & K.D. Hyde associated with sugar exudates from insects.



Figure 5 – *Beelia suttoniae* (BISH 499845, syntype). a Appearance of ascomata on host leaf with darkened mycelium. b Squash of ascoma in water. c Vertical section of ascoma. d–e Vertical section through ascoma wall. f, g Ascus with ascospores. h, i Ascospores. Scale bars: b = 100 μ m, c–e, g = 50 μ m, f = 25 μ m, h = i = 10 μ m.

Camptophora hylomeconis (Crous, de Hoog & H.D. Shin) Réblová & Unter., PLoS ONE 8(5): e63547, 14 (2013) Fig. 6

≡ *Cyphellophora hylomeconis* Crous, de Hoog & H.D. Shin, Stud. Mycol. 58: 200 (2007)

Index Fungorum number: IF803680; Facesoffungi number: FoF 10333

Description – see Crous et al. (2007), Réblová et al. (2013) and Yang et al. (2018)

Type material – Korea, Yangpyeong, on leaves of *Hylomecon verlanche* Maxim. (Papaveraceae), 4 June 2003, H.D. Shin (CBS 113311, ex-type).

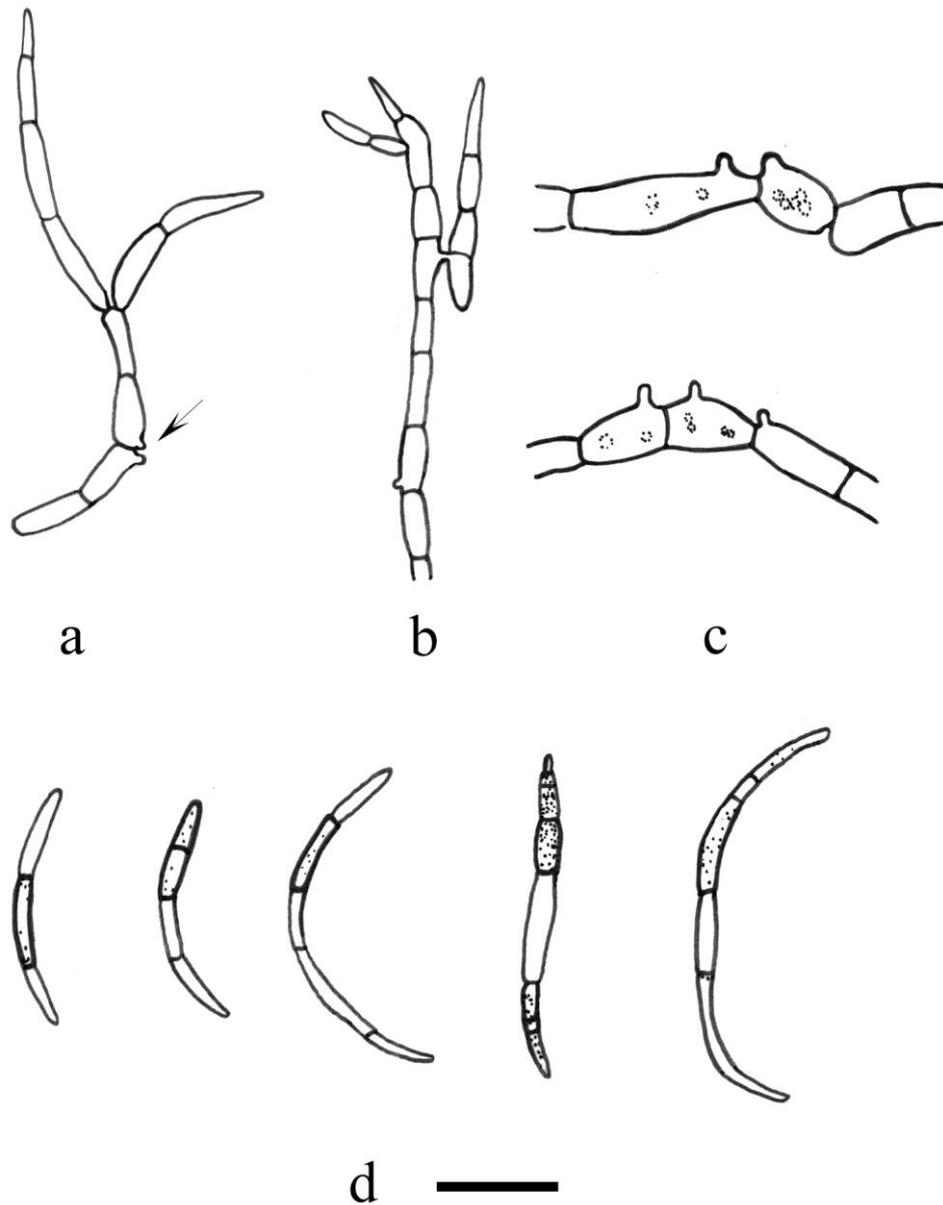


Figure 6 – *Camptophora hylomeconis* (redrawn from Crous et al. 2007, ex-type). a Phialides with conidia. b Anastomosing conidia. c Phialidic loci that can proliferate percurrently above the collarette. d Conidia. Scale bar: 10 μ m.

Ceramothyrium Bat. & H. Maia, Publicações Inst. Micol. Recife 23(1-3): 5 (1956)

Index Fungorum number: IF880, 36 morphological species (Species Fungorum 2021), 11 species with molecular data.

Type species – *Ceramothyrium paiveae* Bat. & H. Maia

Epiphytic on leaves. *Mycelium* superficial, elongate, brownish, septate, with dark mycelium without penetrating host tissues. Sexual morph: *Ascomata* superficial, solitary, scattered, pale brown, globose to subglobose. *Wall of ascoma* composed of multi-layers, externally comprising pigmented, dark brown, thick-walled cells, with inner layer thinner composed of hyaline, thin-walled cells.

Hamathecium lacking paraphyses. *Asci* 8-spored, bitunicate, broadly obovoid, short pedicellate, apically rounded, with an ocular chamber. *Ascospores* overlapping, irregularly triseriate, oblong to ellipsoid, hyaline, muriform, slightly constricted at the septa, smooth-walled, with a mucilaginous sheath. Asexual morph: Undetermined.

Notes – *Ceramothyrium* species have similar characters and ecological habitats to other sooty mould genera in Capnodiaceae (Chomnunti et al. 2012b, 2014). *Ceramothyrium* is characterized by ascomata covered by a subiculum, with a circumferential space around the maturing ascomata and at times with olivaceous to fuscous hyphae (Batista & Maia 1956, Hughes 1976, Chomnunti et al. 2012). *Ceramothyrium* resembles *Phaeosaccardinula* but ascospores of *Ceramothyrium* are not muriform. Most species were introduced based solely on morphological data. Winka et al. (1998) placed *Ceramothyrium* in Chaetothyriaceae with molecular data and this classification was confirmed by subsequent studies (Lutzoni et al. 2004, Miadlikowska & Lutzoni 2004, Reeb et al. 2004, Chomnunti et al. 2012a, b, 2014, Yang et al. 2014, Hongsanan et al. 2015, Zeng et al. 2016). Although there is a large number of species in *Ceramothyrium* with molecular data showing *Ceramothyrium* clusters in Chaetothyriaceae (Chaetothyriales), there is no molecular data for the type species *C. paiveae*. Hence, based on morphological comparison of collection of *Ceramothyrium* and phylogenetic analysis (Fig. 1), *Ceramothyrium* is maintained in Chaetothyriaceae.

Ceratocarpia Rolland, Bull. Soc. mycol. Fr. 12(1): 2 (1896)

Index Fungorum number: IF884, Facesoffungi number: FoF 10334, 2 morphological species (Species Fungorum 2021), molecular data unavailable.

Saprobic on branches or twigs in terrestrial habitats. Sexual morph: *Ascomata* dense, gregarious, sub-immersed to erumpent, globose to subglobose. *Ostiole* inconspicuous. *Wall of ascoma* comprising two cell types, externally comprising pigmented, dark brown, thick-walled cells and inner layer thinner, composed of lightly pigmented to hyaline, thin-walled cells. *Hamathecium* composed of filiform, long, septate pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, clavate to broadly clavate, pedicellate. *Ascospores* irregularly arranged, ellipsoid to fusiform, dictyosporous, constricted at the central septum, light brown to brown, with a long germ tube-like protuberance at each end, smooth and thick-walled, lacking a gelatinous sheath or appendages. Asexual morph: Undetermined.

Type species – *Ceratocarpia cactorum* Rolland

Notes – *Ceratocarpia* is characterized by dark mycelium adpressed to the host cuticle, ascomata forming beneath an external hyphal mat, lack of setae, bitunicate or fissitunicate asci, and muriform, light brown ascospores (Rolland 1896). The genus was placed in Dothideomycetes, genera *incertae sedis* by Lumbsch & Huhndorf (2010). *Ceratocarpia* is similar to *Chaetothyrium* as both have similar glabrous ascomata, muriform ascospores and evanescent pseudoparaphyses, while *Ceratocarpia* has light brown to brown, muriform ascospores with long germ tube-like protuberance at each end, and *Chaetothyrium* has hyaline, septate or muriform ascospores. Tian et al. (2014) suggested to accommodate *Ceratocarpia* in Chaetothyriaceae. We agree with Tian et al. (2014) and retain *Ceratocarpia* within Chaetothyriaceae based on morphology.

Ceratocarpia cactorum Rolland, Bull. Soc. mycol. Fr. 12(1): 2 (1896)

Fig. 7

Index Fungorum number: IF217302; Facesoffungi number: FoF 10335

Saprobic on branches of *Erica* sp. in terrestrial habitats. Sexual morph: *Ascomata* 100–235 × 110–190 µm (\bar{x} = 169 × 128 µm, n = 10), dense, gregarious, sub-immersed in the thallus of the dark brown or black subiculum, not easily removed, globose to subglobose. *Ostiole* inconspicuous. *Wall of ascoma* 22–35 µm (\bar{x} = 31 µm, n = 10) wide, comprising two layers, externally comprising pigmented, dark brown, thick-walled cells of *textura globulosa*, with inner layer thinner, composed of lightly pigmented to hyaline, thin-walled cells of *textura angularis*. *Hamathecium* 1.3–2 µm in width (\bar{x} = 1.5 µm, n = 10), composed of filiform, long, septate pseudoparaphyses, asci embedded in mucilage matrix. *Asci* 30–65 × 12–32 µm (\bar{x} = 41 × 18 µm, n = 10), 8-spored, bitunicate, fissitunicate, clavate to broadly clavate, pedicellate, lacking a distinct ocular chamber. *Ascospores* 20–32 × 8–11 µm (\bar{x} = 27 × 10 µm, n = 10), bi-seriate or multi-seriate, irregularly arranged, ellipsoid to fusiform, dictyosporous, constricted

at the central septum, light brown to brown, with up to 4 μm long germ tube-like protuberances at each end, smooth and thick-walled, lacking a gelatinous sheath or appendages. Asexual morph: Undetermined.

Material examined – France, La Molle: Var, in the branches of *Erica* sp. (Ericaceae), April 1911, G. Arnaud (S F46332).



Figure 7 – *Ceratocarpia cactorum* (S! F46332). a, b Envelop and collection information of *Ceratocarpia cactorum*. c Herbarium material. d, e Appearance of ascomata on the branches of *Erica* sp.. f Vertical section of ascoma. g Vertical section through ascoma wall. h Vertical section through ostiole. i, j, l, m Asci with ascospores. k, n Asci and ascospores, stained in lactophenol cotton blue reagent. o Hamathecium, stained in lactophenol cotton blue reagent. p–r Ascospores. s Ascospores, stained in lactophenol cotton blue reagent. Scale bars: d, e = 100 μm , f = 50 μm , g, h = 20 μm , i–n = 10 μm , o–s = 5 μm .

Chaetothyriomyces Pereira-Carv., Inácio & Dianese, Mycotaxon 107: 484 (2009)

Index Fungorum number: IF512105, Facesoffungi number: FoF 10336, 1 species (Species Fungorum 2021), molecular data unavailable.

Type species – *Chaetothyriomyces brasiliensis* Pereira-Carv.

Epiphytic on living leaves in terrestrial habitats. Colonies effuse, superficial. Mycelium superficial, branches, septate, brown to dark brown. Sexual morph: *Ascomata* dense, gregarious, superficial, globose to subglobose, brown to dark brown, smooth-walled. *Ostiole* lacking. *Wall of ascoma* comprising two cell types, externally comprising pigmented, dark brown, thick-walled cells of *textura globulosa* and inner layer thinner, composed of lightly pigmented to hyaline, thin-walled cells of *textura angularis*. *Hamathecium* lacking paraphyses. *Asci* 16-spored, bitunicate, fissitunicate, broadly clavate, pedicellate. *Ascospores* irregularly arranged, ellipsoid to fusiform, hyaline, 1-septate, smooth-walled, lacking a gelatinous sheath or appendages. Asexual morph: Undetermined (Pereira-Carvalho et al. 2009).

Notes – The monotypic genus *Chaetothyriomyces* was introduced by Pereira-Carvalho et al. (2009) with *C. brasiliensis* Pereira-Carv. et al. as the type species and accommodated in Chaetothyriaceae. Species of *Chaetothyriomyces* are characterized by superficial ascoma with mycelium containing septate hyphae covering, broadly clavate, 16-spored asci and ellipsoid to fusiform ascospores. No asexual morph is linked to this genus (Pereira-Carvalho et al. 2009). With the unique 16-spored asci, we maintain this genus in Chaetothyriaceae pending fresh collection and DNA sequence data.

Chaetothyriomyces brasiliensis Pereira-Carv., Inácio & Dianese, Mycotaxon 107: 484 (2009)

Fig. 8

Index Fungorum number: IF512643; Facesoffungi number: FoF 10337

Description: see Pereira-Carvalho et al. (2009)

Type material – Brazil, Mato Grosso do Sul, Campo Grande, Reserva Ecológica da Embrapa at Depate Empaer, on living leaves of *Qualea grandiflora* Mart. (Vochysiaceae), 16 April 1996, M. Sanchez 1892 (UB Col. Micol. 12116, holotype).

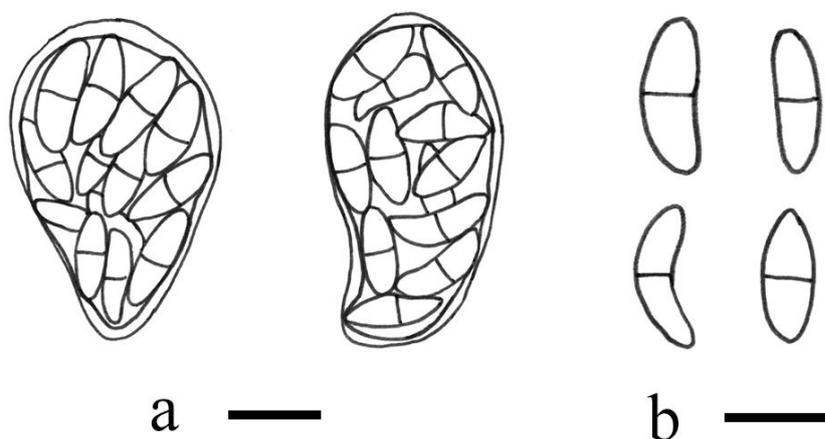


Figure 8 – *Chaetothyriomyces brasiliensis* (UB Col. Micol. 12116, holotype, redrawn from Pereira-Carvalho et al. 2009). a Broadly clavate, 16-spored asci. b Ellipsoid to fusiform, 1-septate ascospores. Scale bars: 10 µm.

Cyphellophoriella Crous & A.J. Sm., Sydowia 67: 95 (2015)

Index Fungorum number: IF812524, Facesoffungi number: FoF 10338, 1 species with molecular data.

Type species – *Cyphellophoriella pruni* Crous & A.J. Sm.

Epiphytic on healthy living leaves. Sexual morph: Undetermined. Asexual morph: *Mycelium* composed of branched, septate, pale brown hyphae. *Conidiophores* reduced to conidiogenous cells on hyphae. *Conidiogenous cells* phialidic, in a flower-like arrangement, intercalary, brown, inconspicuous collarete, forming an outer tent-like collarete surrounding the conidiogenous cells, brown, verruculose.

Conidia solitary, fusiform to filiform, hyaline to pale brown, curved, obtuse at the apex, truncate at the base, smooth-walled (Crous et al. 2015b).

Notes – The monotypic genus *Cyphellophoriella* was introduced to accommodate a cyphellophora-like species and placed in Chaetothyriaceae by Crous et al. (2015b). It is characterized by phialides formed directly on hyphae, petal-like conidiogenous cells and curved conidia (Crous et al. 2015b). The key distinction between *Cyphellophoriella* and other genera is its flower-like arrangement of conidiogenous cells on a mother cell. Based on the differences in ITS sequence, *Cyphellophoriella* was clarified as a new genus (Crous et al. 2015b). In our phylogenetic analyses combined LSU and ITS (Fig. 1), *Cyphellophoriella* is not congeneric to *Cyphellophora* (Cyphellophoraceae), but resides in Chaetothyriaceae with a distinct clade affinity to *Ceramothyrium*, *Chaetothyrium* and *Nullicamyses*. Thus, *Cyphellophoriella* is accepted as a distinct genus in Chaetothyriaceae.

Cyphellophoriella pruni Crous & A.J. Sm., Sydowia 67: 96 (2015)

Fig. 9

Index Fungorum number: IF812525; Facesoffungi number: FoF 10339

Description – see Crous et al. (2015b)

Type material – USA, California, Berkeley, on an apparently healthy leaf of *Prunus* sp. (Rosaceae), 26 March 2014, A. J. Smith (CBS 140001, ex-type).

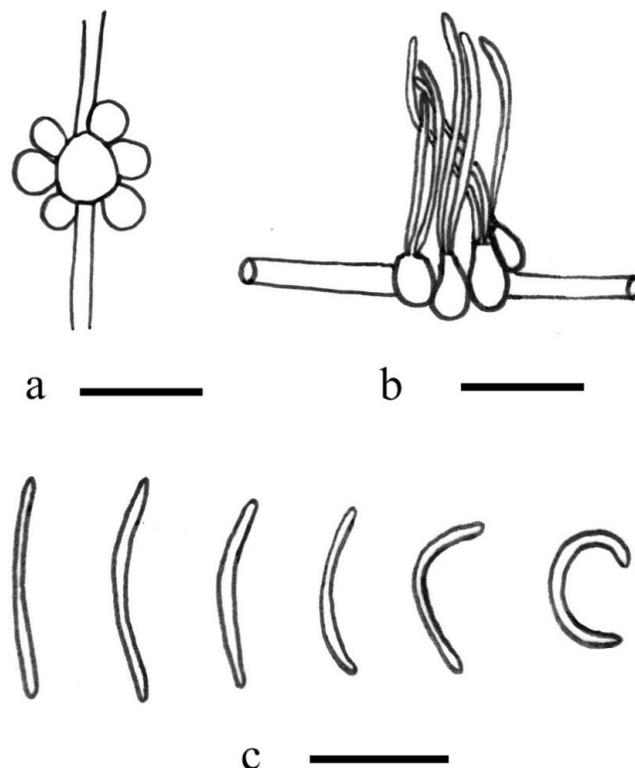


Figure 9 – *Cyphellophoriella pruni* (CBS 140001, ex-type, redrawn from Crous et al. 2015b). a Flower-like conidiogenous cells. b Subcylindrical to ampulliform conidiogenous cells with conidia. c Conidia. Scale bars: 10 µm.

Longihyalospora D.S. Tennakoon, C.H. Kuo & K.D. Hyde, MycoKeys 61 (2019)

Index Fungorum number: IF556715, Facesoffungi number: FoF 06136, 2 species with molecular data.

Type species – *Longihyalospora ampeli* D.S. Tennakoon, C.H. Kuo & K.D. Hyde, MycoKeys 61: 100 (2019)

Description: see Tennakoon et al. (2019)

Notes – *Longihyalospora* was introduced by Tennakoon et al. (2019) with *L. ampeli* (the type species) and a new combination *L. vermisorum* (Hansf.) Tennakoon, C.H. Kuo & K.D. Hyde. Species

of *Longihyalospora* are characterized by a dark mycelium covering the upper leaf surface, an elongate mycelial pellicle, a ring of setae around the pellicle, broadly obovoid, short pedicellate asci and hyaline, elongate fusiform and 8–11-septate ascospores, with a thin mucilaginous sheath. Phylogenetically, *Longihyalospora* formed a single sub-clade with strong support (Tennakoon et al. 2019). *Longihyalospora* resembles *Chaetothyrium*, but the two genera can be distinguished by morphology, such as the colour of hyphae, size and shape of asci and ascospores (Spegazzini 1888, Hansford 1946, Tennakoon et al. 2019).

Nullicamyces Crous, Persoonia 40: 361 (2018)

Index Fungorum number: IF825417, 1 species with molecular data.

Type species – *Nullicamyces eucalypti* Crous, Persoonia 40: 361 (2018)

Description – see Crous et al. (2018)

Notes – The key distinction between *Nullicamyces* and other genera is that *Nullicamyces* has dimorphic morphology, forming matsushimaea-like (conidia ellipsoid, aseptate, forming acropetal chains of conidia, appearing star-shaped with radiating arms) and pseudocercospora-like (Conidia long flexuous, obclavate, multiseptate, frequently giving rise to secondary) asexual morphs in culture. Based on the differences in ITS sequence data. *Nullicamyces* was confirmed as a new genus (Crous et al. 2018). *Nullicamyces* shows a sister relationship with *Ceramothyrium* in Chaetothyriaceae (Fig. 1).

Phaeosaccardinula Henn., Hedwigia 44: 67 (1905)

Index Fungorum number: IF3943, Facesoffungi number: FoF 04392, 27 morphological species (Species Fungorum 2021), 4 species with molecular data.

Epiphytic on the surface of leaves forming a sooty-like coating. *Mycelium* superficial, black, composed of dark brown to black, reticulate to branched, septate hyphae. Sexual morph: *Ascomata* superficial, scattered, globose to subglobose, cupulate when dry, dark brown to black, with or without setae, thick-walled cells at the outside, ostiolate or ostiole inconspicuous. *Wall of ascoma* multi-layered, composed of brown, thick-walled cells outside, becoming light brown and flattened in the inner region. *Hamathecium* lacking paraphyses, or paraphyses hyaline, aseptate. *Asci* 4–8-spored, bitunicate, oblong-ellipsoid, clavate, subglobose to oval, sessile or short pedicellate, early evanescent, lacking an ocular chamber when mature. *Ascospores* overlapping 2–4-seriate, hyaline, olivaceous-green at the septa of mature ascospores, oblong-ellipsoid, muriform, constricted at the septa, with a mucilaginous sheath. Asexual morph: Undetermined.

Type species – *Phaeosaccardinula diospyricola* Henn.

Notes – *Phaeosaccardinula* is characterized by its superficial ascomata, formed beneath a layer that attaches the ascomata to the host surface and muriform ascospores. Species of *Phaeosaccardinula* were later transferred to *Limacinula* and *Treubiomyces* (Reynolds 1971, 1983). In our study *Phaeosaccardinula ficus* (MFLUCC 10-0009) clustered in Chaetothyriaceae without support. Hence, based on morphological comparison of other *Phaeosaccardinula* species and phylogenetic analysis (Fig. 1), the genus is retained in Chaetothyriaceae pending new sequence data.

Phaeosaccardinula diospyricola Henn., Hedwigia 44: 67 (1905)

Fig. 10

Index Fungorum number: IF156465; Facesoffungi number: FoF 10340

Epiphytic on the upper surface of living leaves of *Diospyros* sp. forming a sooty-like coating. *Mycelium* 3–6 μm wide (\bar{x} = 5.2 μm , n = 20), superficial, black, composed of dark brown to black, reticulate to branched, septate hyphae. Sexual morph: *Ascomata* 165–235 \times 125–190 μm (\bar{x} = 197 \times 162 μm , n = 10), superficial, scattered, globose to subglobose, cupulate when dry, dark brown to black, lacking setae, thick-walled, ostiole inconspicuous. *Wall of ascoma* 20–35 μm wide, multi-layered, externally comprising pigmented, dark brown, thick-walled cells of *textura globulosa*, with inner layer thinner, composed of lightly pigmented to hyaline, thin-walled cells of *textura prismatica*. *Hamathecium* lacking paraphyses. *Asci* 42–58 \times 28–36 μm (\bar{x} = 52 \times 32 μm , n = 10), 6–8-spored, bitunicate, oblong-ellipsoid, clavate when young, subglobose to oval when mature, sessile or short pedicellate, early evanescent, lacking an ocular chamber when mature. *Ascospores* 55–62 \times 6–9 μm (\bar{x}

= $58 \times 8 \mu\text{m}$, $n = 10$, overlapping 2–4-seriate, hyaline, olivaceous green at the septa of mature ascospores, oblong-ellipsoid, muriform, with 7–9 transverse septa and 3–5 longitudinal septa, constricted at the septa, with a mucilaginous sheath. Asexual morph: Undetermined.

Material examined – Peru, Rio Amazonas, Tarapoto, on leaves of *Diospyros* sp. (Ebenaceae), September 1902, E. Ule 6471 (S-F9582, isotype).

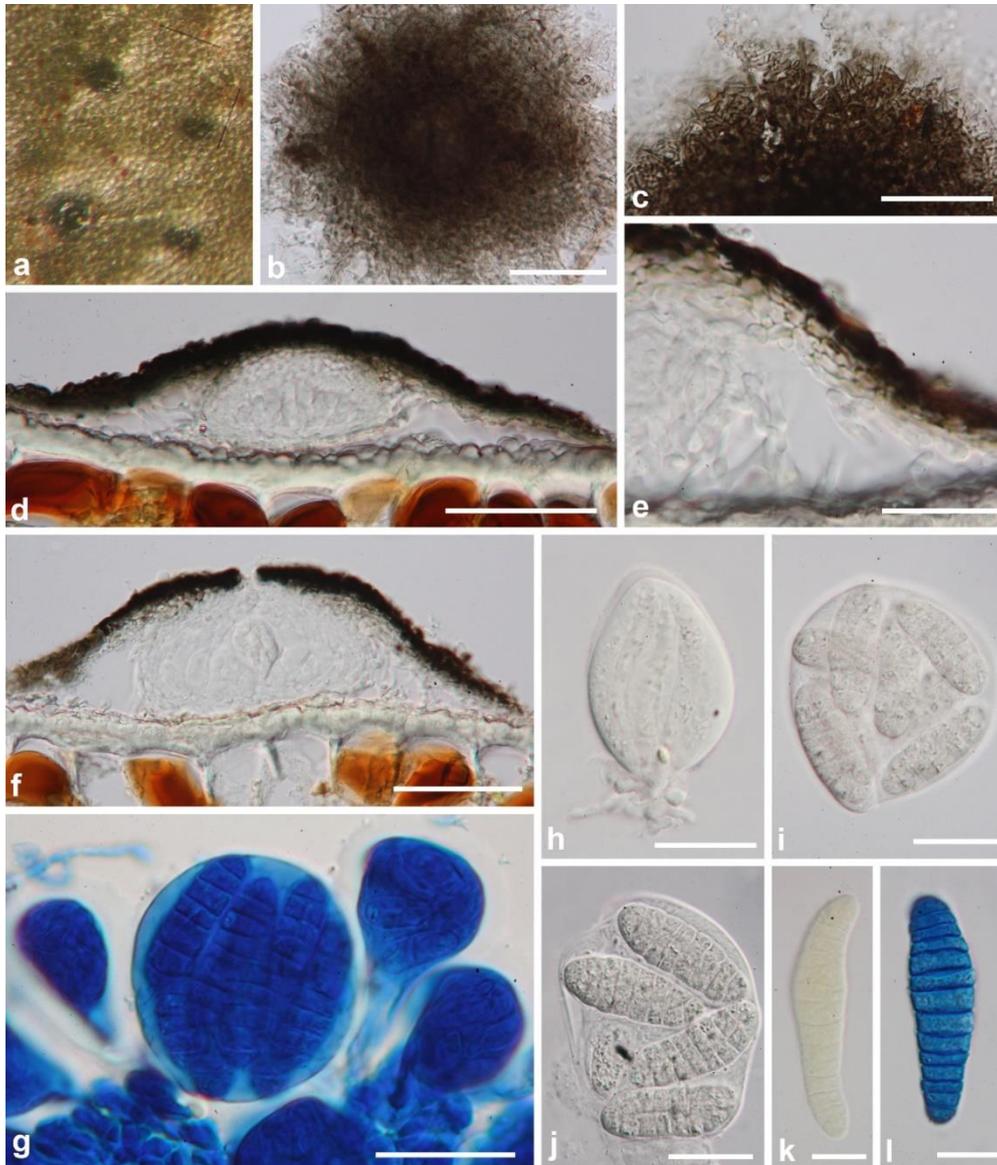


Figure 10 – *Phaeosaccardinula diospyricola* (S-F9582, isotype). a Appearance of superficial ascomata on the host surface. b, c Squash mount of ascoma. d, f Vertical sections of ascomata. e Vertical section through ascoma wall. g Asci with ascospores, stained in lactophenol cotton blue reagent. h–j Asci with ascospores. k Ascospores. l Ascospores, stained in lactophenol cotton blue reagent. Scale bars: b, c, g = $50 \mu\text{m}$, d, f = $100 \mu\text{m}$, e, h–j = $20 \mu\text{m}$, k, l = $10 \mu\text{m}$.

Phaeosaccardinula malloti (Rehm) Theiss., in Theissen & Sydow, *Annl. mycol.* 15(6): 481 (1918) [1917] Fig. 11

≡ *Limacinula malloti* Rehm, *Philipp. J. Sci., C, Bot.* 8(5): 395 (1913)

For synonyms see *Species Fungorum*

Index Fungorum number: IF156268; Facesoffungi number: FoF 10341

Epiphytic on the upper surface of living leaves of *Mallotus philippensis*, forming a sooty-like coating. *Mycelium* 4–6 μm wide ($\bar{x} = 5.3 \mu\text{m}$, $n = 20$), superficial, black, composed of dark brown to black, reticulate to branched, septate hyphae. Sexual morph: *Ascomata* 135–250 μm diam ($\bar{x} = 220 \mu\text{m}$,

n = 10), superficial, scattered, globose to subglobose, cupulate when dry, dark brown to black, lacking setae, thick-walled, ostiolate. *Ostiole* in the center, periphysate or apapillate. *Wall of ascoma* 25–42 μm wide, multi-layered, externally comprising pigmented, dark brown, thick-walled cells of *textura globulosa*, with inner layer thinner, composed of lightly pigmented to hyaline, thin-walled cells of *textura prismatica*. *Hamathecium* lacking paraphyses. *Asci* 80–110 \times 18–32 μm (\bar{x} = 103 \times 28 μm , n = 10), 8-spored, bitunicate, oblong-ellipsoid, broadly clavate, subglobose to oval when young, short pedicellate, early evanescent, lacking an ocular chamber when mature. *Ascospores* 18–24 \times 6–9 μm (\bar{x} = 20 \times 8 μm , n = 10), overlapping 2–4-seriate, hyaline, olivaceous-green at the septa of mature ascospores, oblong-ellipsoid, muriform, with 4–7 transverse septa and 4–6 longitudinal septa, constricted at the septa, rounded at both ends, with a mucilaginous sheath. Asexual morph: Undetermined.

Material examined – Philippines, Los Baños, on leaves of *Mallotus philippensis* (Lam.) Müll. Arg. (Euphorbiaceae), March 1913, C. F. Baker (PC0084486, holotype).



Figure 11 – *Phaeosaccardinula malloti* (PC0084486, holotype). a Herbarium material, with superficial ascomata on the host. b, c Squash mounts of ascomata. d, f Vertical section through peridium. e Vertical sections of ascoma. g Vertical section through ostiole. h–k Asci with ascospores. l–o Ascospores. Scale bars: b = 200 μm , c, e = 100 μm , d, f, g, h–j, l–o = 20 μm , k = 50 μm .

Treubiomyces Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 1180 (1909)

Index Fungorum number: IF5532, Facesoffungi number: FoF 10342, 7 morphological species (Species Fungorum 2021), molecular data unavailable.

Epiphytic on leaves of various plants in terrestrial habitats. *Mycelium* superficial, black, composed of thin, branched to reticulate, membranous, hyaline, septate hyphae. Sexual morph: *Ascostromata* solitary to gregarious, globose-flattened, setose, with periphysate ostioles. *Wall of ascoma* composed of several layers of hyaline to light brown flattened cells of *textura globulosa*. *Hamathecium* lacking paraphyses. *Asci* 8-spored, bitunicate, fissitunicate, clavate, sessile, with a conspicuous refractive ring, thickened at the apex. *Ascospores* overlapping multi-seriate, cylindrical to oblong, hyaline, muriform, with or without a gelatinous sheath. Asexual morph: Undetermined (Batista & Ciferri 1962, Pohlád et al. 1989).

Type – *Treubiomyces pulcherrimus* Höhn.

Notes – *Treubiomyces* is characterized by globose-flattened, setose, periphysate ostiole, bitunicate clavate asci and cylindrical to oblong, muriform ascospores (Batista & Ciferri 1962, Pohlád & Reynol 1974). *Treubiomyces* has been recognized as a genus in Capnodiaceae (Theissen 1913, Theissen & Sydow 1917, Petrak 1929, Arnaud 1930, Fraser 1935, Eriksson 1981, Reynolds 1983). *Treubiomyces pulcherrimus* resembles *Chaetothyrium* in having superficial mycelia appressed to the host surface with globose ascomata developing beneath a mycelial shield, periphysate ostioles, and bitunicate asci, but differs in its muriform ascospores. Thus, Fisher (1939), Hansford (1946), Batista & Ciferri (1957, 1962), Luttrell (1973), von Arx & Müller (1975), Hughes (1976) and Barr (1979) assigned *Treubiomyces* to Chaetothyriaceae based on morphology. Herein, we accept *Treubiomyces* in Chaetothyriaceae pending epitypification. *Treubiomyces* is unique in this family in having muriform ascospores and setose ascomata.

Treubiomyces pulcherrimus Höhn., Sber. Akad. Wiss. Wien, Math. -naturw. Kl., Abt. 1 118: 1181 (1909) Fig. 12

Index Fungorum number: IF149202; Facesoffungi number: FoF 10343

Type material – Indonesia, Java, on *Ficus* sp. (Moraceae) (holotype).

Vonarxia Bat., Publicações Inst. Micol. Recife 283: 5 (1960)

Index Fungorum number: IF10422, Facesoffungi number: FoF 10344; 2 morphological species (Species Fungorum 2021), 1 species with molecular data.

Epiphytic on leaves of various plants in terrestrial habitats. Sexual morph: Undetermined. Asexual morph: *Mycelium* immersed to superficial, composed of branched to reticulate, hyaline, pale to medium brown, septate hyphae. *Conidiomata* pycnidial, superficial, globose, setose, membranous. *Setae* irregularly scattered, simple, subulate with a bulbous base, dark brown, smooth to slightly rough-walled. *Conidiogenous cells* aggregated, doliiform to ellipsoid, hyaline or pale brown, from the upper cell of conidioma, sympodial proliferation. *Conidia* filiform, hyaline, aseptate or 1-septate, subcylindrical to clavate to doliiform at the base and upper three arms subcylindrical to cylindrical, 3–10-septate (Batista et al. 1960, Crous et al. 2009).

Type species – *Vonarxia anacardii* Bat. & J.L. Bezerra

Notes – *Vonarxia* is characterized by pycnidial conidiomata, with subulate setae, doliiform to ellipsoid conidiogenous cells, sympodial proliferation, and filiform conidia with subcylindrical to doliiform base and upper three arms subcylindrical to cylindrical, multi-septate. Nag Raj (1977) commented that these fruiting bodies may be a sexual morph which he regarded as *Kazulia*. However, *Kazulia* was subsequently synonymized under *Vonarxia* (Aa van der & van Oorschot 1985, Aa van der & von Arx 1986). *Vonarxia* resembles *Fumagopsis* (Wu & Sutton 1995), however, *Fumagopsis* has star-like conidia, while conidia in *Vonarxia* have three upper arms that are subcylindrical to cylindrical, and multi-septate. Besides, setae of *Vonarxia* are septate and have a simple, bulbous base. Based on combined LSU and ITS sequence analysis, *V. vagans* formed a single lineage as a distinct genus in Chaetothyriaceae with 79% ML BS and 0.9 BY PP support (Fig. 1).

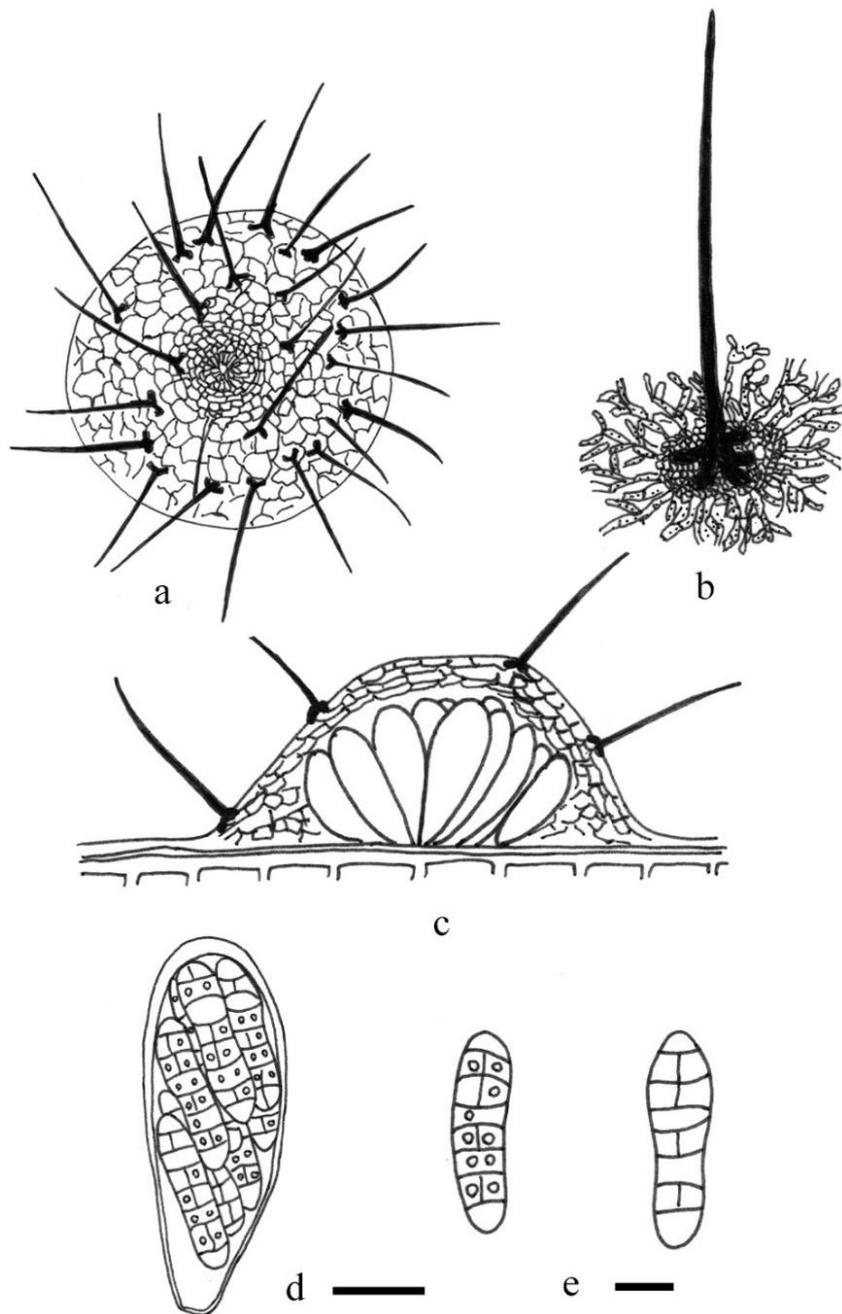


Figure 12 – *Treubiomyces pulcherrimus* (redrawn from Höhnelt 1909, holotype). a Top view of ascoma with setae. b Seta with superficial mycelium on the host. c Vertical section through ascoma wall. d Ascus. e Ascospores. Scale bars: d = 20 μ m, e = 10 μ m.

Vonarxia anacardii Bat. & J.L. Bezerra, in Batista, Bezerra, Maia & Silva, Publicações Inst. Micol. Recife 283: 7 (1960) Fig. 13

Index Fungorum number: IF340977; Facesoffungi number: FoF 10345

Description – see Batista et al. (1960), Crous et al. (2009)

Type material – On leaves of *Anacardium occidentale* L. (Anacardiaceae), Hughes (18881, IMUR, holotype).

Coccodiniaceae Höhn. ex O.E. Erikss., Op. bot. Soc. bot. Lund 60: 42 (1981)

Index Fungorum number: IF80615, Facesoffungi number: FoF 10352, 23 known species

Saprobic, epiphytic or *biotrophic* on the branches, stems, leaves as sooty moulds and mostly adpressed to the surface of host gaining nutrients from sugary exudates. *Subiculum* well-developed,

superficial, loose, comprising effuse, branched, dark brown to blackish brown, septate hyphae. Sexual morph: *Ascomata* superficial, embedded in subiculum or sometimes sessile on subiculum developing on the surface of the host, solitary to gregarious, globose to subglobose, cupulate when dry, uniloculate, brown to blackish brown, with periphysate ostioles, with or without papillate, covering individual hyphae, with or without setae. *Wall of ascoma* composed of several layers with outer layers dark brown cells to inner layers hyaline to light brown flattened cells. *Hamathecium* comprising filiform, hyaline, septate pseudoparaphyses or lacking. *Asci* 8-spored, bitunicate, fissitunicate, saccate, broadly clavate to oval, sessile or short pedicellate, lacking an ocular chamber, forming in a basal layer of ascoma wall. *Ascospores* overlapping 1–3-seriate, irregularly arranged, ellipsoid to broadly clavate, fusiform, hyaline to lightly pigmented, yellowish to brownish at maturity, 2–4-trans-septate, or muriform, slightly constricted at the septa, thin-walled, without a gelatinous sheath or appendages, eguttulate. Asexual morph: hyphomycetous (Hughes 1976, Barr 1987, Winka et al. 1998, Crous et al. 2007).

Type – *Coccodinium* A. Massal.

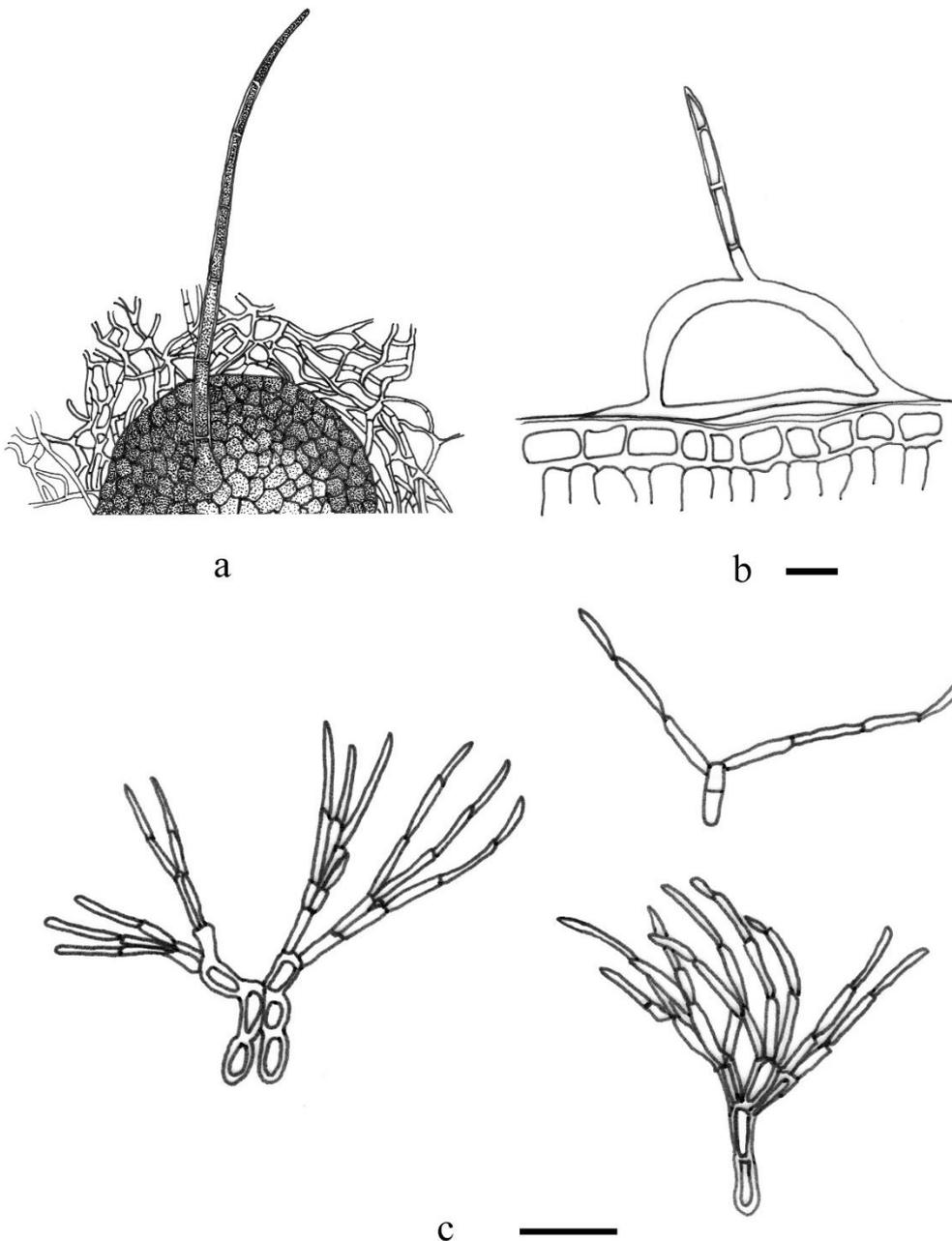


Figure 13 – *Vonarxia anacardii* (18881, IMUR, holotype, Batista et al. 1960). a Conidioma with a seta. b Vertical section through peridium. c Conidiogenous cells and filiform conidia. Scale bars: b = 20 μ m, c = 10 μ m.

Notes – The members of Coccodiniaceae are sooty moulds. The species of Coccodiniaceae are adpressed to the surface of leaves, branches, stems, twigs, even whole plants. They obtain nutrients and water from sugary exudates secreted by sap-feeding insects. The family was introduced by Eriksson (1981), comprising *Coccodinium* A. Massal. (type genus), *Dennisiella* Bat. & Cif. and *Limacinula* Höhn. Kirk et al. (2008) added the asexual genera *Bisbyopeltis* Bat. & A.F. Vital and *Microxiphium* (Harv. ex Berk. & Desm.) Thüm. to Coccodiniaceae. The family comprises taxa that grow on dark superficial subicula on honeydew on plants (Eriksson 1981), have limacinuloid ascomata (a collabent ascomata on living hosts, producing on a subiculum composed of a very loose arrangement of hyaline hyphae which are individually connected as a component of the lower portion of the fruit body wall, Reynolds 1971), with the hamathecium of pseudoparaphyses. Hughes (1976) found phialidic conidiogenous cells formed in rosettes on the ascospores, and subsequently, Barr (1987) found a *Microxiphium* asexual state. *Microxiphium* was placed in Capnodiaceae based on phylogenetic analyses (Schoch et al. 2006, Crous et al. 2007, Hyde et al. 2013, Liu et al. 2017). *Microxiphium* is polyphyletic and the type species has already been linked to *Dennisiella* in Coccodiniaceae (Schoch et al. 2006, Crous et al. 2007, Ruibal et al. 2009). Winka et al. (1998) found that the asexual state shares similar characters with *Capnodendron* species (Antennulariellaceae). Crous et al. (2007) found that colonies of *C. bartschii* on MEA are slow-growing and produce the asexual state. Hyde et al. (2013) suggested further collections and sequence data are needed to sort out the confusion surrounding these taxa. In our study, we found the asexual morph around the ascomata, characterized by brown hypha with globose cells, phialidic, globoid to oblong, subhyaline to pale brown conidiogenous cells, with 1–3 conidia produced from phialides, and fusoid-ellipsoidal to clavate, 3–5-septate, brown conidia. Liu & Hall (2004) assigned Coccodiniaceae to Chaetothyriales based on RPB2 protein sequences analysis. Subsequently, Crous et al. (2007) indicated that the type species of *Coccodinium*, *C. bartschii* clustered with 100% bootstrap support in Herpotrichiellaceae (Chaetothyriales). The phylogenetic analysis based on a combined LSU and ITS dataset showed that Coccodiniaceae forms a distinct clade with affinity to Herpotrichiellaceae and is accommodated in Chaetothyriales with 92% ML BS and 1.00 BY PP support (Fig. 1). Coccodiniaceae is however, poorly studied phylogenetically. Sequence data from *Dennisiella* and *Limacinula* are required to resolve the generic relationships.

Coccodinium A. Massal., Atti Inst. Veneto Sci. lett., ed Arti, Sér. 3 5: 336 (1860) [1859-1860]

Index Fungorum number: IF1140, 4 morphological species (Species Fungorum 2021), 1 species with molecular data.

Type species – ***Coccodinium bartschii*** A. Massal.

Notes – *Coccodinium* was introduced by Massalongo (1860) and is typified by *C. bartschii* A. Massal. This is a sooty mould genus, occurring with other fungal taxa on the surface of plants, obtaining water and nutrition from the honey-dew of sap-feeding insects (Eriksson 1981, Lumbsch & Huhndorf 2010, Hyde et al. 2013, Chomnunti et al. 2014). This genus is characterized by a dark brown collabent ascomata forming on well-developed subiculum attached to the host surface, periphysate ostioles, filiform, hyaline, septate pseudoparaphyses, bitunicate asci and muriform ascospores (Reynolds 1971, Eriksson 1981, Barr 1987, Hyde et al. 2013). *Coccodinium* resembles *Naetrocymbe* and was synonymized under *Naetrocymbe* in Arthopyreniaceae (Pleosporales, von Höhnelt 1918a, b). In both genera, ascomata are superficial and frequently collabent on a well-developed dark subiculum (von Höhnelt 1918a, b). Batista & Ciferri (1957) transferred *Coccodinium bartschii* to *Cucurbitaria*, because they considered the moisture or physical conditions caused the dry, collapsed ascomata to become the full spherical-globose ascomata, which fit *Cucurbitaria* rather than *Naetrocymbe*. Both genera are similar in having muriform ascospores in bitunicate asci, but *Naetrocymbe* is different from *Coccodinium* by clustered ascomata on a basal hypostroma beneath the host periderm and cylindrical asci with a uni-seriate arrangement of spores (Hyde et al. 2013). Eriksson (1981) compared the type species of *Coccodinium* and excluded it from *Naetrocymbe*, establishing the new family Coccodiniaceae.

The possible asexual morph of *Coccodinium* is hyphomycetous. Winka et al. (1998) found that the asexual morph resembled a *Capnodendron* species (Antennulariellaceae). DNA was extracted from

the culture and herbarium material of *Coccodinium bartschii* (UME30232). The phylogeny showed that *C. bartschii* can be accommodated in Dothideales. Crous et al. (2007) obtained the asexual morph from a pure culture of a sexual strain of *C. bartschii*. The parsimony analysis of the LSU region showed *C. bartschii* clustered with 100% bootstrap support with Herpotrichiellaceae (Chaetothyriales). We re-examined the herbarium specimen (ex herb IMI 370066), but setae were not observed, maybe they had fallen off as a result of long storage. However, we found the asexual morph around the ascomata which is consistent with the description of Crous et al. (2007). In our study, phylogenetic analysis based on the combined LSU and ITS dataset showed *C. bartschii* (CPC 13861) can be accommodated in Chaetothyriales with 92 % ML BS and 1.00 BY PP support (Fig. 1).

Coccodinium bartschii A. Massal., Atti Inst. Veneto Sci. lett., ed Arti, Sér. 3 5: 336 (1860) [1859-1860]

Fig. 14

Index Fungorum number: IF153614; Facesoffungi number: FoF 10353

Epiphytic or *biotrophic* on the branches of *Quercus macrocarpa* as sooty molds and mostly adpressed to the surface of branches gaining nutrients from sugary exudates of sap-feeding insects. *Subiculum* well-developed, superficial, loose, comprising effuse, branched, blackish brown, septate hyphae. Sexual morph: *Ascomata* 220–350 μm high \times 120–300 μm diam. (\bar{x} = 305 \times 245 μm , n = 10), superficial, sessile on subiculum developing on the surface of the branch, perithecial, scattered to aggregated, globose to subglobose, circular when mature, cupulate when dry, uniloculate, brown to dark brown, with periphysate ostioles, with or without papillate, thick-walled, setose at times. *Wall of ascoma* 18–32 μm (\bar{x} = 25 μm , n = 10), thicker at the apex and base, multi-layered, externally comprising pigmented, dark brown, thick-walled cells of *textura angularis*, with inner layer thinner, composed of irregularly-shaped, flattened, lightly pigmented to hyaline, thin-walled cells of *textura prismatica*. *Hamathecium* lacking paraphyses, with numerous periphyses near the ostiole. *Asci* 48–52 \times 13–17 μm (\bar{x} = 48 \times 15.8 μm , n = 10), 8-spored, bitunicate, fissitunicate, saccate, broadly clavate, short pedicellate, lacking a distinct ocular chamber. *Ascospores* 18–27 \times 3–5 μm (\bar{x} = 24 \times 4.2 μm , n = 10), overlapping bi-seriate or multi-seriate, irregularly arranged, ellipsoidal or clavate, fusiform, hyaline to brown, muriform, with 2–4 transverse septa, 1–2 longitudinal septa in the middle cells and sometimes 1–2 longitudinal septa at end cells, constricted at the septum, smooth and thick-walled, lacking a gelatinous sheath or appendages. Asexual morph: hyphomycetous. *Hyphe* comprising of brown, globose cells, giving rise to indistinct phialides with 1–3 conidia. *Conidiogenous cell* 3–8 μm in diam. (\bar{x} = 6 μm , n = 10), phialidic, globoid to oblong, subhyaline to pale brown, smooth-walled. *Conidia* 15–22 \times 5–9 μm (\bar{x} = 18 \times 6 μm , n = 10), fusoid-ellipsoidal to clavate, widest in the upper third of the conidium, apex obtuse, base subtruncate, lightly pigmented to brown, 3–5-septate, constricted at the septa, smooth-walled, guttulate.

Material examined – Canada, Ontario, on a dead fallen branch of *Quercus macrocarpa* Michx. (Fagaceae), 19 July 1994, S. J. Hughes (ex herb IMI 370066).

Ecological and economic significance of Coccodiniaceae

Coccodiniaceae is a sooty mould family, lives on the surface of the host gaining water and nutrients from sugary exudates which have largely sugars and smaller amounts of amino acids, proteins, minerals, vitamins and other organic compounds (Auclair 1963). The honeydew drips cover the whole leaves, branches, stems, twigs even the whole plant tissues with a sticky sugary coating. The sooty moulds cover the sugary exudates and produce a thin or thick subiculum composed of dense, dark hyphae (Hughes 1976, Faull et al. 2002, Chomnunti et al. 2014) which block sunlight and reduces photosynthesis, may result in the death of the plant, lower growth rates and thus reduced yields (de Filho & Paiva 2006, Nelson 2008, Laemmlen 2011, Santos et al. 2013).

Genera included in Coccodiniaceae

Dennisiella Bat. & Cif., Beih. Sydowia 3: 37 (1962)

Index Fungorum number: IF1457, Facesoffungi number: FoF 10354, 7 morphological species (Species Fungorum 2021), molecular data unavailable.

Type species – *Dennisiella babingtonii* (Berk.) Bat. & Cif.

Notes – *Dennisiella* Bat. & Cif. was established to accommodate the type species *D. babingtonii* (Berk.) Bat. & Cif. and *D. caucasica* (Woron.) Bat. & Cif., *D. setosicola* (Woron.) Bat. & Cif. and *D. theae* (Sawada) Bat. & Cif. (Batista & Ciferri 1962). The genus is characterized by a well-developed, setose subiculum, comprising effuse, branched, septate hyphae, erect, straight, setae with bulbous base, perithecial, globose ascomata with periphysate ostiole, bitunicate, cylindrical to broadly clavate asci and fusoid, hyaline, 2–6 septate ascospores. *Dennisiella* resembles *Coccodinium* in characters of limacinuloid ascomata and hamathecium consisting of periphyses, while species of *Dennisiella* has ascospores only with 2–6 transverse septa, without longitudinal septa and setose hyphae. *Microxiphium* is polyphyletic which is clustered with *Dennisiella* in Coccodiniaceae (Schoch et al. 2006, Crous et al. 2007, Ruibal et al. 2009) and Capnodiaceae (Chomnunti et al. 2011, 2014, Hyde et al. 2013, Liu et al. 2017). However, the type species of *Microxiphium* is presently placed as a synonym of *D. babingtonii* and thus included in the Coccodiniaceae. Herein, we accept *Dennisiella* in Coccodiniaceae pending epitypification and neotypification.

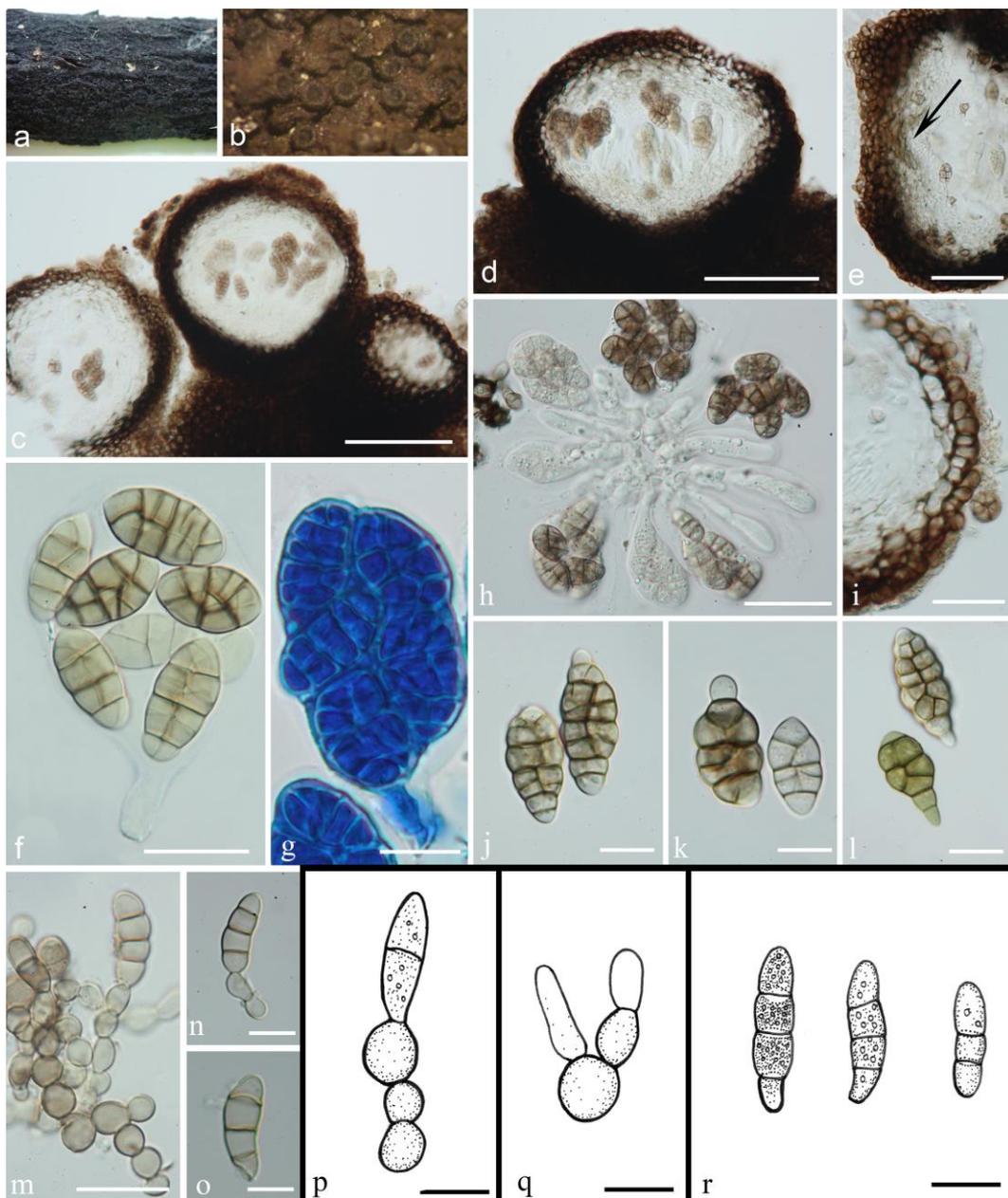


Figure 14 – *Coccodinium bartschii* (IMI 370066). a Herbarium material. b Appearance of ascomata on the superficial of the branch of *Quercus macrocarpa*. c, d Vertical sections of ascomata. e Vertical

section through ostiole (point by an arrow). f–h Asci with ascospores. i Vertical section through ascoma wall. j–l Ascospores. m, n Conidiogenous cell giving rise to conidia. o Conidium. p–r Redrawn from Crous et al. (2007); p, q show conidiogenous cell with conidia, r shows conidia. Scale bars: c, d = 100 μ m, e, h, i = 50 μ m, f, m = 20 μ m, g, j–l, n–r = 10 μ m.

Dennisiella babingtonii (Berk.) Bat. & Cif., Beih. Sydowia 3: 38 (1962)

\equiv *Strigula babingtonii* Berk., Suppl. Engl. Bot. 4: tab. 2957 (1849)

For other synonyms see Index Fungorum

Index Fungorum number: IF329804; Facesoffungi number: FoF 10355

Fig. 15

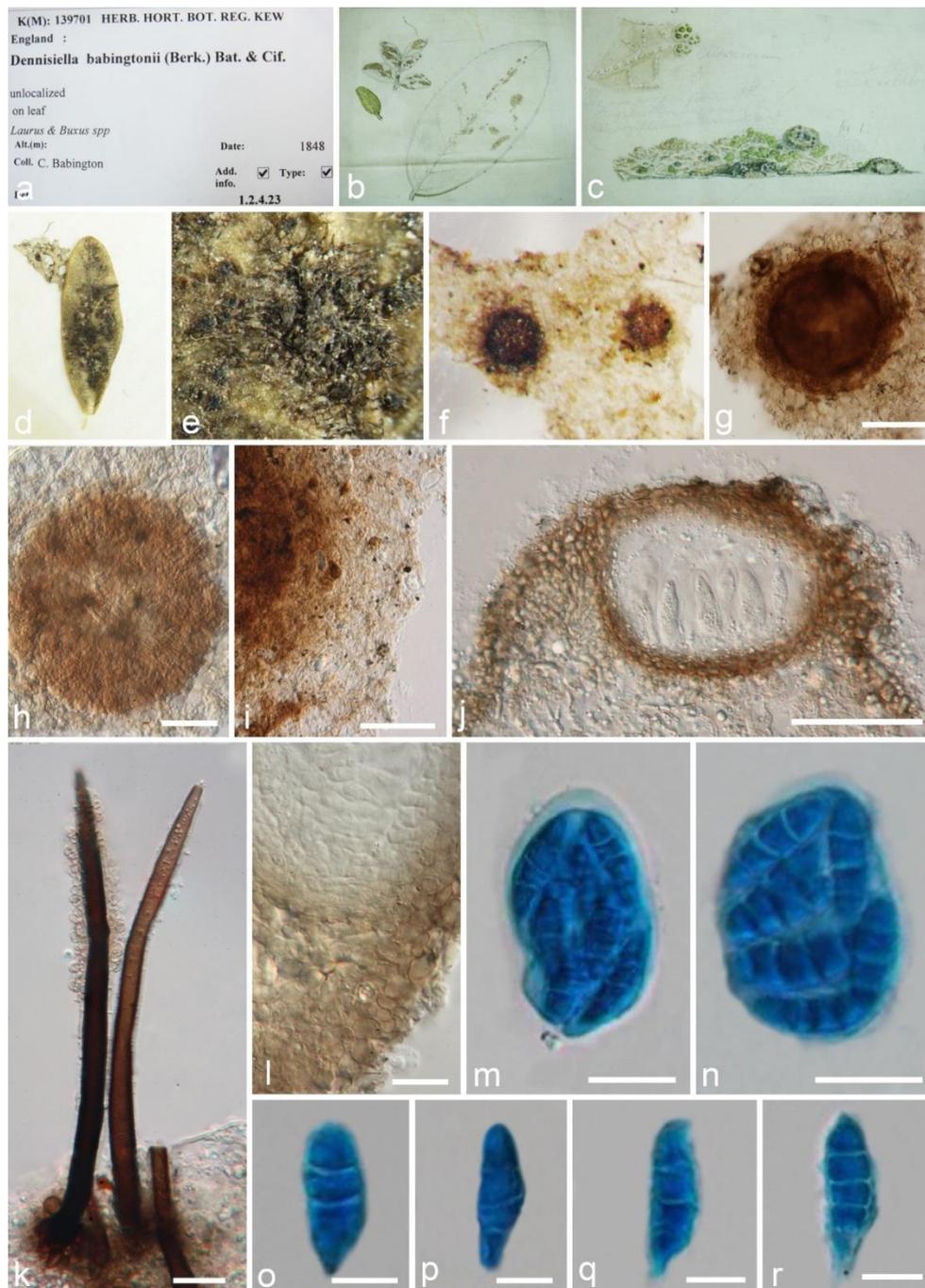


Figure 15 – *Dennisiella babingtonii* (K(M) 139701, holotype of *Strigula babingtonii*). a Envelop and collection information of *Dennisiella babingtonii*. b, c Drawing of ascomata on the host leaves. d Herbarium material. e Appearance of ascomata with setae on the superficial of the host. f–i Squash mount of ascomata. j Vertical section of ascoma. k Setae. l Vertical section through ascoma wall.

m, n Asci with ascospores, stained in lactophenol cotton blue. o–r Ascospores, stained in lactophenol cotton blue. Scale bars: g–j = 50 µm, l, k = 20 µm, m, n = 10 µm, o–r = 5 µm.

Epiphytic or *biotrophic* on the leaves of *Laurus* spp. and *Buxus* spp. as sooty molds adressed to the surface of host gaining nutrients from sugary exudates of sap-feeding insects. *Subiculum* well-developed, superficial, pelliculose, loose, blackish or grayish, comprising effuse, branched, subhyaline to olivaceous, 2–3 µm, septate hyphae, setose, reticulate. *Setae* erect, straight, tapering to the apex, bulbous at the base (Batista & Ciferri 1962). Sexual morph: *Ascomata* 85–250 µm in diam. (\bar{x} = 187 µm, n = 10), superficial, sessile on subiculum, perithecial, scattered to aggregated, globose, circular when dry, uniloculate, brown to black, with periphysate ostiole, thick-walled, glabrous. *Wall of ascoma* 32–56 µm (\bar{x} = 43 µm, n = 10), multi-layered, externally comprising pigmented, dark brown, thick-walled cells of *textura angularis*, with inner layer thinner, composed of irregularly-shaped, flattened, lightly brown to hyaline, thin-walled cells of *textura prismatica*. *Hamathecium* lacking paraphyses. *Asci* 48–65 × 13–17 µm (\bar{x} = 55 × 16.2 µm, n = 10), 8-spored, bitunicate, fissitunicate, cylindrical to broadly clavate, short pedicellate or sessile, lacking a distinct ocular chamber. *Ascospores* 15–25 × 4–8 µm (\bar{x} = 21 × 6.8 µm, n = 10), overlapping bi-seriate or multi-seriate, irregularly arranged, fusoid, hyaline, 2–6 septate, slightly constricted at the septum, smooth and thick-walled, lacking a gelatinous sheath or appendages. Asexual morph: Undetermined.

Material examined – UK, unlocalized, on leaves of *Laurus* (Lauraceae) and *Buxus* spp. (Buxaceae), 1848, C. Babington (K(M) 139701, holotype of *Strigula babingtonii*).

Limacinula Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 116: 101 (1907)

Index Fungorum number: IF2869, Facesoffungi number: FoF 10356, 12 morphological species (Species Fungorum 2021), molecular data unavailable.

Type species – ***Limacinula samoensis*** Höhn. [as ‘samoënsis’]

Notes – Reynolds (1971) introduced *Limacinula* to accommodate six species, viz., *L. anomala*, *L. butleri*, *L. javanica*, *L. musicola*, *L. samoensis* and *L. theae*. The genus is characterized by a well-developed, superficial *subiculum* composed of effuse, branched hyphae, perithecial, setose ascomata with periphysate ostiole, paraphyses, bitunicate, clavate, obpyriform to obovoid asci and fusoid to oblong, hyaline to light brown, muriform ascospores. *Limacinula* and *Phaeosaccardinula*, have been merged in earlier studies by von Höhnelt (1909, 1910). Reynolds (1971) distinguished *Limacinula* from *Phaeosaccardinula* as indicated by differences in ascomata anatomy, ascospore pigmentation and presence of hamathecium. Species of *Limacinula* are similar to *Coccodinium*, as both genera have limacinuloid ascomata and a hamathecium lacking paraphyses, however, the former genus has hyaline to pale brown ascospores, while in the latter the ascospores are dark brown. Considering the morphological similarities, we retain *Limacinula* in Coccodiniaceae, however, fresh collections and sequence data are needed to clarify the familial placement.

Limacinula samoensis Höhn. [as ‘samoënsis’], Sber. Akad. Wiss. Wien, Math. -naturw. Kl., Abt. 1 118: 1200 (1909) Fig. 16

Index Fungorum number: IF627637, Facesoffungi number: FoF 10357

Saprobic, *Epiphytic* or *biotrophic* on the leaves of *Ficus elastica*, mixed with other fungal taxa, as sooty molds adressed to the surface of host gaining nutrients from sugary exudates of sap-feeding insects. *Subiculum* well-developed, superficial, loose, brown, comprising effuse, branched, subhyaline to brown, septate hyphae, reticulate. Sexual morph: *Ascomata* 135–220 µm in diam. (\bar{x} = 155 µm, n = 10), superficial, sessile on subiculum, perithecial, scattered to aggregate, globose, collabent when mature, uniloculate, brown to black, with periphysate ostiole, thick-walled, more or less setose. *Wall of ascoma* 32–48 µm (\bar{x} = 40 µm, n = 10), multi-layered, externally comprising pigmented, dark brown, thick-walled cells of *textura angularis*, with inner layer thinner, composed of irregularly-shaped, flattened, lightly brown to hyaline, thin-walled cells of *textura angularis*. *Hamathecium* lacking paraphyses. *Asci* 58–115 × 22–52 µm (\bar{x} = 87 × 38 µm, n = 10), 8-spored, bitunicate, fissitunicate, clavate when immature, obpyriform to obovoid at maturity, short pedicellate or sessile, lacking a

distinct ocular chamber. *Ascospores* 22–35 × 8–12 μm (\bar{x} = 30 × 9.5 μm, n = 10), overlapping uni-seriate to multi-seriate, irregularly arranged, fusoid to oblong, basal cells thinner than upper cells, rounded at both ends, hyaline to light brown, muriform, with 6–8 transverse septa, 3–6 longitudinal septa, constricted at the septum, slightly constricted at the septum, smooth and thick-walled, lacking a gelatinous sheath or appendages. Asexual morph: Undetermined.

Material examined – Indonesia, Java, on leaves of *Ficus elastica* Roxb. ex Hornem. (Moraceae), 1908, von Höhnelt (K, Ex Herbarium von Höhnelt).

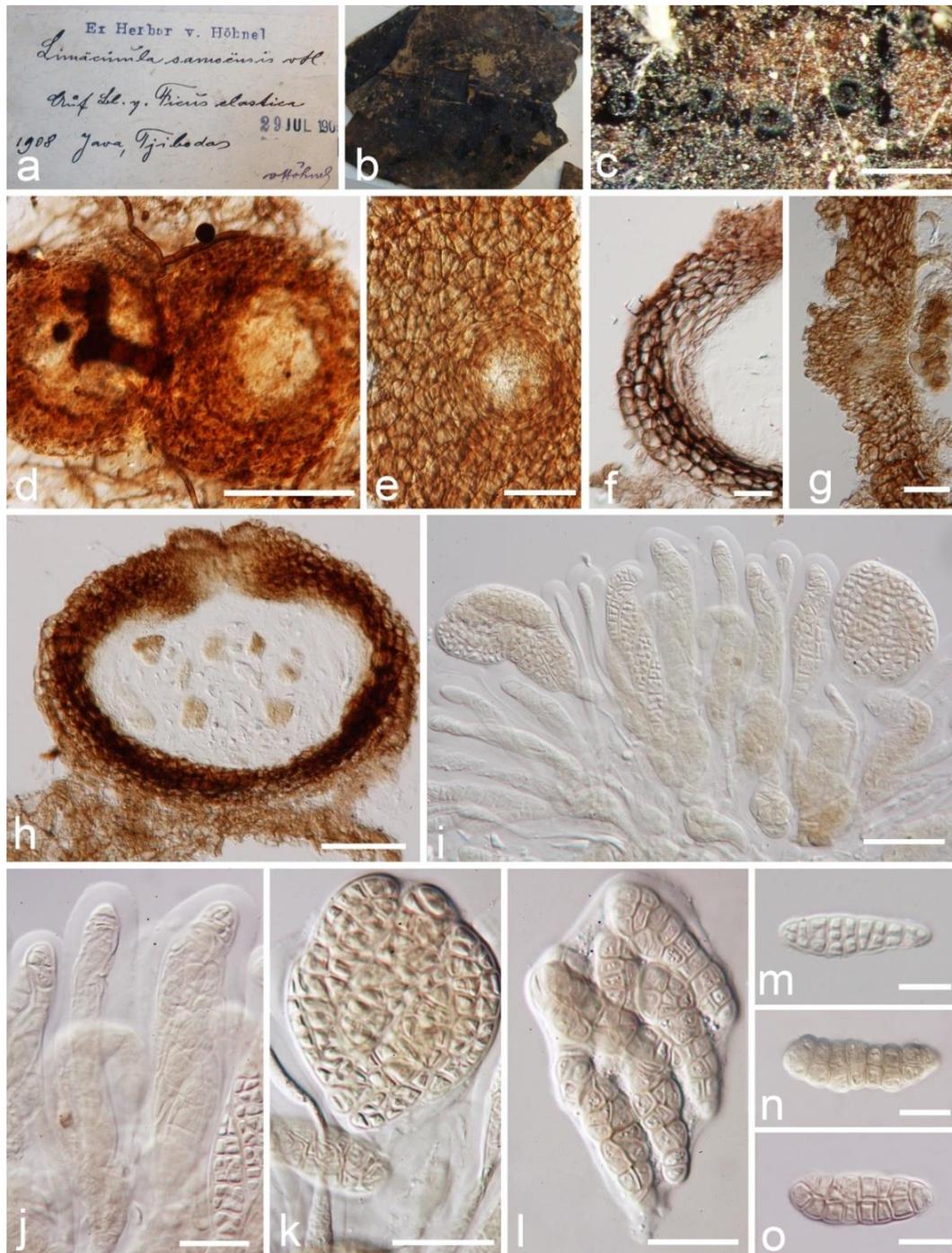


Figure 16 – *Limacinula samoensis* (K, Ex Herbarium von Höhnelt). a Envelope and collection information of *Limacinula samoensis*. b Herbarium material. c Appearance of ascomata on the superficial of the host. d, e Squash mounts of ascoma. f Vertical section through ascoma wall. g Vertical section through ostiole. h Vertical section of ascoma. i–l Asci with ascospores. m–o Ascospores. Scale bars: c = 500 μm, d = 100 μm, e, h = 50 μm, f, g, i = 25 μm, j–l = 20 μm, m–o = 10 μm.

Cyphellophoraceae Réblová & Unter., PLoS ONE 8(5): e63547, 10 (2013)

Index Fungorum number: IF803682, Facesoffungi number: FoF 10358, 26 known species.

Epiphytic, saprobic or pathogenic on a range of hosts worldwide. *Colonies* mostly growing slowly, pale grey-brown in the center, cream-colored, light mouse grey to dark grey, loose, cottony, woolly-velvety, margin entire, flat, straight or sharp, dark brown to olivaceous black, reverse olivaceous black, somewhat moist. *Vegetative hyphae* hyaline initially, pale brown or grey olivaceous when mature, septate, constrictions at the septa, straight or undulate, smooth-walled, guttulate or aguttulate, with or without oil droplets. Sexual morph: *Ascomata* scattered, subglobose to globose, dark brown, glabrous, thick-walled, ostiolate or ostiole inconspicuous, with or without dark superficial hyphae. *Wall of ascoma* multi-layered, comprising brown to hyaline cells of *textura angularis* and *textura globulosa*. *Asci* 8-spored, bitunicate, ellipsoidal to cylindrical, ovoid to ampulliform, with a short pedicel. *Ascospores* 2–3-seriate, ellipsoidal to fusiform, hyaline, 1–3-septate, not constricted at the septa, narrowly round at the ends, with or without a guttule in each cell (Yang et al. 2018, Phookamsak et al. 2019). Asexual morph: hyphomycetous. *Conidiophores* absent or rarely reduced to a short cell basal to the conidiogenous cells. *Conidiogenous cells* enteroblastic, phialidic, short cylindrical to flask-shaped, ampulliform, intercalary, lateral or terminal, sometimes arising at short side branches of hyphae, with indistinct sessile collarettes or short and flaring to funnel-shaped collarettes, sub-hyaline to pale olivaceous brown, producing subsequent conidia in more or less sympodial order, thin-walled. *Conidia* aggregated, oblong-fusoid or oblong-ovoid or triangular, 1–multi-septate or aseptate, constricted at the septa, hyaline to brown, straight or sometimes concave, smooth-walled, guttulate or aguttulate, with or without oil droplets, without a gelatinous sheath or appendages. *Spermatial state* absent. *Chlamydospores* absent.

Type – *Cyphellophora* G.A. de Vries

Notes – Réblová et al. (2013) introduced Cyphellophoraceae Réblová & Unter. to accommodate the type genus *Cyphellophora* G.A. de Vries with eight species from *Cyphellophora* and six species from *Phialophora* Medlar based on morphology, secondary structure data and phylogenetic analysis which formed a distinct lineage within Chaetothyriales. *Anthopsis* was formally established in Cyphellophoraceae by Moussa et al. (2016). Thus, the definition of Cyphellophoraceae was extended to include flask-shaped or ampulliform phialides or phialide-like cells with indistinct sessile collarettes or short and flaring to funnel-shaped collarettes, and oblong-fusoid to oblong-ovoid or triangular conidia with or without septa. Currently, two sexual morph species are accepted, *viz.* *Cyphellophora jingdongensis* H. Yang & K.D. Hyde and *C. filici* Hongsanan et al. isolated from plant material (Yang et al. 2018, Phookamsak et al. 2019).

Cyphellophora G.A. de Vries, Mycopath. Mycol. appl. 16(1): 47 (1962)

Index Fungorum number: IF7885, Facesoffungi number: FoF 10359, 26 morphological species (Species Fungorum 2021), 22 species with molecular data.

Epiphytic, saprobic and pathogenic on a range of hosts worldwide. *Colonies* mostly growing slowly, pale grey-brown in the center, loose, cottony, woolly-velvety, margin entire, flat, straight or sharp, dark brown to olivaceous black, reverse olivaceous black, somewhat moist. *Vegetative hyphae* hyaline initially, pale brown in older hyphae, septate, constrictions at the septa, straight or undulate, smooth-walled, guttulate or aguttulate, with or without oil droplets. Sexual morph: *Ascomata* scattered, subglobose to globose, dark brown, glabrous, thick-walled, ostiolate or ostiole inconspicuous, with or without dark superficial hyphae. *Wall of ascoma* multi-layered, comprising brown to hyaline cells of *textura angularis* and *textura globulosa*. *Asci* 8-spored, bitunicate, ellipsoidal to cylindrical, ovoid to ampulliform, with a short pedicel. *Ascospores* 2–3-seriate, ellipsoidal to fusiform, hyaline, 1–3 septate, not constricted at the septa, narrowly rounded at the ends, with or without a guttule in each cell (Yang et al. 2018, Phookamsak et al. 2019). Asexual morph: *Hyphomycetous*. *Conidiophores* absent or rarely reduced to a short cell, basal to the conidiogenous cells. *Conidiogenous cells* enteroblastic, phialidic, short cylindrical to flask-shaped, intercalary, lateral or terminal, sometimes arising at short side branches of hyphae, with indistinct sessile collarettes or short and flaring to funnel-shaped collarettes, sub-hyaline to pale olivaceous brown, producing subsequent conidia in more or less sympodial order,

thin-walled. *Conidia* aggregated, oblong-fusoid or oblong-ovoid, 1–multi-septate, constricted at the septa, hyaline to brown, straight or curved, smooth-walled, guttulate or aguttulate, with or without oil droplets, without a gelatinous sheath or appendages. *Spermatial state* absent. *Chlamydospores* absent (de Vries 1962, Feng et al. 2014).

Type species – *Cyphellophora laciniata* G.A. de Vries

Notes – *Cyphellophora* G.A. de Vries is widespread and is ecologically important. Species of *Cyphellophora* comprise; (1) mostly human and animal pathogens, such as *C. laciniata* G.A. de Vries (type species), *C. europaea* (de Hoog, Mayser & Haase) Réblová & Unter. and *C. pluriseptata* G.A. de Vries which were isolated from nails or skin of humans (de Vries 1962, de Hoog et al. 2000a, Feng et al. 2012, 2014), *C. phyllostachysdis* G.Y. Sun & Liu Gao, *C. europaea*, from a human or mammal eyes, resulting in infection of hyperkeratosis (de Hoog et al. 2000a); (2) saprobes, such as *C. filici* isolated from dead fronds of a fern, without superficial dark hyphae (Phookamsak et al. 2019), *C. oxyspora* (W. Gams) Réblová & Unter. isolated from a decaying leaf of *Clerodendron monahassa* (Vu et al. 2019); (3) epiphytes, such as *C. jingdongensis* which can reduce photosynthesis, but does not cause plant disease (Chomnunti et al. 2014, Yang et al. 2018), and (4) plant pathogens, such as *C. phyllostachysdis* G.Y. Sun & Liu Gao and *C. sessilis* (de Hoog) Réblová & Unter. causing sooty blotch and flyspeck disease of bamboo, resulting in economic damage (de Hoog et al. 2000, Decock et al. 2003, Zhuang et al. 2010, Gleason et al. 2011, Gao et al. 2015).

To date, 26 species are accepted in *Cyphellophora*, with two sexual morph species, *C. jingdongensis* isolated from living leaves of *Alnus nepalensis* (Yang et al. 2018) and *C. filici* isolated on dead fronds of a fern (Phookamsak et al. 2019). There are nine species reported from plant material, namely as *C. artocarpus* G.Y. Sun & Liu Gao, *C. filici*, *C. guyanensis* Decock & G. Delgado, *C. jingdongensis*, *C. musae*, *C. olivacea* (W. Gams) Réblová & Unter., *C. oxyspora*, *C. phyllostachysdis* and *C. sessilis* (Gams & Holubová-Jechová 1976, de Hoog et al. 1999, Decock et al. 2003, Gao et al. 2015, Yang et al. 2018, Phookamsak et al. 2019).

The asexual morphs of *Cyphellophora* are recognized as black yeasts which are difficult to identify solely based on morphology. *Cyphellophora* resembles black yeasts, such as *Phialophora* Medlar and *Pseudomicrodochium* B. Sutton, but they differ from each other in having different conidia and thallus colours (Decock et al. 2003, de Hoog et al. 2011, Réblová et al. 2013). Thus, a combination of morphology, ecological traits and phylogenetic analyses provide accurate generic and species delimitation in *Cyphellophora*. Phylogenetic studies have shown that *Cyphellophora* clustered in a well-supported clade within Chaetothyriales (Feng et al. 2014, Gao et al. 2015, Yang et al. 2018, Phookamsak et al. 2019).

Cyphellophora laciniata G.A. de Vries, Mycopath. Mycol. appl. 16(1): 47 (1962)

Fig. 17

Index Fungorum number: IF329520; Facesoffungi number: FoF 10360

Pathogenic on skin scales of a human patient. *Colonies* woolly-velvety, grey, margin entire, reverse olivaceous black to black. *Vegetative hyphae* 2–3 µm wide, hyaline initially, pale brown in older hyphae, septate, constrictions at the septa, straight or undulate, smooth-walled, with inflated cells, sometimes with dark brown excrescences in older hyphae, guttulate when young, the older hyphae with many oil droplets. *Sexual morph*: Undetermined. *Asexual morph*: hyphomycetous. *Conidiophores* absent or rarely reduced to a short cell basal to the conidiogenous cells. *Conidiogenous cells* enteroblastic, phialidic, short cylindrical to flask-shaped, intercalary, lateral or terminal, sometimes arising at short side branches of hyphae, with a short flaring collarete, sub-hyaline to pale olivaceous brown, thin-walled. *Conidia* 11–25 × 2–5 µm, oblong-fusoid or oblong-ovoid, 1–3-transverse-septate, constricted at the septa, hyaline to brown, straight or curved, smooth-walled, guttulate when young, with many oil droplets in the older hyphae, without a gelatinous sheath or appendages. *Spermatial state* is absent. *Chlamydospores* absent (Description modified according to de Vries 1962, Feng et al. 2014).

Type material – Switzerland, Basel, probably as a contaminant, from skin scales of a human patient, 1954, Wissel K.M. (Centraalbureau voor Schimmelcultures, holotype).

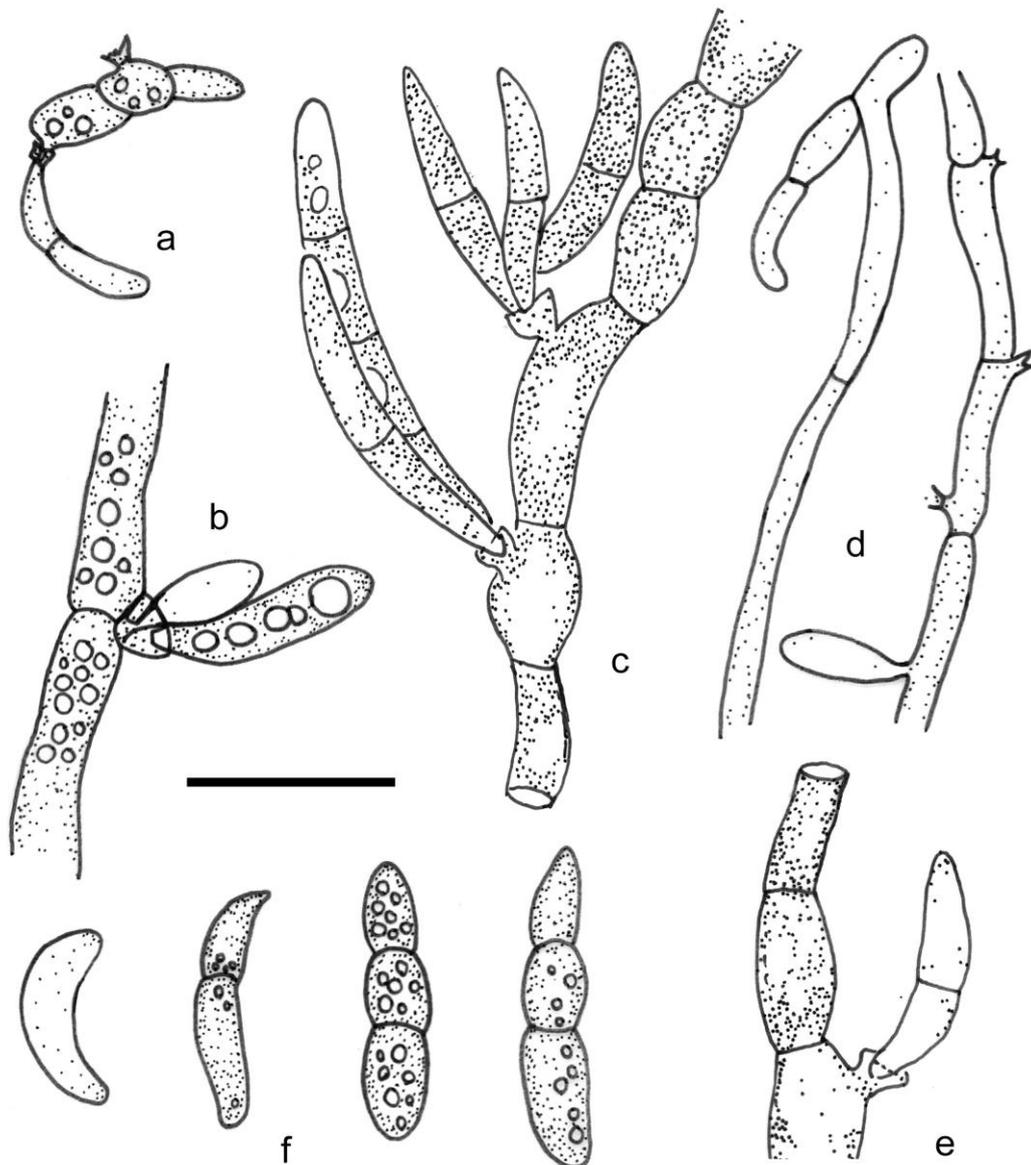


Figure 17 – *Cyphellophora laciniata* (Centraalbureau voor Schimmelcultures, holotype, redrawn from de Vries 1962). a–e Conidiogenous cells with conidia. f Conidia. Scale bar: 20 µm.

Ecological and economic significance of Cyphellophoraceae

Species of Cyphellophoraceae are cosmopolitan and comprise saprobes, epiphytes and plant and animal (including humans) pathogens from a variety of habitats. *Anthopsis deltoidei*, *Cyphellophora laciniata*, *C. europaea*, *C. oxyspora*, *C. pauciseptata*, *C. pluriseptata*, *C. phyllostachysdis*, *C. reptans*, *C. suttonii*, *C. vermisporea*, *C. suttonii* and *C. fusarioides* have been reported from animals including human clinical samples causing infection or human phaeohyphomycosis (de Vries 1962, Ajello et al. 1980, Sutton et al. 1991, Perfect & Schell 1996, de Hoog et al. 1999, 2000, Feng et al. 2012). *Anthopsis catenata*, *A. deltoidei*, *A. microspora*, *Cyphellophora europaea*, *C. reptans*, *C. laciniata* and *C. suttonii* have been reported from nonclinical sources from environmental samples in humid environments (i.e., foam of a river, soil samples, bathrooms, washing machines and food) (Marchisio et al. 1977, Gams & Holubová-Jechová 1976, Sutton et al. 1991, Lopez et al. 2007, Li et al. 2011). *Cyphellophora filici* and *C. oxyspora* was found on dead fronds and decaying leaves respectively (Phookamsak et al. 2019, Vu et al. 2019). *Cyphellophora jingdongensis* is a sooty mould species that reduce photosynthesis rates in the host (Yang et al. 2018). *Cyphellophora phyllostachysdis* and *C. sessilis* are plant pathogens that cause

sooty blotch and flyspeck (Gao et al. 2015). Therefore, most species of Cyphellophoraceae have ecological and economic significance being harmful to the animals (including humans) and plants or beneficial.

Genera included in Cyphellophoraceae

Anthopsis Fil. March., A. Fontana & Luppi Mosca, Can. J. Bot. 55(2): 117 (1977)

Index Fungorum number: IF7173, Facesoffungi number: FoF 10361, 3 morphological species (Species Fungorum 2021), 2 species with molecular data.

Type species – *Anthopsis deltoidea* Fil. March., A. Fontana & Luppi Mosca

Saprobic on soil, foam of a river, or *pathogenic* on human subcutaneous infection. Colonies cream-colored, light mouse grey to dark grey, velvety-woolly. *Hyphae* grey olivaceous when mature, septate, constrictions at the septa, smooth-walled, guttulate or aguttulate, with or without oil droplets. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* absent or rarely reduced to a short cell basal to the conidiogenous cells. *Conidiogenous cells* enteroblastic, inverted, phialidic, clustering as two to eight ampulliform phialides, arising from a hyphal swelling, with distinct sessile collarettes at the base, near the point where the phialide is inserted on the hypha, forming disk flowers of a capitulum, sometimes integrated, with a sessile collarette, sub-hyaline to pale olivaceous. *Conidia* aggregated, but easily dispersed, ellipsoidal or pyriform, mature conidia deltoid, sometimes ellipsoidal to subspherical in chains, aseptate, hyaline to pale brown, grey olivaceous, straight at one side or sometimes concave, smooth-walled, aguttulate, without oil droplets, without a gelatinous sheath or appendages. *Spermatial state* absent. *Chlamydozoospores* absent (Rayner 1970, Moussa et al. 2016)

Notes – Marchisio et al. (1977) introduced *Anthopsis* Fil. March. et al. to accommodate *Anthopsis deltoidei* Fil. March. et al. which was isolated from soil in Italy. Subsequently, *A. catenata* Oorschot et al. and *A. microspora* K. Ando & Tubaki were added, but represented by only one or two strains with a brief description (van Oorschot et al. 1982, Ando & Tubaki 1985, Moussa et al. 2016). *Anthopsis* is reported from Germany, Italy, and Japan and are isolated from soil and foam in stream (*A. catenata*, *A. deltoidei* and *A. microspora*) and a human pathogen causing phaeohyphomycosis (*A. deltoidei*) (Marchisio et al. 1977, van Oorschot et al. 1982, Ando & Tubaki 1985). Species are dematiaceous hyphomycetes with melanized filamentous thalli, inverted, ampulliform phialides with conidiogenous loci, flower-shaped phialides and collarettes and triangular conidia, sometimes in chains. The conidiogenous cells resemble *Phialophora* Medlar, but *Anthopsis* has unique triangular conidia. The type species *A. deltoidei* clustered with *Cyphellophora* G.A. de Vries in phylogenetic analysis and was transferred to Cyphellophoraceae (Moussa et al. 2016, this study, Fig. 1). However, The LSU sequence of *Anthopsis catenata* (CBS 492.81) is shown that is not related to any species of Cyphellophoraceae (Moussa et al. 2016 and this study). Thus, our tree does not include the unrelated sequence and the placement of *Anthopsis* in Cyphellophoraceae is confirmed based on the asexual morph species, *Anthopsis deltoidei* and *A. microspora*.

Anthopsis deltoidea Fil. March., A. Fontana & Luppi Mosca, Can. J. Bot. 55(2): 117 (1977)

Fig. 18

Index Fungorum number: IF308727; Facesoffungi number: FoF 10362

Description: see Marchis et al. (1977)

Type material – Italy, Botanical Garden of the University of Turin, isolated from a horticultural soil, June 1974, Ceruti and Luppi Mosca (CMT 11 11.74, holotype).

Epibryaceae S. Stenroos & Gueidan, Mycol. Progr. 13(4): 1037 (2014)

Index Fungorum number: IF808432; Facesoffungi number: FoF 10363

Saprobic on or between hairy leaves or leaf lamellae of hosts. Sexual morph: *Ascomata* perithecioid, superficial, solitary, subglobose to globose, ovoid or pyriform, light to dark brown to black, ostioles without periphyses, apapillate, setose. *Setae* simple, arising at the upper part, usually, apex rounded, occasionally tapering towards the apex, dark brown, straight or curved, septate, slightly

constricted at the septa. *Wall of ascoma* multi-layered, comprising brown to dark brown cells of *textura angularis*, apex cells darker and thicker walls, lacking interascal tissue cells. *Hamathecium* lacking paraphyses. *Asci* 8-spored, bitunicate, oblong to ovoid, ellipsoid, to nearly subcylindrical, without a pedicel, apex rounded, with or without apical structures, sometimes hymenial jelly reddish in Lugol's solution, embedded in a gelatinous matrix. *Ascospores* overlapping 2–3-seriate, ellipsoid to fusiform, sub-clavate, tapering towards both ends, hyaline or pale grey to lightly brown, 0 to trans-septate, not constricted or slightly constricted at the septa, thin-walled, with or without gelatinous sheath, guttulate. Asexual morph: Undetermined.

Type – *Epibryon* Döbbeler

Notes – Gueidan et al. (2014) established Epibryaceae to accommodate most *Epibryon* species, including the type species *E. plagiochilae*, and *Leptomeliola ptilidii*, *Cladophialophora minutissima* and some rock-inhabiting taxa. The key characters of Epibryaceae are globose to subglobose, setose ascomata and oblong to fusiform to sub-clavate ascospores. The family contains a single genus *Epibryon* with sexual morphs and asexual collections are from rocks and vascular plants (Gueidan et al. 2014).

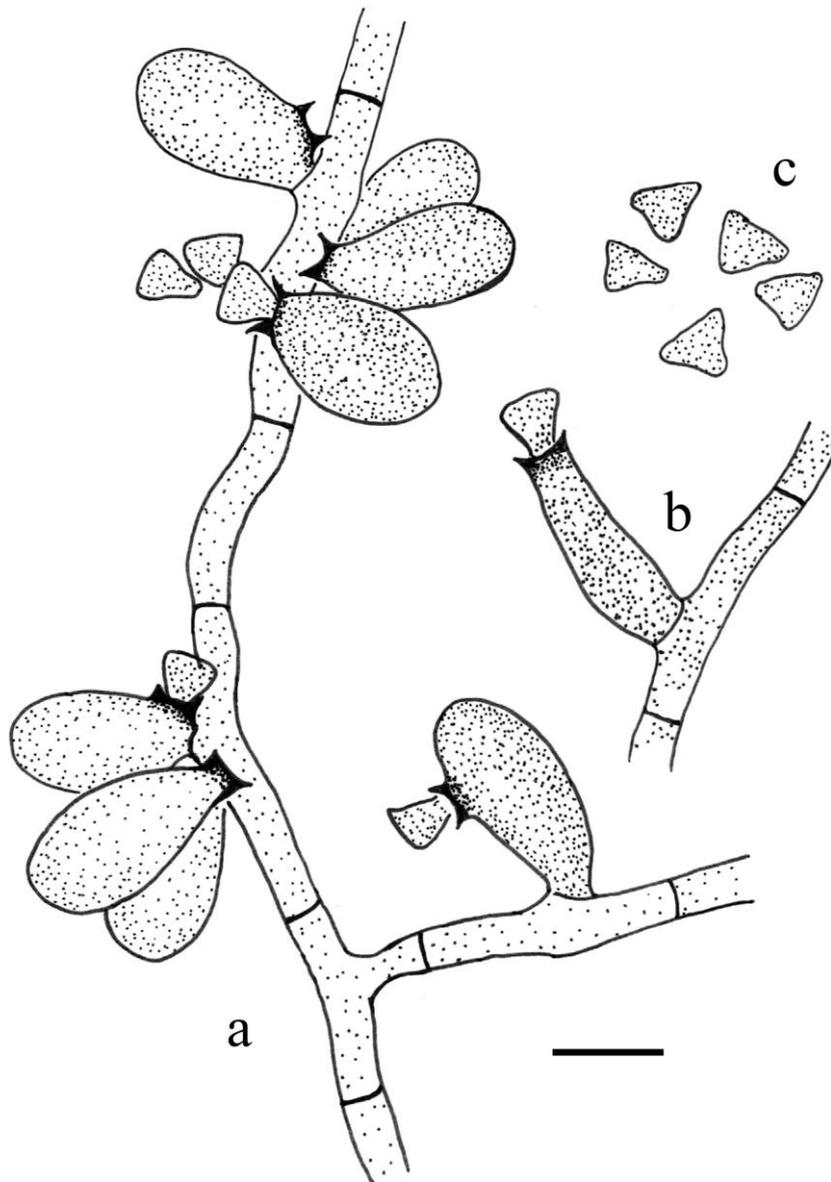


Figure 18 – *Anthopsis deltoidea* (redrawn from Seifert et al. 2011). a, b Conidiogenous cells have a typical basal collarette. c Conidia. Scale bar: 5 μ m.

Epibryon Döbbeler, Mitt. bot. StSamml., Münch. 14: 260 (1978)

Index Fungorum number: IF1855, Facesoffungi number: FoF 10366, 46 morphological species (Species Fungorum 2021), 7 species with molecular data.

Saprobic on or between hairy leaves or leaf lamellae of hosts. Sexual morph: *Ascomata* perithecioid, superficial, solitary, subglobose to globose, ovoid or pyriform, light to dark brown to black, ostioles without periphyses, apapillate, setose. *Setae* simple, arising at the upper part, usually, apex rounded, occasionally tapering towards the apex, dark brown, straight or curved, septate, slightly constricted at the septa. *Wall of ascoma* multi-layered, comprising brown to dark brown cells of *textura angularis*, apical cells darker and thicker walls, lacking interascal tissue cells. *Hamathecium* lacking paraphyses. *Asci* 8-spored, bitunicate, oblong to ovoid, ellipsoid, to nearly subcylindrical, without a pedicel, apex rounded, with or without apical structures, sometimes hymenial jelly reddish in Lugol's solution, embedded in a gelatinous matrix. *Ascospores* overlapping 2–3-seriate, ellipsoid to fusiform, tapering towards both ends, hyaline or pale grey to lightly brown, 0-multi-trans-septate, not constricted or slightly constricted at the septa, thin-walled, with or without gelatinous sheath, guttulate. Asexual morph: Undetermined.

Type species – ***Epibryon plagiophilae*** (Gonz. Frag.) Döbbeler

Notes – The monotypic *Epibryon* Döbbeler was introduced by Döbbeler (1978) to accommodate *E. plagiophilae* (Gonz. Frag.) Döbbeler, which has globose or subglobose, setose ascomata and hyaline to brown ascospores; the hymenium gel stains red in Lugol's solution (Döbbeler 1978). Döbbeler (1978) proposed that *Epibryon* is a polyphyletic assemblage of morphologically diverse species. *Epibryon* has been placed in Pseudoperisporiaceae (Dothideomycetes) by morphological characters (Lumbsch & Huhndorf 2007, Hyde et al. 2013, Wijayawardene et al. 2014). Subsequently, Stenroos et al. (2010) and Gueidan et al. (2014) regarded *Epibryon* as a polyphyletic genus based on molecular data. Phylogenetically, most species of *Epibryon*, together with the type species *E. plagiophilae* formed a highly supported distinct clade in Chaetothyriales (Gueidan et al. 2014). Members of *Epibryon* are mostly biotrophic parasites of bryophytes such as *Sphagnum* and non-symptomatic lichens, and sometimes are saprobes (Döbbeler 1978, U'Ren et al. 2010, Gueidan et al. 2014, Döbbeler 2016, Muggia et al. 2016, Darmostuk & Khodosovtsev 2019). *Epibryon* comprises 46 species (Species Fungorum 2021) with sexual morphs, and some melanized asexual morphs isolated from rocks or plants.

Epibryon plagiophilae (Gonz. Frag.) Döbbeler, Mitt. bot. StSamml., Münch. 14: 293 (1978)

≡ *Coleroa casaresii* var. *plagiophilae* Gonz. Frag. [as 'casaresi'], Mém. R. Soc. Española Hist. Nat. 11(3): 108 (1919)

Index Fungorum number: IF313925, Facesoffungi number: FoF 03720

Description: see Boonmee et al. (2017)

Material examined – Austria, Steiermark, Grazer Bergland, Dürrbachgraben östlich Graz-Andritz, reichlich, on leaves of *Plagiophilae asplenoidis* (L. em. Tayl.) Dum. (Plagiophilaceae), July 1972, J. Poelt, Inv. Nr. 88-89 (DigiBota ID 266896, GZU 000291905).

Ecological and economic significance of Epibryaceae

Species in Epibryaceae have a widespread distribution in Australia, Europe, Japan, New Zealand and North and South America and include saprobes on plants that play important roles in the recycling of organic matter. Most species are regarded as biotrophic parasites of algae, mosses, or asymptomatic on lichens (Döbbeler 1978, U'Ren et al. 2010, Gueidan et al. 2014, Döbbeler, 2016, Muggia et al. 2016, Darmostuk & Khodosovtsev 2019). Taxa decompose the lower parts of plants.

Herpotrichiellaceae Munk, Dansk bot. Ark. 15(no. 2): 131 (1953)

Index Fungorum number: IF80856

Type – *Herpotrichiella* Petr.

Notes – Munk (1953) introduced Herpotrichiellaceae to accommodate *Herpotrichiella* based on the type species *H. moravica*. The family Herpotrichiellaceae has the largest number of species in

Chaetothyriales (Wijayawardene et al. 2017, Quan et al. 2020). Species of Herpotrichiellaceae are characterized by superficial, setose, ostiolate, small ascomata with short and extending periphyses near or over the ostiole, bitunicate asci with a thickened endotunica and greenish-grey to brown, 1-multi transversely septate ascospores, rarely with longitudinal septa (von Arx & Müller 1975, Barr 1976, 1991, Samuels & Müller 1978, Müller et al. 1987, Untereiner et al. 1995). The asexual morphs of Herpotrichiellaceae are dematiaceous, black yeasts (Müller et al. 1987, Untereiner et al. 1995, Untereiner & Naveau 1999, Crous et al. 2007, Untereiner et al. 2008, de Hoog et al. 2011, Réblová et al. 2013, Gueidan et al. 2014, Liu et al. 2015, Dong et al. 2018, Untereiner 2020). It is difficult to distinguish species, especially the dematiaceous asexual morphs, based on limited features, and therefore molecular sequences are essential for species delimitation.

Before molecular data, the systematics of Herpotrichiellaceae was confused. Munk (1953) recognized that species in Herpotrichiellaceae should be similar to species in *Coenosphaeria* and *Trichometasphaeria* in Dothideomycetes. Müller & von Arx (1962) and Bigelow & Barr (1963) rejected the classification of Herpotrichiellaceae and placed the type genus *Herpotrichiella* in Pleosporales, Dothideomycetes. Herpotrichiellaceae was considered to be related to Capnodiales and Dothideales in Dothideomycetes, until Barr (1976, 1987) and Sivanesan (1984) regarded Herpotrichiellaceae is closely related to Chaetothyriales. In this study, 18 recognized genera are accepted in this family.

Petrak (1914) introduced *Herpotrichiella* with *H. moravica* as the type species. Untereiner et al. (1995) compared two collections CBS 125.88 and CBS 522.79 (identified as *H. moravica*), and found that they are morphologically indistinguishable. Subsequently, *H. moravica* was considered as a synonym of *Capronia pilosella* (Untereiner 1997). Thus, Quan et al. (2020) synonymized *Herpotrichiella* under the older name *Capronia* with the type species *Capronia sexdecimspora*. In their study, because of the lack of molecular data of *Capronia sexdecimspora*, they considered *C. pilosella* (AFTOL 657) as a reference for the family. We follow Quan et al. (2020) to synonymize *Herpotrichiella* under the older name *Capronia*.

Other genera included:

Aculeata W. Dong, H. Zhang & K.D. Hyde, Mycol. Progr. 17(5): 622 (2018)

Index Fungorum number: IF554259, Facesoffungi number: FoF 04111, 1 morphological species (Species Fungorum 2021), 1 species with molecular data.

Type species – ***Aculeata aquatica*** W. Dong, H. Zhang & K.D. Hyde

Saprobic on submerged wood. *Colonies* sporodochial, scattered, punctiform, black, granular, glistening. *Mycelium* mostly immersed in the substratum, consisting of branched, septate, subhyaline to pale brown, smooth hyphae. Sexual morph: Undetermined. Asexual morph: *Conidiophores* indistinct. *Conidiogenous cells* monoblastic, holoblastic, integrated, terminal, determinate, hyaline to light olive, pyriform or obovoid. *Conidia* acrogenous, solitary, subhyaline to light olive, vesiculate, smooth at first, progressively becoming olive, crucially septate, finally becoming olive to brown, muriform, moderately constricted at the septa, darker and thicker at septa, aculeate, bearing densely packed, subulate, obtuse, brown to black spines around conidia, ellipsoid or oval in surface view, clavate in lateral view, composed of a light-colored, cuneiform basal cell, thick-walled (Dong et al. 2018).

Notes – *Aculeata* W. Dong et al. was introduced to accommodate *A. aquatica* W. Dong et al. which has short or indistinct conidiophores and oval, muriform conidia. The asexually typified genera in Herpotrichiellaceae, i.e. *Cladophialophora*, *Fonsecaea*, are dematiaceous black yeasts with unicellular conidia in chains, or fused and bent in chains and may be related to *Aculeata* (Dong et al. 2018). *Aculeata* resembles *Melanoctona* in having short conidiophores and muriform conidia, while species of *Aculeata* have a vesiculate wall with densely packed spines versus being smooth-walled in *Melanoctona* (Tian et al. 2016, Dong et al. 2018).

Aculeata aquatica W. Dong, H. Zhang & K.D. Hyde, Mycol. Progr. 17(5): 622 (2018)

Index Fungorum number: IF554261, Facesoffungi number: FoF 04112

Description: see Dong et al. 2018

Type material – Thailand, Chiang Rai, Pong Phra Bat, on submerged wood, 10 May 2011, Huang Zhang, i21 (MFLU 11-1094, holotype), ex-type living culture MFLUCC 11- 0529.

Atrokylandriopsis Y.R. Ma & X.G. Zhang, Mycol. Progr. 14: 2 (2015)

Index Fungorum number: IF811416, Facesoffungi number: FoF 10367, 1 morphological species (Species Fungorum 2021), 1 species with molecular data.

Saprobic on dead branches of an unidentified broadleaf tree in terrestrial habitats. *Colonies* effuse, hairy, brown. *Mycelium* immersed to superficial, composed of branched, pale brown to brown, septate, smooth-walled hyphae. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* macronematous, erect, unbranched, cylindrical, brown, septate, straight or slightly flexuous, smooth-walled, thick-walled. *Conidiogenous cells* terminal, integrated, enteroblastic, phialidic, brown, smooth-walled. *Conidia* solitary, acrogenous, broadly cylindrical or rounded-cubical, pale brown to brown, longitudinally 3-euseptate, straight or curved, with a setula at each corner, attached to the conidiogenous locus at the midpoint of their long side and giving the appearance of a ‘T’, smooth-walled (Ma et al. 2015).

Type – *Atrokylandriopsis setulosa* Y.R. Ma & X.G. Zhang, Mycol. Progr. 14: 3 (2015)

Index Fungorum number: IF811417; Facesoffungi number: FoF 10368

Notes – *Atrokylandriopsis* Y.R. Ma & X.G. Zhang was established by Ma et al. (2015) to accommodate *A. setulosa* Y.R. Ma & X.G. Zhang associated with dead branches of an unidentified broadleaf tree in China. It is characterized by monophialidic conidiogenous cells and pigmented, septate, setulate conidia that are attached to conidiophores at the midpoint of their long side during conidiogenesis, giving the appearance of a ‘T’. Ma et al. (2015) suggested placing *Atrokylandriopsis* in Chaetothyriales, but no family was assigned. Wijayawardene et al. (2020) placed this genus in an uncertain phylogenetic position in Chaetothyriales genera *incertae sedis*. Quan et al. (2020) showed that *A. setulosa* clustered with *Capronia fungicola* in Herpotrichiellaceae. In our study, we include the type species of *Atrokylandriopsis* and the combined ITS and LSU phylogenetic analysis shows that *A. setulosa* (HMAS245592) forms a sister group with *Marinophialophora garethjonesii* (MFLUCC 16-1449) with 0.93 BY PP support in Herpotrichiellaceae (Fig. 1).

Brycekendrickomyces Crous & M.J. Wingf., Persoonia 22: 141 (2009)

Index Fungorum number: IF509515, Facesoffungi number: FoF 10369, 1 morphological species (Species Fungorum 2021), 1 species with molecular data.

Type species – ***Brycekendrickomyces acaciae*** Crous & M.J. Wingf., Persoonia 22: 141 (2009)

Mycelium consisting of branched, septate, smooth, pale brown hyphae. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* solitary, erect, cylindrical, straight to somewhat flexuous, basal cell bulbous, without rhizoids, stalk medium to dark brown, smooth, transversely euseptate, upper cell giving rise to (1–)2–4(–6) conidiogenous cells. *Conidiogenous cells* subcylindrical to allantoid or doliiform, straight to gently curved, pale brown, polyblastic, proliferating sympodially. *Conidia* hyaline, aggregating in slimy mass (never in chains), ellipsoid, apex subobtuse, base subtruncate (Crous et al. 2009).

Notes – Crous et al. (2009) introduced *Brycekendrickomyces* Crous & M.J. Wingf. to accommodate the type species *B. acaciae* Crous & M.J. Wingf. which has a simple conidiophore branching system, and ellipsoid conidia which are not in chains. Crous et al. (2009) compared the morphology of *Brycekendrickomyces* with *Argopericonia* (*Incertae sedis*), *Haplographium* (Hyaloscyphaceae, Helotiales, Leotiomyces) and *Lauriomyces* (Lauriomycetaceae, Lauriomycetales, *Incertae sedis*). *Brycekendrickomyces* have a simple conidiophore branching system, while *Haplographium* and *Lauriomyces* have an intricate series of branched conidiophores and conidia arising in chains. *Argopericonia* has apical conidiogenous heads, and catenate conidia with a prominent, globose guttule (Crous et al. 2009). Phylogenetically, *Brycekendrickomyces acacia* (CBS 124104)

formed a distinct clade in Chaetothyriales with 92% ML BS, 1.00 BY PP support in this study (Fig. 1). We maintain *Brycekendrickomyces* in Herpotrichiellaceae pending further studies.

Brycekendrickomyces acaciae Crous & M.J. Wingf., Persoonia 22: 141 (2009)

Fig. 19

Index Fungorum number: IF509517; Facesoffungi number: FoF 10370

Description – see Crous et al. 2009

Type material – Indonesia, Pelalawan, living leaves of *Acacia auriculiformis* Benth. (Leguminosae), March 2008, leg. M.J. Wingfield, isol. P.W. Crous (CBS H-20198, holotype), culture ex-type CPC 15078 = CBS 124104.

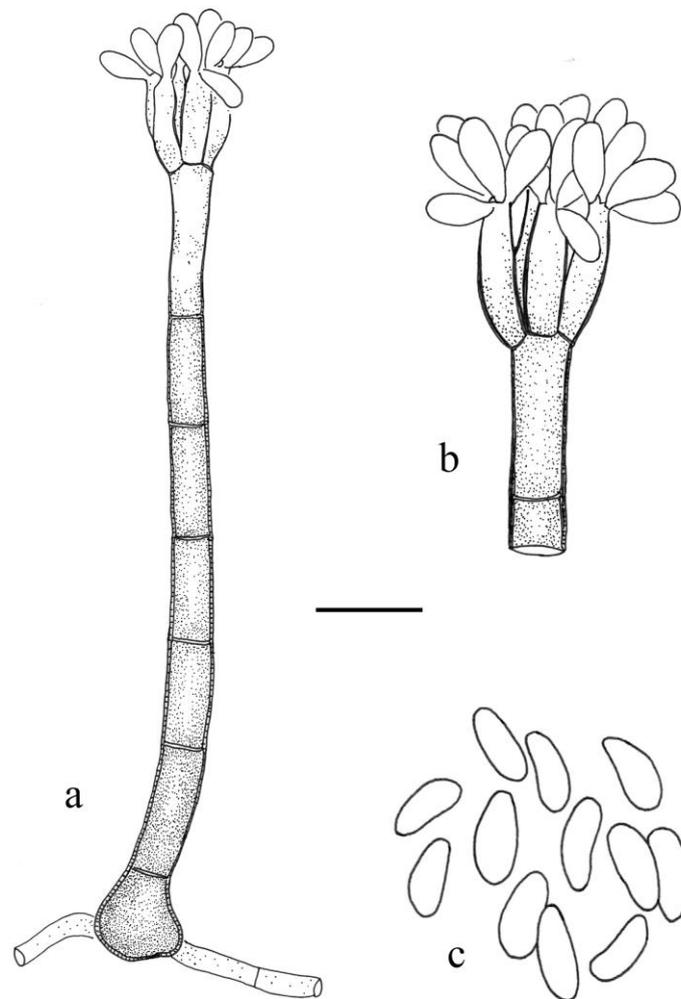


Figure 19 – *Brycekendrickomyces acaciae* (CBS 124104, holotype, redrawn from Crous et al. 2009). a Cylindrical, transversely euseptate conidiophore. b Subcylindrical conidiogenous cells with conidia. c Ellipsoid conidia. Scale bar: 10 μ m.

Capronia Sacc., Syll. fung. (Abellini) 2: 288 (1883)

= *Herpotrichiella* Petr., Anns mycol. 12(5): 472 (1914)

Index Fungorum number: IF815, Facesoffungi number: FoF 10371, 79 morphological species (Species Fungorum 2021), 18 species with molecular data.

Type species – *Capronia sexdecimspora* (Cooke) Sacc. [as ‘sexdecemspora’]

Saprobic on cone of *Pinus sylvestris*. Sexual morph: *Ascomata* perithecioid, arising singly, dispersed, superficial, immersed only at the base when mature, subglobose, black, smooth-walled, but with aseptate or 1-multi septate, unbranched, dark brown setae, arising from the upper part, ostiolate. *Setae* smooth-walled, rounded at the apex and hardly attenuated or tapering to the end. *Ostiole* lateral,

black, flattened. *Peridium* thick, composed of multi-layered, hyaline to brown cells of *textura angularis*. *Hamathecium* gelatinized, lacking pseudoparaphyses. *Asci* 8-spored or multi-spored, bitunicate, obpyriform to broadly clavate, wall apically thickened, J-. *Ascospores* overlapping, irregularly biseriate, oval to fusiform, muriform, hyaline to yellow-brown or grey, 1–7-trans-septate, constricted at the septa, with or without longitudinal septa, some slightly curved, smooth-walled, with or without guttules, without a gelatinous sheath or appendages. Asexual morph: hyphomycetous.

Notes – *Capronia* is cosmopolitan and includes saprobes on rooting or decaying plant tissues, taxa on the thalli of lichens on Ascomycota and Basidiomycota and hypersaprobes, fungicolous and lichenicolous taxa (Cooke 1871, Munk 1957, Barr 1987, 1991, Müller et al. 1987, Untereiner 1997, 2000, Halıcı et al. 2010, Sun et al. 2019). With the exception of *C. glabra* and *C. episphaeria*, the genus is characterized by setose ascomata with periphysate ostioles, bitunicate asci and 1-multi-septate or muriform ascospores (Barr 1991, Hsieh et al. 1997, Untereiner 1997, 2000, Halıcı et al. 2010). Asexual morphs of *Capronia* are black yeasts and related to species in *Exophiala*, *Ramichloridium*, the *Rhinochloidiella* species complex and phialophora and cladophialophora-like species (Müller et al. 1987, Untereiner et al. 1995, Untereiner 2020). However, all the sexual and asexual links should be confirmed based on culture and DNA molecular sequences. Establishing the asexual and sexual morph connections should be a focus of future work.

Capronia sexdecimspora (Cooke) Sacc. [as ‘sexdecemspora’], Syll. fung. (Abellini) 2: 289 (1883)

Fig. 20

≡ *Sphaeria sexdecimspora* Cooke, Handb. Brit. Fungi 2: 860 (1871)

For synonyms see Species Fungorum

Index Fungorum number: IF195056; Facesoffungi number: FoF 10372

Saprobic on cone of *Pinus sylvestris*. Sexual morph: *Ascomata* 96–150 µm diam, perithecioid, arising singly, dispersed, superficial, immersed only at the base when mature, subglobose, black, smooth-walled, but with aseptate, unbranched, dark brown setae, arising from the upper part, ostiolate. *Setae* 30–38 × 2–3 µm ($x = 35 \times 2.4 \mu\text{m}$, $n = 10$), smooth-walled, rounded at the apex and tapering to the ends. *Ostiole* lateral, black, flattened. *Peridium* thick, composed of multi-layered, hyaline to brown cells of *textura angularis*, the outermost layers brown to dark brown. *Hamathecium* lacking paraphyses. *Asci* (40–)43–63(–72) × (8–)9–15(–17) µm ($x = 55 \times 13 \mu\text{m}$, $n = 10$), 8-spored, bitunicate, obpyriform to broadly clavate. *Ascospores* (7–)8–16(–18) × 5.5–7.5 µm ($x = 14.3 \times 6.2 \mu\text{m}$, $n = 20$), overlapping, irregularly biseriate, oval to fusiform, muriform, hyaline to yellow-brown, 3-septate, constricted at the septa, with a single longitudinal septum, smooth-walled, without a gelatinous sheath or appendages. Asexual morph: Undetermined.

Material examined – UK, Scotland, Perthshire, on *Pinus sylvestris* L. (Pinaceae), 21 June 1978, D.W. Math (IMI 230725).

Cladophialophora Borelli, Proc. 5th International Conference on Mycoses: 355 (1980)

Index Fungorum number: IF7677, Facesoffungi number: FoF 10373, 38 morphological species (Species Fungorum 2021), 12 species with molecular data.

Type species – ***Cladophialophora carrionii*** (Trejos) de Hoog, Kwon-Chung & McGinnis

Pathogenic, lichenicolous, saprobic, parasitic, endophytic, fungicolous and *rock-inhabiting* on a variety of hosts. *Colonies* olivaceous, powdery to hairy. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Fertile hyphae* smooth-walled, hyaline to pale brown, irregularly septate. *Conidiophores* absent or present, semi-macronematous, pale olivaceous to brown, septate, oblong to cylindrical. *Conidial chains* forming laterally or terminally on undifferentiated hyphae, branched or unbranched, acropetal. *Conidia* sessile or ascending, subspherical, limoniform, fusiform, ellipsoidal to ovoidal, pale olivaceous green, aseptate, conidial scars slightly pigmented, smooth- and melanized-walled, with pale scars at the narrow ends. *Phialides* (asexual genus *Phialophora*) absent or present, flask-shaped, funnel-shaped, collarettes occasionally present. *Phialoconidia* absent or present, hyaline, subspherical, aseptate. *Chlamydospores, yeast cells* or *muriform cells* absent, or occasionally present,

thick-walled, brown (Borelli 1980, de Hoog et al. 1995, Badali et al. 2008).



Figure 20 – *Capronia sexdecimspora* (IMI 230725). a Envelop, slide and collection information of *Capronia sexdecimspora*. b Squash mount of ascomata. c Setae. d, e Asci with ascospores. f–h Ascospores. Scale bars: b = 50 μ m, c = 20 μ m, d, e = 10 μ m, f–h = 5 μ m.

Notes – *Cladophialophora* Borelli was introduced by Borelli (1980) to accommodate asexual, melanized taxa. Species of *Cladophialophora* have conidia which are produced in branched chains on poorly differentiated hyphae (Trejos 1954, de Hoog et al. 2007, Badali et al. 2008). The type species, *C. carrionii*, is the only species that has phialophora-like, phialidic conidiogenous cells in addition to conidial chains (Borelli 1980, de Hoog et al. 1995, Badali et al. 2008). *Cladophialophora* is polyphyletic in Chaetothyriales and closely related to asexually typified genera *Exophiala* J.W. Carmich., *Fonsecaea* Negroni, *Knufia* L.J. Hutchison & Unter., *Phialophora* Medlar, and *Rhinocladiella* Nannf.. Species of *Capronia* have been recorded as the sexual morphs of *Cladophialophora* (de Hoog et al. 2007, Badali et al. 2008, Feng et al. 2014). Phylogenetically, the majority of species of *Cladophialophora* separate into two main clades (carrionii- and bantiana-clades). *Cladophialophora* is ecological diverse. The genus includes species causing opportunistic diseases of humans and other mammals, such as *C. bantiana* (Sacc.) de Hoog et al., *C. carrionii* (Trejos) de Hoog et al., *C. devriesii* (A.A. Padhye & Ajello) de Hoog et al. and *C. samoënsis* Badali et al. (Mitchell et al. 1990, Mendoza et al. 1993, Tintelnot et al. 1995, McGinnis et al. 1999, Badali et al. 2008, 2009, Lastoria et al. 2009). *Cladophialophora cladoniae* (Diederich) Diederich, *C. hawksworthii* (Etayo & Diederich) Diederich, *C. megalosporae* Diederich, *C. normandinae* (Diederich & Etayo) Diederich and *C. parmeliae* (Etayo & Diederich) Diederich & Unter. are lichenicolous (Diederich 2010, Diederich et al. 2013). *Cladophialophora* species are also epiphytes, saprobes, pathogens, endophytes, soil and environmental inhabitants and may occupy different ecological niches (Iwatsu 1984, Crous et al. 2007, 2013, de Hoog et al. 2007, Badali et al. 2011, Park & Shin 2011, Feng et al. 2014, Rashmi et al. 2019).

Cladophialophora carrionii (Trejos) de Hoog, Kwon-Chung & McGinnis, Journal of Medical and Veterinary Mycology 33: 345 (1995) Fig. 21

≡ *Cladophialophora ajelloi* Borelli, Proc. 5th International Conference on Mycoses: 335 (1980)

For other synonyms see Index Fungorum

Index Fungorum number: IF412794

Description – see Trejos (1954), de Hoog et al. (2007) and Badali et al. (2008)

Type material – Australia, isolated from human chromoblastomycosis, 1951, Chester W. Emmons, Trejos 27 (CBS H-18465, lectotype), CBS 160.54 = ATCC 16264 = CDC A-835 = MUCL 40053, ex-type.

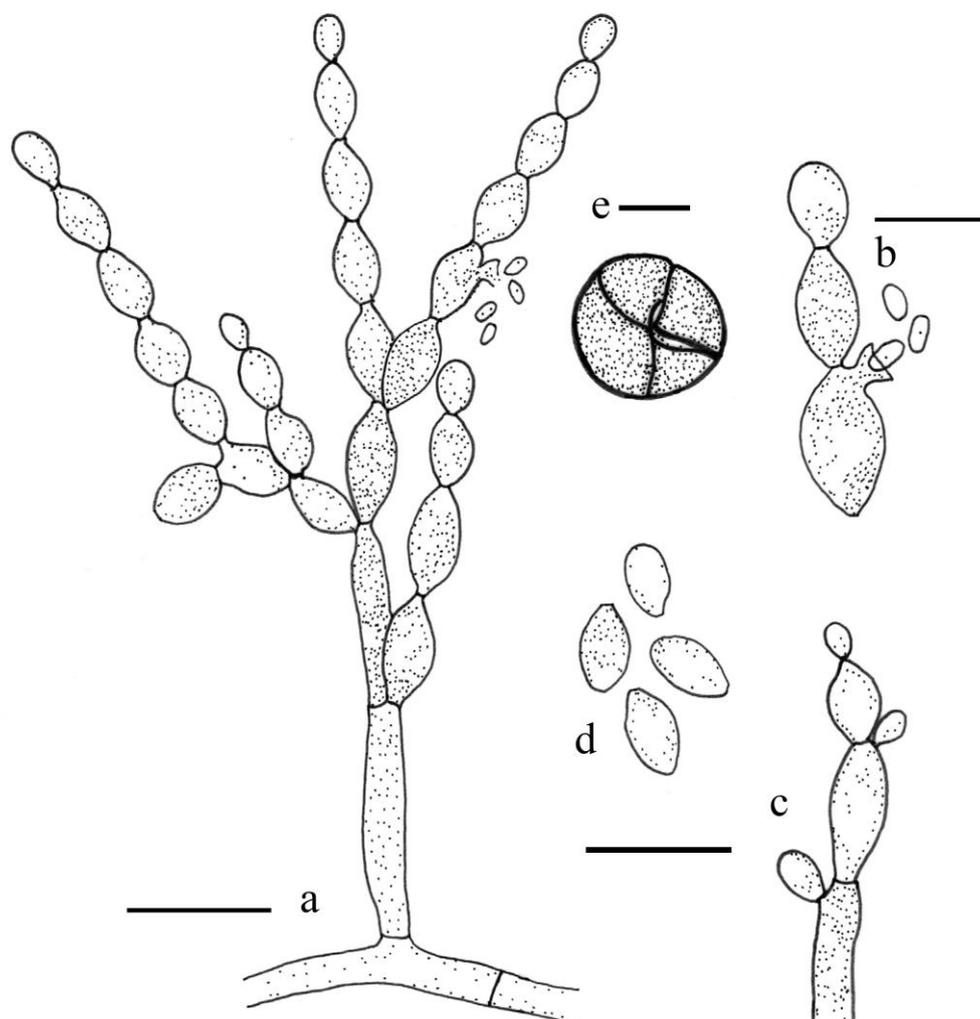


Figure 21 – *Cladophialophora carrionii* (CBS 160.54, ex-type, a–d redrawing from de Hoog et al. 2007, e redrawing from Badali et al. 2008). a, c Conidiophore and conidial chains. b Conidiophores with conidiogenous cells. d Conidia. e Muriform cells. Scale bar: a–e = 10 μ m.

Exophiala J.W. Carmich., *Sabouraudia* 5: 122 (1966)

Index Fungorum number: IF8233, Facesoffungi number: FoF 10374, 51 morphological species (Species Fungorum 2021), 17 species with molecular data.

Pathogenic, saprobic, endophytic and *fungicolous* on a variety of hosts. *Vegetative hyphae* branched, unswollen, forming protruding fascicles. *Hyphae* hyaline to pale brown, irregularly septate, smooth-walled, thin-walled, sometimes pigmented. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* absent or present, erect, multicellular, brown, septate, oblong to cylindrical. *Conidiogenous cells* sympodial, lateral, intercalary or terminal, mono- or polyphialidic, ovoid to clavate, subhyaline to pale brown, septate. *Conidia* ellipsoidal, cylindrical, allantoid, hyaline to brown, aseptate or 1-septate, with a conspicuous conidial scar, smooth-walled, with small oil drops. *Chlamydospores* absent (Carmichael 1966).

Type species – *Exophiala salmonis* J.W. Carmich., Sabouraudia 5: 122 (1966)

Fig. 22

For synonyms see Species Fungorum

Index Fungorum number: IF119468; Facesoffungi number: FoF 10375

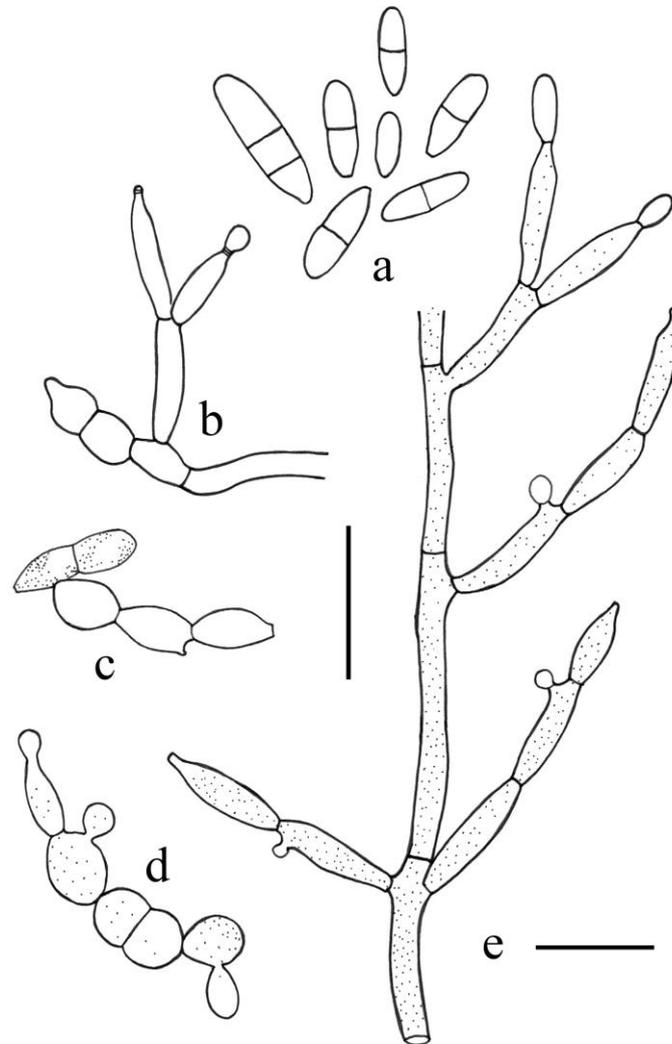


Figure 22 – *Exophiala salmonis* (redrawn from Seifert et al. 2011). a Conidia. b, d Conidiogenous cells. c Conidiogenous cells with conidia. e Conidiophore. Scale bar: a–e = 10 µm.

Notes – The black yeast genus *Exophiala* J.W. Carmich. was established by Carmichael (1966) to accommodate *Exophiala salmonis* J.W. Carmich. Species of *Exophiala* are characterized by brown, aseptate to 1-septate conidia, forming successively from the apex of the sporogenous cells and forming protruding fascicles, aggregating in slime balls (Carmichael 1966). Members of *Exophiala* have been linked to the sexual genus *Capronia* (Herpotrichiellaceae, Chaetothyriales) (Carmichael 1966, Hironaga et al. 1981, de Hoog et al. 2011).

Exophiala has remarkable ecological traits. Species of *Exophiala* appears to be an opportunistic pathogen of animals, including humans (Richards et al. 1978, de Hoog et al. 2011, Najafzadeh et al. 2013, Wen et al. 2016) and environmental taxa in anthropogenic habitats or natural environments (Ávila et al. 2005, Bukovská et al. 2010, de Hoog et al. 2011, Ferrari et al. 2011, Isola et al. 2013), endophytes from roots (Ali et al. 2016, Maciá-Vicente et al. 2016) and saprobes or fungicolous taxa, occurring on a wide range of substrates (Madrid et al. 2016).

Exophiala species are difficult to identify by morphology because of the polymorphic morphology, therefore, phylogenetic affinities and ecological traits are necessary for species identification (de Hoog et al. 2011, Isola et al. 2013, Maciá-Vicente et al. 2016).

Type material – Canada, Alberta, isolated from the brain of *Salmo clarkii* Richardson (Salmonidae), 1966, J.W. Carmich. (CBS 157.67, ex-type).

Fonsecaea Negroni, Revista Inst. Bacteriol. ‘Dr. Carlos G. Malbrán’ 7: 424 (1936)

Index Fungorum number: IF8264, Facesoffungi number: FoF 10376, 8 morphological species (Species Fungorum 2021), 8 species with molecular data.

Type species – ***Fonsecaea pedrosoi*** (Brumpt) Negroni, Revista Inst. Bacteriol. ‘Dr. Carlos G. Malbrán’: 424 (1936)

≡ *Hormodendrum pedrosoi* Brumpt, Précis Parasitol. hum., Edn 3 (Paris): 1105 (1922)

For synonyms see Species Fungorum

Pathogenic on a variety of plants, and organs of animals, including humans. *Colonies* restricted or moderately expanding, powdery to velvety, olivaceous brown to olivaceous black. *Vegetative hyphae* branched, pale olivaceous brown, septate, smooth-walled. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* absent or present, branched or unbranched, erect, slightly differentiated, oblong to cylindrical, olivaceous brown. *Conidiogenous cells* sympodial, lateral, intercalary or terminal, enteroblastic, phialidic, pale olivaceous, septate, with prominent denticles. *Conidia* ellipsoidal, cylindrical, in short chains, pale olivaceous brown, aseptate, with a conspicuous conidial brown scar, smooth-walled. *Chlamydospores* absent or present, globose (de Hoog et al. 2000a, Najafzadeh et al. 2010a, b).

Fonsecaea pedrosoi (Brumpt) Negroni, Revista Inst. Bacteriol. ‘Dr. Carlos G. Malbrán’: 424 (1936) Fig. 23

Index Fungorum number: IF253857; Facesoffungi number: FoF 10377

Type material – Isolated from a human, 1922 (holotype).

Notes – *Fonsecaea* species are important clinical taxa that cause human chromoblastomycosis and phaeohyphomycosis in tropical and subtropical climates (de Hoog et al. 2007, Najafzadeh et al. 2009, 2010a, b, 2011, Xi et al. 2009, Koo et al. 2010). *Fonsecaea* lacks budding cells, sympodial conidiogenous cells and has conidia arranged in short chains, melanized conidiophores with cylindrical denticles and aseptate conidia (de Hoog et al. 2000a, Najafzadeh et al. 2010a, b). *Fonsecaea* resembles *Cladophialophora* and also always clusters together in phylogenetic trees, but *Cladophialophora* differs in having very long conidial chains. *Fonsecaea* species lack a known sexual morph. Currently, *Fonsecaea* comprises eight species, most being potential etiologic agents of human chromoblastomycosis and phaeohyphomycosis (Surash et al. 2005, Takei et al. 2007, Vicente et al. 2008, 2014, Najafzadeh et al. 2009, 2010b, Koo et al. 2010).

Marinophialophora J.F. Li, Phookamsak & K.D. Hyde, Phytotaxa 345(1): 4 (2018)

Index Fungorum number: IF552733, Facesoffungi number: FoF 02753, 1 morphological species (Species Fungorum 2021), 1 species with molecular data.

Saprobic on a decaying mangrove wood associated with *Halocyphina* sp. *Hyphae* immersed to superficial, branched, hyaline to subhyaline, septate, smooth-walled, thin-walled. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* single or caespitose, macronematous, mononematous, unbranched, erect, oblong to cylindrical, hyaline to subhyaline, aseptate, arising from hyphae. *Conidiogenous cells* integrated, terminal or intercalary, enteroblastic, phialidic, globose to ellipsoidal, hyaline to subhyaline, without a conspicuous collarette. *Conidia* globose to subglobose, hyaline to subhyaline, aseptate, borne basipetally, developing in unbranched or branched chains, smooth-walled. *Chlamydospores* absent (Li et al. 2018).

Type species – ***Marinophialophora garethjonesii*** J.F. Li, Phookamsak, Dayar. & K.D. Hyde, Phytotaxa 345(1): 4 (2018)

Index Fungorum number: IF552734

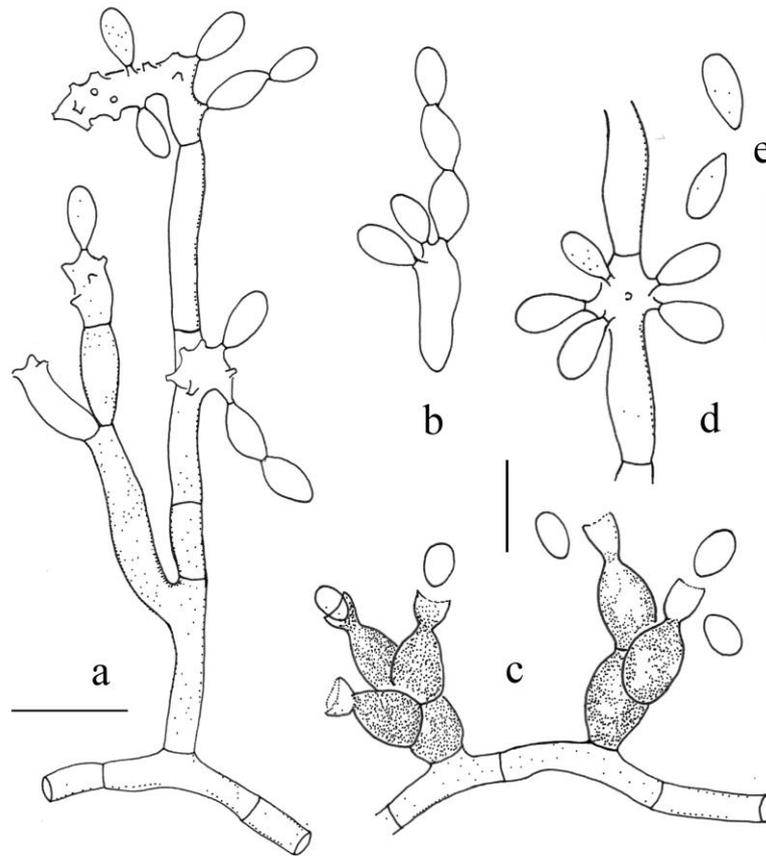


Figure 23 – *Fonsecaea pedrosoi* (redrawn from Seifert et al. 2011). a Conidiophore. b, d Conidiogenous cells with conidia. c Phialides. e Conidia. Scale bar: a–e = 10 μ m.

Notes – *Marinophialophora* J.F. Li et al. was introduced by Li et al. (2018) to accommodate *M. Garethjonesii* J.F. Li et al. based on morphology and phylogenetic analysis. It was associated with *Halocyphina* from marine habitats in Thailand. This genus is characterized by mononematous, macronematous conidiophores, hyaline, phialidic conidiogenous cells without conspicuous collarettes and subhyaline, aseptate conidia. *Marinophialophora* is a monotypic genus and resembles *Cladophialophora* and *Phialophora* (Herpotrichiellaceae, Chaetothyriales) in having similar conidiophores, phialidic conidiogenous cells and conidia in chains. *Marinophialophora* mainly differs in having conidia borne in basipetally, branched chains and septate conidiophores. *Marinophialophora Garethjonesii* (MFLUCC 16-1449) clusters with *Atrokyliandriopsis setulosa* (HMAS245592) in Herpotrichiellaceae (Chaetothyriales) with high statistical support (1.00 BYPP) (Fig. 1).

Melanoctona Qing Tian, Doilom & K.D. Hyde, Cryptog. Mycol. 37(4): 487 (2016)

Index Fungorum number: IF552157, Facesoffungi number: FoF 02225, 1 morphological species (Species Fungorum 2021), 1 species with molecular data.

Saprobic on decaying wood in terrestrial habitats. *Colonies* superficial, effuse, scattered, dark brown to black. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* mononematous, macronematous, unbranched, erect, straight or flexuous, smooth, dark brown. *Conidiogenous cells* integrated, sympodially proliferating, terminal and intercalary, enteroblastic, phialidic, pale brown or subhyaline. *Conidia* acrogenous, brown to black, ovoid, muriform, rounded at base and apex, smooth-walled.

Type species – *Melanoctona tectonae* Qing Tian, Doilom & K.D. Hyde

Notes – *Melanoctona* was introduced to accommodate an asexual species in Herpotrichiellaceae and is typified by *M. tectonae* which forms a distinct clade (Tian et al. 2016). To date, the asexual morphs of Herpotrichiellaceae are predominantly black yeasts with holoblastic, conidiogenous cells which proliferate percurrently and aseptate or septate conidia, and include *Cladophialophora*, *Exophiala*, *Fonsecaea*, *Phialophora*, *Ramichloridium* and *Rhinoctadiella* species (Müller et al. 1987, Untereiner et al. 1995, Crous et al. 2007, Gueidan et al. 2014, Liu et al. 2015), and undetermined pyricularia-like taxa (Klaubauf et al. 2014). Species of *Exophiala* are characterized by brown, aseptate to 1-septate conidia, forming successively from the apex of the sporogenous cell and aggregating in slime balls (Carmichael 1966). *Phialophora* produces hyaline to pigmented, aseptate conidia, forming from flask-shaped to straight phialides (Harrington & Mcnew 2003). *Cladophialophora* has aseptate, hydrophobic conidia and is mostly isolated as clinical fungi (Badali et al. 2011). *Fonsecaea* has melanized conidiophores with cylindrical denticles and aseptate, acrogenous conidia (de Hoog et al. 2000a). *Melanoctona* however, has dark brown to black, muriform or multi-septate, acrogenous, conidia. *Melanoctona tectonae* was isolated from a dead branch of *Tectona grandis* as a saprobe, while other asexual morphs in Herpotrichiellaceae have been isolated as human pathogens (such as human chromoblastomycosis) (de Hoog et al. 2007). *Melanoctona* was collected on decaying wood of *Tectona grandis* in Chiang Rai Province, Thailand and phylogenetic analyses of combined ITS, LSU sequence data place *Melanoctona* in a distinct lineage in Herpotrichiellaceae (Fig. 1).

Melanoctona tectonae Qing Tian, Doilom & K.D. Hyde, Cryptog. Mycol. 37(4): 487 (2016)

Fig. 24

Index Fungorum number: IF552158; Facesoffungi number: FoF 02226

Saprobic on decaying wood of *Tectona grandis* L.f. in terrestrial habitat. *Colonies* superficial, effuse, scattered, dark brown to black. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* 3–6 μm (\bar{x} = 5.2 μm , n = 7) wide, mononematous, macronematous, unbranched, erect, straight or flexuous, smooth, dark brown. *Conidiogenous cells* integrated, sympodially proliferating, terminal and intercalary, enteroblastic, phialidic, pale brown or subhyaline. *Conidia* 28–39 \times 43–49 μm (\bar{x} = 34.5 \times 47.3 μm , n = 10), acrogenous, light brown to black, ovoid, muriform, rounded at base and apex, smooth-walled.

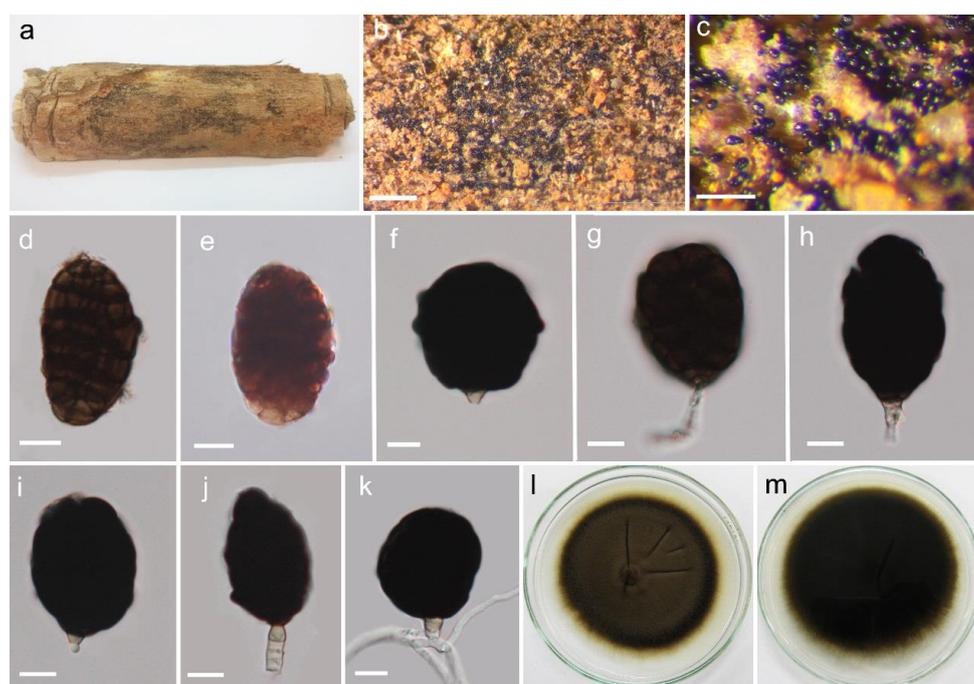


Figure 24 – *Melanoctona tectonae* (MFLU 15-3528, holotype). a Appearance of fungus on a dead branch of *Tectona grandis*. b, c Conidia scattered on the surface of the wood. d, e Conidia.

f–j Conidiophores with conidia. k Germinating conidium. l Surface view of culture on PDA. m Reverse view of culture on PDA. Scale bars: b = 1000 µm, c = 200 µm, d–k = 10 µm.

Culture characteristics – Conidia germinating on PDA within 12 h and germ tubes produced from both ends. Colonies on PDA, fast-growing, reaching up to 15 mm diam. in 14 days at 25°C. Mycelium superficial, circular, hairy, with an entire edge, brown, dark brown at the periphery, completely dark brown from below.

Material examined – Thailand, Chiang Rai Province, Mae Chan District, on a dead branch of *Tectona grandis* L.f. (Lamiaceae), 1 July 2012, M. Doilom MKT062 (MFLU 15-3528, holotype), *ibid.*, (HKAS 94893, isotype), ex-type living culture, MFLUCC 12-0389, KUMCC 16-0009.

Metulocladosporiella Crous, Schroers, J.Z. Groenew., U. Braun & K. Schub., Mycol. Res. 110(3): 269 (2006)

Index Fungorum number: IF500224, Facesoffungi number: FoF 10378, 6 morphological species (Species Fungorum 2021), 6 species with molecular data.

Epiphytic on living leaves. *Hyphae* immersed to superficial, branched, septate, hyaline, subhyaline to pale olivaceous, thin-walled. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* macronematous, mononematous, solitary or aggregated, erect, subcylindrical, arising from hyphae, smooth-walled. *Conidiogenous cells* integrated, terminal, occasionally intercalary, sympodial, polyblastic, with or without conidial scars, subdenticulate, truncate. *Conidia* in simple and branched chains, ellipsoid, ovoid, subcylindrical, fusiform, subhyaline to pale olivaceous, 0–1-septate, thin-walled, smooth-walled, conidial secession schizolytic. *Chlamydospores* absent (Crous et al. 2006).

Type species – ***Metulocladosporiella musae*** (E.W. Mason) Crous, Schroers, J.Z. Groenew., U. Braun & K. Schub., Mycol. Res. 110(3): 269 (2006) Fig. 25

≡ *Cladosporium musae* E.W. Mason, in Martyn, Mycol. Pap. 13: 2 (1945)

For synonyms see Species Fungorum

Index Fungorum number: IF500185

Type material – Jamaica, on *Musa* sp., 7 September 1942, E. B. Martyn [slide ex type coll.] (IMI 7521) – lectotypus hic designates; Honduras, on *Musa* sp., R.H. Stover (CBS herb. 14788-epitypus hic designatus; culture ex-epitype CBS 161.74 ¼ ATCC 36973).

Notes – *Metulocladosporiella* Crous et al. was established by Crous et al. (2006) to accommodate *Cladosporium musae* E.W. Mason which is the causal agent of speckle disease on the banana in Herpotrichiellaceae. The genus is characterized by frequently branched, pigmented conidiophores, holoblastic, subconspicuous to conspicuous conidiogenous loci and subhyaline conidia formed in acropetal, often branched chains (Crous et al. 2006). The phylogenetic analysis based on the ITS and LSU sequence data demonstrates that *Metulocladosporiella musae* (E.W. Mason) Crous et al. (CBS 161.74) formed a sister group with *Arthrophia arthrospora* (D.J. Soares, R.W. Barreto & U. Braun) W.S. Lisboa et al. (CPC 19480) with 99% ML BS, 1.00 BYPP support representing as a distinct clade in Chaetothyriales (Fig. 1). In morphology, *Metulocladosporiella* resembles *Cladophialophora* in Herpotrichiellaceae. However, *Cladophialophora* has unbranched, micro- to semimacronematous conidiophores while *Metulocladosporiella* has branched, macronematous, mononematous conidiophores (Crous et al. 2006). Thus, we maintain *Metulocladosporiella* in Herpotrichiellaceae pending further studies.

Minimelanolocus R.F. Castañeda & Heredia, Cryptog. Mycol. 22(1): 7 (2001)

Index Fungorum number: IF28574; Facesoffungi number: FoF 10379, 34 morphological species (Species Fungorum 2021), 10 species with molecular data.

Saprobic on decaying wood in aquatic habitats. *Mycelium* superficial or partly immersed, comprising septate, pale brown to brown hyphae, smooth-walled hyphae. *Colonies* superficial on the host, effuse, scattered, hairy, brightly colored, glistening. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* mononematous, macronematous, unbranched,

erect, dark brown and gradually paler towards the apex, straight or flexuous, cylindrical, smooth, septate. *Conidiogenous cells* holoblastic, integrated, sympodial proliferating, terminal, pale brown to brown or subhyaline to hyaline. *Conidia* acrogenous, oblong or clavate to fusiform, with or without obtuse ends, hyaline to pale brown or brown, solitary, sometimes with secondary conidia, immature conidia aseptate, multi-septate at maturity, dry, smooth-walled. Conidial secession schizolytic.

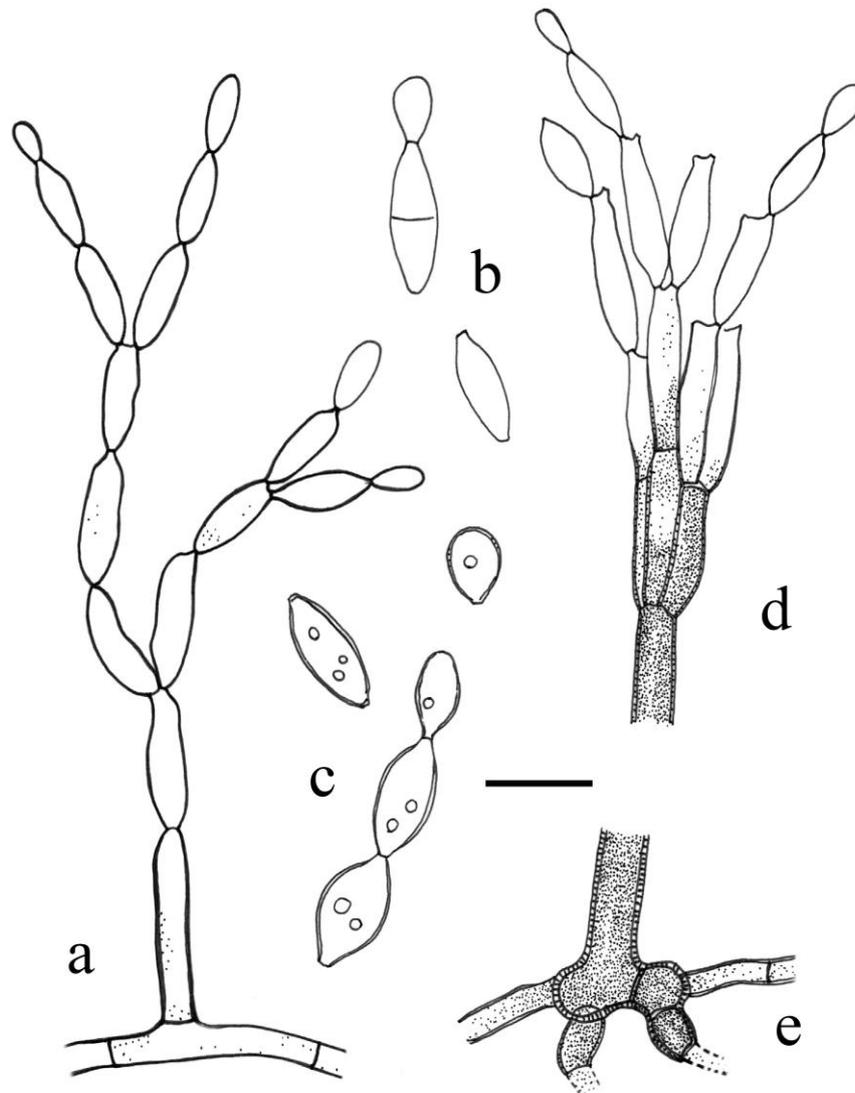


Figure 25 – *Metulocladosporiella musae* (CBS 161.74, ex-epitype, redrawn from Crous et al. 2006). a Conidiophore. b, d Conidiogenous cells with conidia. c Conidia. e Base of conidiophore on hypha. Scale bar: a–e = 10 μ m.

Type species – *Minimelanolocus navicularis* (R.F. Castañeda) R.F. Castañeda, in Castañeda Ruiz, Heredia, Reyes, Arias & Decock, Cryptog. Mycol. 22(1): 9 (2001) Fig. 26
 \equiv *Pseudospiropes navicularis* R.F. Castañeda, Fungi Cubenses II (La Habana): 10 (1987)
 Index Fungorum number: IF474516

Type material – Cuba, Havana, Instituto de Investigaciones Fundamentales en Agricultura Tropical “Alejandro de Humboldt”, on fallen leaves of *Gesneria* sp. (Gesneriaceae), 1987 (Holotype).

Notes – *Minimelanolocus* was introduced by Castañeda-Ruiz et al. (2001) and typified by *M. navicularis* based on segregation of some atypical species from *Pseudospiropes*. The genus is characterized by conspicuous, mononematous, solitary or fasciculate, septate, erect, straight or flexuous, smooth or verrucose, cylindrical, sinuate or geniculate, brown to dark brown conidiophores, with a melanized base and hyaline to brown, oblong, cylindrical, clavate to fusiform, euseptate, acropleurogenous conidia (Castañeda-Ruiz et al. 2001, Hernández-Restrepo et al. 2013, Xia et al. 2014). *Pseudospiropes* species have comparatively smaller, ellipsoidal and distoseptate conidia (Castañeda-Ruiz et al. 2001, Ma et al. 2011a). *Minimelanolocus* is a well-studied genus, which has been described from a wide range of hosts (Zhang et al. 2009, 2010, Ma et al. 2011a, b, Hernández-Restrepo et al. 2013, Xia et al. 2014). Presently, 34 species epithets are listed under *Minimelanolocus* (Index Fungorum 2021). The members of *Minimelanolocus* have a worldwide distribution, and most are saprobes on rotten leaves or dead twigs, wood and bark in aquatic habitats. In this study, *Minimelanolocus rousselianus* (Mont.) R.F. Castañeda & Heredia (CBS 126086) aligned with *Thysanorea papuana* (Aptroot) Arzanlou et al. (CBS 212.96) with 98% ML BS, 1.00 BY PP support in Herpotrichiellaceae (Fig. 1) based on combined LSU and ITS analysis.

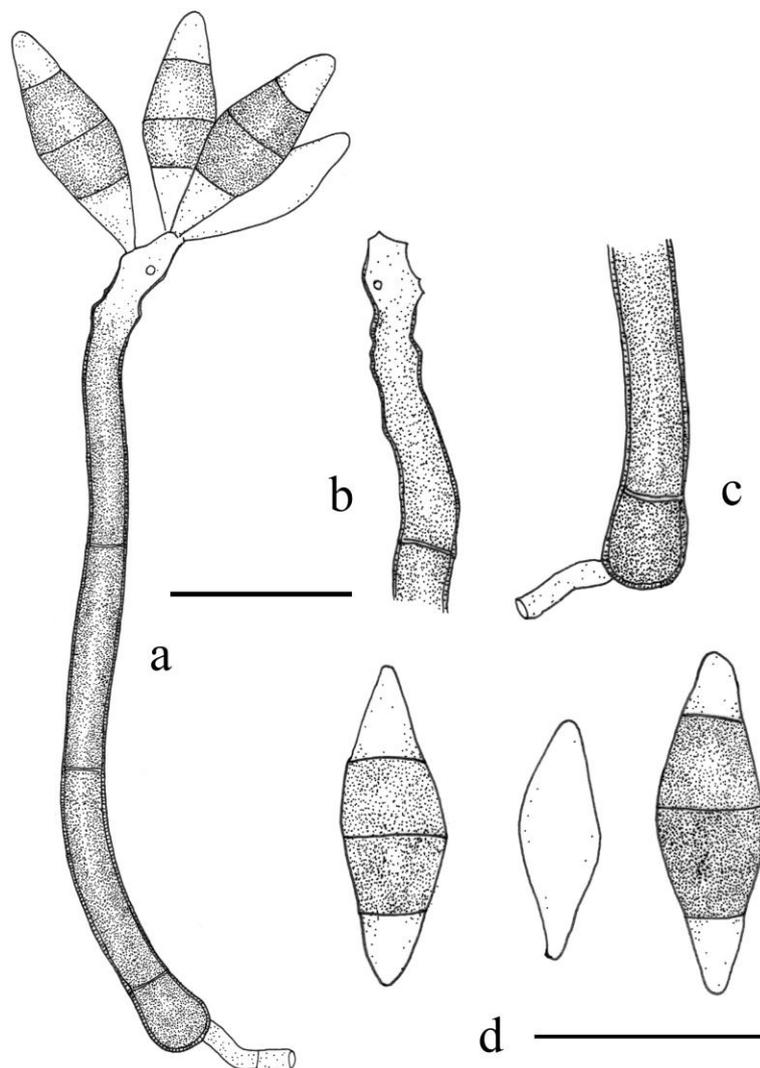


Figure 26 – *Minimelanolocus navicularis* (a–c redrawn from Crous et al. 2006; d redrawn from Castañeda-Ruiz et al. 2001). a Conidiophore. b Conidiogenous cells. c Base of conidiophore. d Conidia. Scale bar: a–d = 10 μ m.

Phialophora Medlar, Mycologia 7(4): 202 (1915)

Index Fungorum number: IF9342, Facesoffungi number: FoF 10380, 41 morphological species (Species Fungorum 2021), 20 species with molecular data.

Saprobic on decaying wood or *pathogenic* or animals, including humans. *Mycelium* superficial or partly immersed, comprising cylindrical, brown, septate hyphae in rope-like strands, tending to become moniliform, smooth-walled. Sexual morph: Capronia-like. *Ascomata* perithecioid, arising singly, dispersed, superficial, immersed only at the base when mature, subglobose, black, smooth-walled but with aseptate or 1-multi-septate unbranched, dark brown setae, arising from the upper part, ostiolate. *Setae* smooth-walled, rounded at the apex and hardly attenuated or tapering to the ends. *Ostioles* lateral, black, flattened. *Peridium* thick, composed of multi-layered, hyaline to brown cells of *textura angularis*. *Hamathecium* gelatinized, lacking pseudoparaphyses. *Asci* 8-spored or multi-spored, bitunicate, obpyriform to broadly clavate, wall apically thickened, J–. *Ascospores* overlapping, irregularly biseriate, oval to fusiform, muriform, hyaline to yellow-brown or grey, 1–7-trans-septate, constricted at the septa, with or without longitudinal septa, some slightly curved, smooth-walled, with or without guttules, without a gelatinous sheath or appendages. Asexual morph: hyphomycetous. *Conidiophores* mononematous, macronematous, unbranched, erect, hyaline to brown, straight or flexuous, cylindrical, smooth. *Conidiogenous cells* enteroblastic, phialidic, terminally or laterally, branched, cylindrical- elongate or occasionally flask-shaped, hyaline to brown, in a globose, gelatinous mass. *Collarettes* conspicuous, narrowly cylindrical to funnel-shaped or slightly flaring. *Conidia* acrogenous, obovoidal, clavate, ellipsoidal or fusiform, and adhere in chains, hyaline to sunhyaline, aseptate or 1-septate, sticky, smooth-walled. Conidial secession schizolytic (Medlar 1915, Schol-Schwarz 1970).

Type species – ***Phialophora verrucosa*** Medlar, Mycologia 7(4): 203 (1915) Figs 27, 28

For synonyms see Species Fungorum

Index Fungorum number: IF214996

Type material – not indicated, from a skin lesion of *Homo sapiens*.

Notes – The black yeast genus *Phialophora* was introduced with *P. verrucosa* as the type species (Medlar 1915) which is a human skin pathogen causing chromoblastomycosis. The genus is characterized by a melanized thallus and subhyaline, obovoidal, clavate, ellipsoidal or fusiform one-celled, sticky conidia, that adhere in chains or slimy heads, that are produced through subhyaline to lightly pigmented, cylindrical- elongate or occasionally flask-shaped phialides with narrowly cylindrical to funnel-shaped or slightly flaring collarettes in a poorly differentiated conidial apparatus (Medlar 1915, Schol-Schwarz 1970). These species occur commonly as saprobes or plant pathogens on decaying wood (Untereiner & Naveau 1999, Untereiner et al. 2008, Zhuang et al. 2010, Crous et al. 2012), and have been isolated from soil, water and food (apples, butter, margarine) (Gezuele et al. 1972, Untereiner & Naveau 1999, Untereiner et al. 2008). *Phialophora* species also cause chromoblastomycosis, disseminated phaeohyphomycosis and mycetoma or other skin infections of humans (de Hoog et al. 2000a, b, Caretta et al. 2006, Untereiner et al. 2008, Al-Tawfiq & Amr 2009, Feng et al. 2012, Morio et al. 2012, Li et al. 2017). Species of the sexual genus *Capronia* Sacc. are linked to *Phialophora* and several hyphomycetous asexual morphs and yeast-like synanamorphs in culture (Untereiner & Naveau 1999, Untereiner et al. 2008, de Hoog et al. 2011, Réblová et al. 2013).

Pleomelogramma Speg., Anal. Mus. nac. B. Aires, Ser. 3 12: 389 (1909)

Index Fungorum number: IF4216, Facesoffungi number: FoF 10381, 2 morphological species (Species Fungorum 2021), molecular data unavailable.

Saprobic on decaying woody plants. Sexual morph: *Ascostromata* perithecioid, aggregated, dense, superficial, globose, black, smooth-walled, ostiolate. *Ostiole* central, black, flattened. *Peridium* multi-layered. *Hamathecium* lacking paraphyses. *Asci* 8-spored, bitunicate, broadly obclavate. *Ascospores* biseriate, fusiform, muriform, hyaline, 5–trans-septate, constricted at the septa, with or without longitudinal septa, slightly curved, smooth-walled, with or without guttules, without a gelatinous sheath or appendages. Asexual morph: Undetermined.

Type species – *Pleomelogramma argentinensis* Speg., Anal. Mus. nac. B. Aires, Ser. 3 12: 389 (1909)

Index Fungorum number: IF536551

Notes – *Pleomelogramma* was established by Spegazzini (1909) to accommodate *P. argentinensis* which was associated with decorticated branches of *Eriobotrya japonica*. The genus is characterized by perithecioid, aggregated, dense ascostromata and fusiform, muriform ascospores. Petch (1924) introduced the second species *P. rugosa* from dead branches in Sri Lanka. Currently, two species are accepted in *Pleomelogramma* but neither sexual morph nor molecular sequences are available. Hence, fresh collections are needed for epitypification and the sequence data are needed to confirm the identification of *Pleomelogramma* in Herpotrichiellaceae.

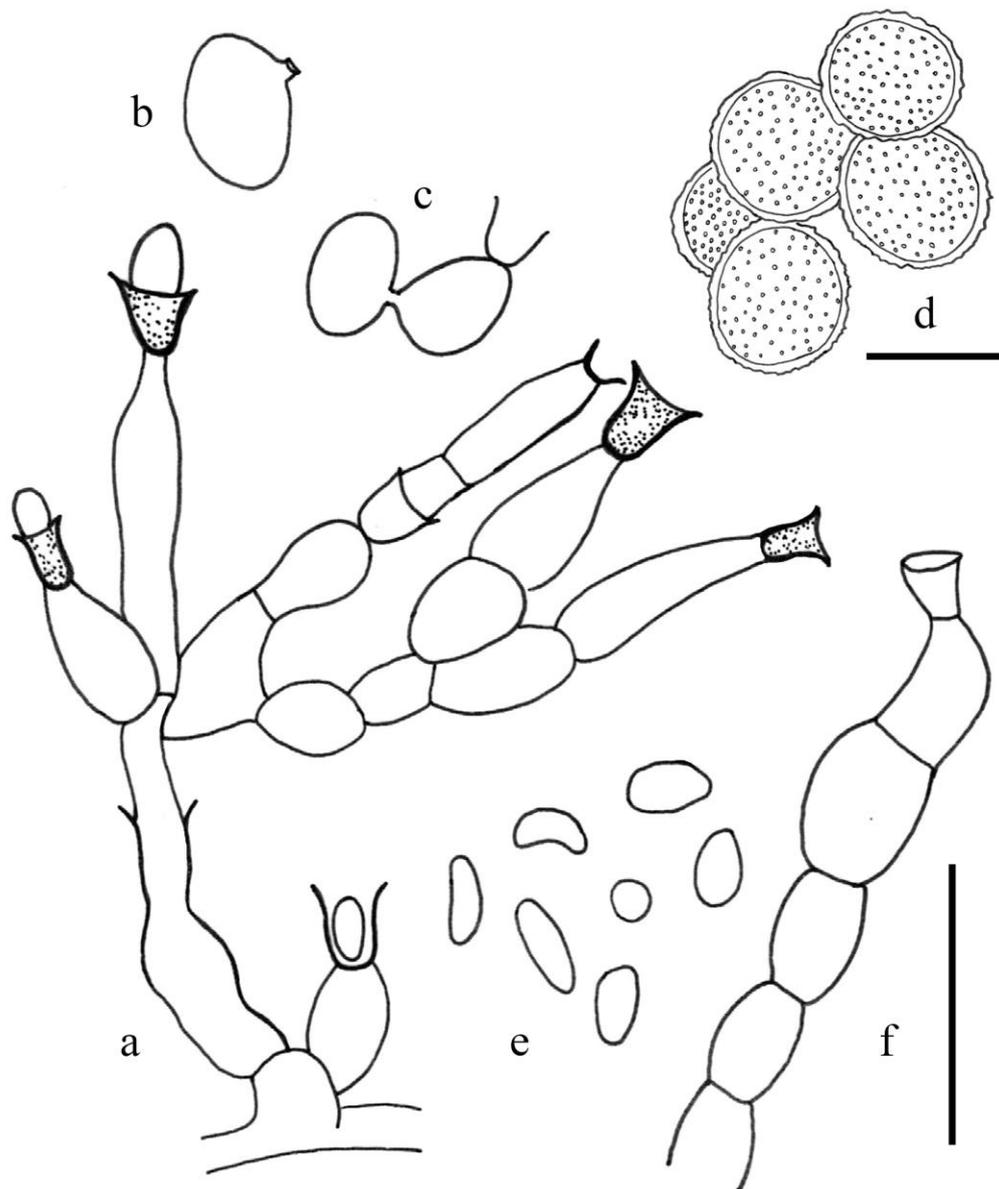


Figure 27 – *Phialophora verrucosa* (a, b CBS 281.35, c, e dried culture of Conant 204 (FH), d, f type material (FH), redrawn from Schol-Schwarz 1970). a Proliferating conidiophore with conidia. b Chlamydospore with muzzle-like protuberance. c Anastomosis of chlamydospores. d Chlamydospores. e Conidia. f Moniliform hypha with terminal phialide. Scale bars: a–c, e, f = 10 μm , d = 5 μm .

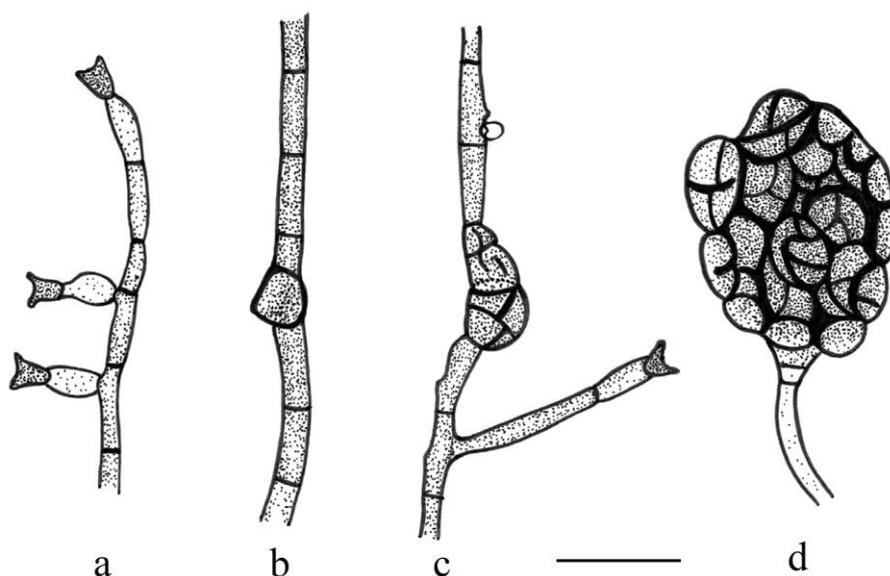


Figure 28 – *Phialophora verrucosa* (redrawn from Ajello & Runyon 1953). a Conidiophore. b Intercalary development of “perithecial initial”. c Early stage of cellular multiplication. d Multi-celled terminal “perithecial” initial. Scale bars: a–d = 10 μ m.

Rhinocladiella Nannf., Svensk Skogsvårdsförening Tidskr. 3-4: 461 (1934)

Index Fungorum number: IF9720, Facesoffungi number: FoF 10382, 17 morphological species (Species Fungorum 2021), 10 species with molecular data.

Saprobic, pathogenic on a variety of plants, organs of humans. *Vegetative hyphae* branched, pale olivaceous brown, septate, smooth-walled. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* absent or present, usually poorly differentiated from the vegetative hyphae, semimacronematous to macronematous, solitary, erect, branched or unbranched, subcylindrical, hyaline to brown, septate. *Conidiogenous cells* sympodial, with prominent denticles, terminal, cylindrical, pale olivaceous brown, septate. *Conidia* obovoid, ellipsoidal, subcylindrical to narrowly clavate, pale olivaceous to brown, aseptate, with an obtuse apex and a truncate base, with an inconspicuous conidial scar, smooth-walled. *Chlamydospores* absent or present. *Yeast-like budding cells* integrated, terminal, subcylindrical, pale brown, usually present in culture (de Hoog & Hermanides-Nijhof 1977).

Type species – ***Rhinocladiella atrovirens*** Nannf., Svensk Skogsvårdsförening Tidskr. 3-4: 461 (1934) Fig. 29

Index Fungorum number: IF257799

Type material – Sweden, on the wood of *Pinus* sp. (Pinaceae) (Holotype).

Notes – The black yeast-like genus was introduced by Melin & Nannfeldt (1934) with *Rhinocladiella atrovirens* Nannf. as the type species. This genus is characterized by differentiated, sympodial conidiophores with a denticulate rachis and elongate, aseptate conidia, sometimes with exophiala-like yeasts (de Hoog & Hermanides-Nijhof 1977). Species of *Rhinocladiella* are polyphyletic, and clustered with *Exophiala sensu stricto* and *Capronia sensu stricto* (Arzanlou et al. 2008, Pratibha & Prabhugaonkar 2015). Moreover, *Rhinocladiella* closely resembles other members of the melanized asexual morphs of Chaetothyriales that have sympodial conidiogenesis, especially the most common etiological agents of chromoblastomycosis, such as the species in *Fonsecaea*, *Cladophialophora* and *Phialophora* (Badali et al. 2010, González et al. 2013, Gomes et al. 2016).

Rhinocladiella has a rich range of ecological niches. Besides causing chromoblastomycosis, species of *Rhinocladiella* cause skin or organ infection, viz., *R. aquaspersa*, *R. basitona* (Badali et al. 2010, Cao et al. 2013). Members of *Rhinocladiella* also occur as saprobes on stems and twigs of a variety of plants, such as *R. amoena*, *R. coryli* and *R. quercus* (Hernandez-Restrepo et al. 2016, Madrid et al. 2016). Currently, members of *Rhinocladiella*, *Exophiala*, *Cladophialophora* and *Phialophora* have been reported as asexual morphs of *Capronia* (Untereiner & Naveau 1999, Hernandez-Restrepo et al. 2016).

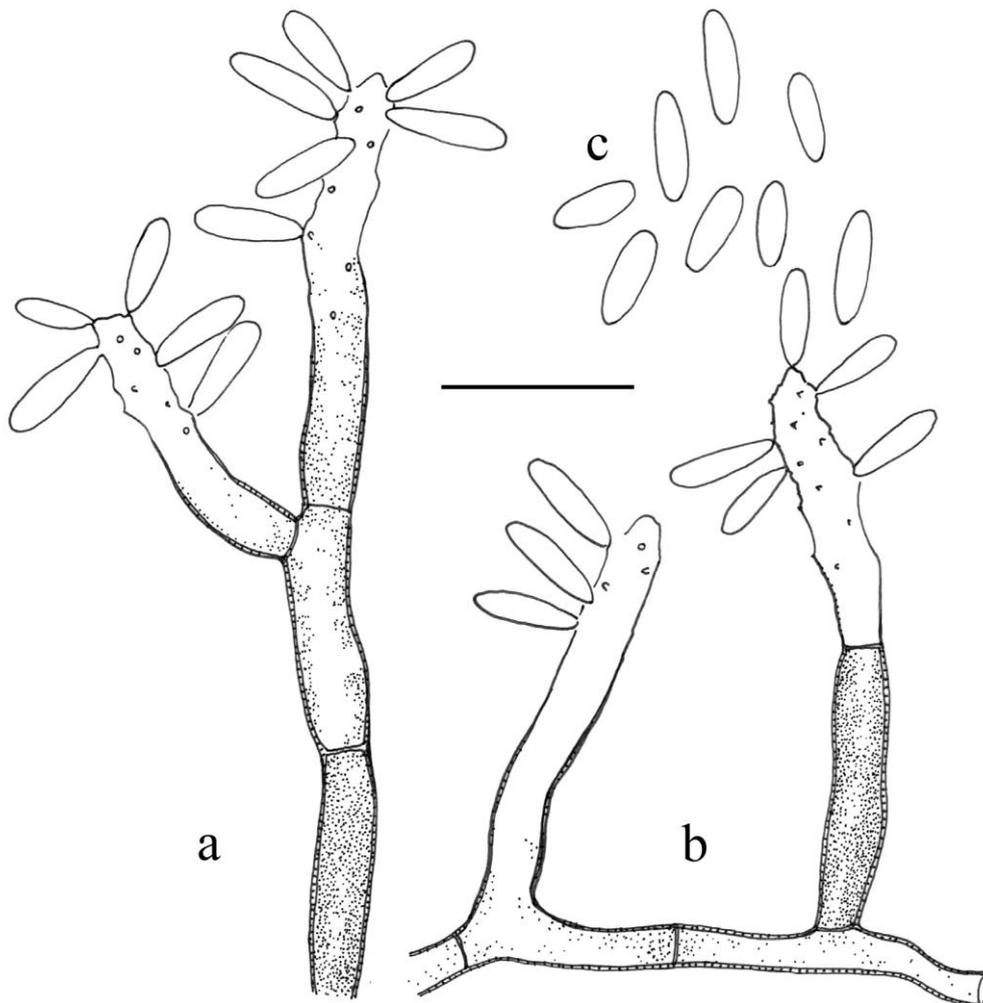


Figure 29 – *Rhinocladiella atrovirens* (redrawn from Seifert et al. 2011). a, b Conidiophores and conidiogenous cells with conidia. c Conidia. Scale bars: a–c = 10 μ m.

Sorocybe Fr., Summa veg. Scand., Sectio Post. (Stockholm): 468 (1849)

Index Fungorum number: IF9958, Facesoffungi number: FoF 10383, 3 morphological species (Species Fungorum 2021), 2 species with molecular data.

Saprobic on the resin of plant hosts. *Hyphae of stipe* infrequently branched, brown to dark brown, septate. Sexual morph: Undetermined. Asexual morph: *Synnemata* scattered or gregarious, dark brown to black, often splayed at the base but with a compact cylindrical stipe, and a compact, dry, ellipsoidal conidial head. *Conidiophores* mononematous or synnematus and arising from dark brown subiculum. *Conidiogenous cells* terminal or in pairs at the ends of the stipe hyphae, cylindrical with a truncate base. *Conidia* in sparingly branched acropetal chains, oblong-ellipsoidal, fusiform, brown, aseptate, rarely septate, secession scars available, smooth-walled, sometimes

adjacent conidia anastomosing, *ramoconidia* infrequent, usually with just two emerging chains, conidial chains appressed and more or less parallel (Crous et al. 2019a).

Type species – *Sorocybe resiniae* (Fr.) Fr., Summa veg. Scand., Sectio Post. (Stockholm): 468 (1849) Fig. 30

Index Fungorum number: IF119429

Type material – Not indicated. In resin of *Pinus* sp. (Pinaceae).

Notes – *Sorocybe* Fr. was introduced by Fries (1849) and it is characterized by conspicuous synnemata, a less conspicuous mononematous morph, fusiform, brown, aseptate conidia and ramoconidia with two emerging chains (Fries 1849, Crous et al. 2019a). All collections of *S. resiniae* are restricted to conifer resin. Pratibha et al. (2005) introduced *S. indica* Gawas et al. with white, terminally olivaceous to median brown synnemata and hyaline [what], but the fusiform, slimy conidia do not fit the genus description as now circumscribed. Seifert et al. (2007) showed the type species of *Sorocybe*, *S. resiniae* was related to *Capronia* and allied asexual genera based on LSU analysis, thus, *S. resiniae* was suggested to be placed in Herpotrichiellaceae. However, Crous et al. (2019a) and our study indicate that the reference sequences of *S. resiniae* and *S. oblongispora* are aligned with Verrucariaceae, Verrucariales based on combined ITS and LSU sequences analysis. Therefore, we maintain *Sorocybe* in Herpotrichiellaceae pending further investigation.

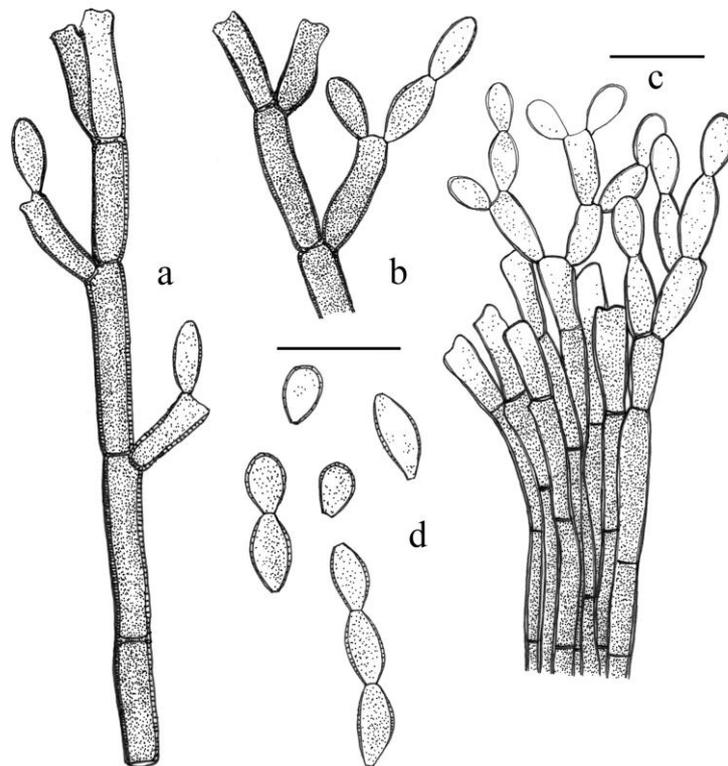


Figure 30 – *Sorocybe resiniae* (redrawn from Seifert et al. 2011). a–c Conidiophores and conidiogenous cells with conidia. d Acropetally developing chains of conidia. Scale bars: a–d = 10 μm .

Thysanorea Arzanlou, W. Gams & Crous, Stud. Mycol. 58: 80 (2007)

Index Fungorum number: IF504555, Facesoffungi number: FoF 10384, 14 morphological species (Species Fungorum 2021), 7 species with molecular data.

Saprobic on submerged wood or dead woody plant. *Mycelium* immersed, comprising septate, pale brown, smooth-walled hyphae. Sexual morph: Undetermined. Sexual morph: hyphomycetous.

Conidiophores micronematous, macronematous, erect, simple or apically branched, sometimes proliferating percurrently in the apex, cylindrical, dark brown, septate, slightly constricted at septa, smooth-walled. *Conidiogenous cells* sympodial, terminal or intercalary, polyblastic, cylindrical, clavate to doliiform, hyaline towards the apex, brown at the base, with crowded conidiogenous loci inconspicuous to slightly prominent, refractive to somewhat obscure, more or less prominent denticles. *Conidia* acropleurogenous, oblong, obovoid, cylindrical, broadly fusiform to subpyriform, pale brown, rounded at apex, attenuate and narrowly truncate at base, brown, 0–3-septate, constricted at septa, smooth-walled, guttulate. conidial secession schizolytic. Synasexual morph: hyphomycetous. *Conidiophores* simple, erect, brown, smooth-walled. *Conidiogenous cells* terminal, discrete, phialidic, subglobose to lageniform, with a balloon- to funnel-shaped collarete, brown, often in clusters at the apex of the conidiophores. *Conidia* solitary, subglobose to obovate, unicellular, hyaline, guttulate, smooth-walled. (Dong et al. 2018, Wang et al. 2019, Hernández-Restrepo et al. 2020).

Type species – *Thysanorea papuana* (Aptroot) Arzanlou, W. Gams & Crous, Stud. Mycol. 58: 80 (2007) Fig. 31

≡ *Periconiella papuana* Aptroot, Nova Hedwigia 67(3-4): 491 (1998)

Index Fungorum number: IF504556

Type material – Papua New Guinea, on petiole of leaf, Aptroot 36647 (CBS, holotype).

Notes – Arzanlou et al. (2007) introduced *Thysanorea* Arzanlou et al. with *T. papuana* (Aptroot) Arzanlou et al. as the type species. *Thysanorea papuana* is similar to *Periconiella* Sacc. species based on the branched conidiophores, but phylogenetically segregates from *Periconiella*. *Thysanorea* is characterized by dimorphic conidiophores, denticle-like conidiogenous loci and pale brown, obovoid to pyriform, mostly 3-septate conidia (Arzanlou et al. 2007). Hernández-Restrepo et al. (2020) revised the generic description and included species with phialidic synasexual morphs. Based on the morphological differences and phylogenetic analysis, 12 new combinations from *Minimelanolocus* R.F. Castañeda & Heredia fit the new concept of delimitation of *Thysanorea*, therefore 14 species are accepted in *Thysanorea*.

Uncispora R.C. Sinclair & Morgan-Jones, Mycotaxon 8(1): 140 (1979)

Index Fungorum number: IF10352, Facesoffungi number: FoF 10385, 4 morphological species (Species Fungorum 2021), 2 species with molecular data.

Saprobic on dead twigs of various plants in terrestrial habitats. *Colonies* broadly effuse, hairy, pale brown to brown. *Mycelium* immersed to superficial, composed of branched, hyaline to pale brown, septate, smooth-walled hyphae. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* macronematous, synnematosus or - fasciculate, simple or branched, erect, cylindrical, brown, septate, straight or flexuous, smooth-walled, thick-walled. *Conidiogenous cells* integrated, terminal, determinate, monoblastic, cylindrical, brown, smooth-walled. *Conidia* solitary, acrogenous, obclavate, hooked towards the apex, truncate at the base, subhyaline to pale brown, septate, straight or curved, smooth-walled or verrucose-walled at maturity (Sinclair & Morgan-Jones 1979).

Type species – *Uncispora harroldiae* R.C. Sinclair & Morgan-Jones [as ‘harroldii’], Mycotaxon 8(1): 142 (1979)

Fig. 32

Index Fungorum number: IF325266

Type material – USA, Alabama, on dead twigs of *Picea nigra* (Du Roi) Link (Pinaceae), 15 May 1978, Harrold (AUA, holotype).

Notes – Sinclair & Morgan-Jones (1979) introduced *Uncispora* R.C. Sinclair & Morgan-Jones with *U. harroldiae* R.C. Sinclair & Morgan-Jones as the type species. The genus is characterized by macronematous, synnematosus or fasciculate, brown conidiophores, and subhyaline to pale brown, obclavate conidia with a hooked apex. *Uncispora* is similar to *Sporidesmium* Link (Ellis 1971) in its holoblastic, monoblastic, integrated, non-cicatrized conidiogenous cells and broadly truncate conidia, but differs by its occasionally branched and synnematosus conidiophores

and its unique conidia with curved or hooked terminal cells. *Uncispora* formed a sister clade with *Minimelanolocus rousselianus* (Mont.) R.F. Castañeda & Heredia and *Thysanorea papuana* (Aptroot) Arzanlou, W. Gams & Crous and clustered in Herpotrichiellaceae with 73% ML BS and 1.00 BY PP bootstrap support (Fig. 1).

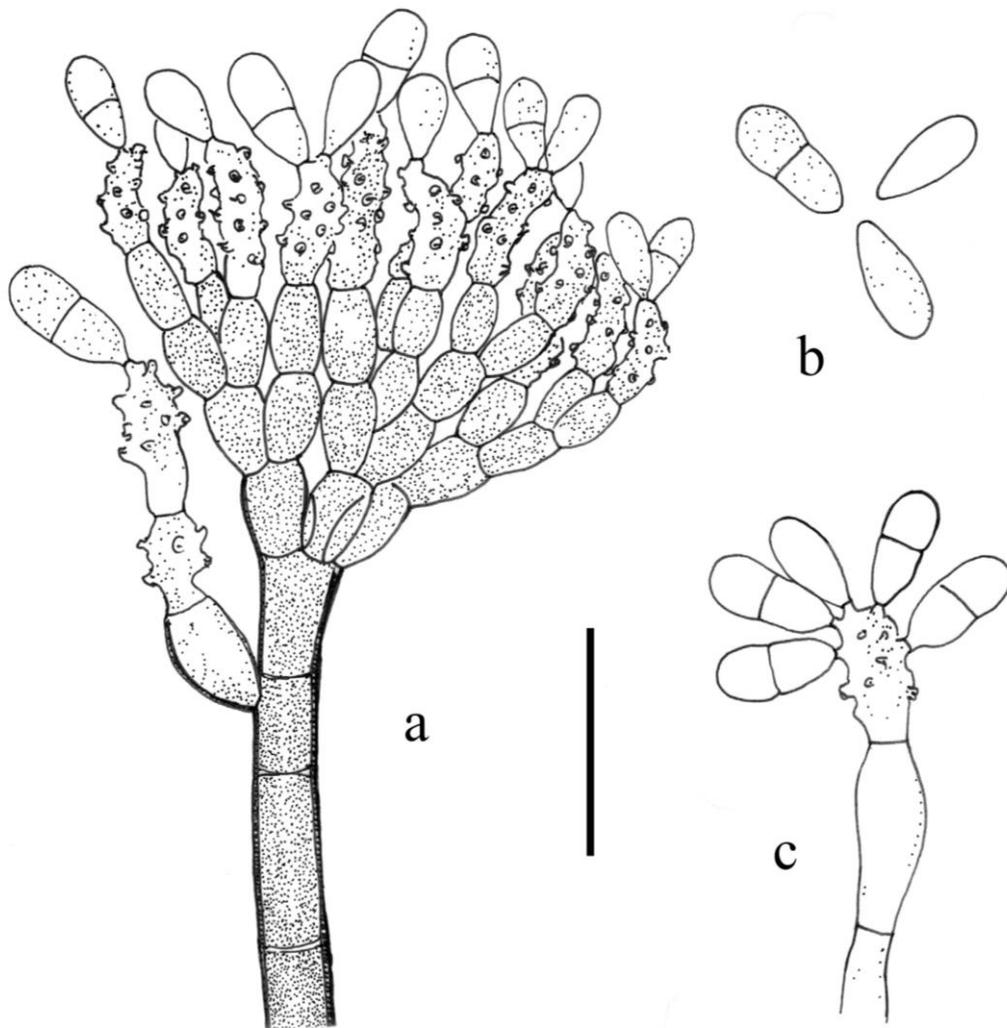


Figure 31 – *Thysanorea papuana* (CBS 212.96, redrawn from Arzanlou et al. 2007). a, b Conidiophores and conidiogenous cells with conidia. b Conidia. Scale bars: a–c = 10 μ m.

Veronaea Cif. & Montemart., Atti Ist. bot. Univ. Lab. crittog. Pavia, sér. 5 15: 68 (1957)

Index Fungorum number: IF10387, Facesoffungi number: FoF 10386, 19 morphological species (Species Fungorum 2021), 4 species with molecular data.

Biotrophic or *saprobic* on various plants, animal dung and soil. *Colonies* effuse, velvety, pale olivaceous-brown. *Hyphae* immersed, hyaline to pale olivaceous, darkly pigmented in aerial hyphae, smooth-walled. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* erect, straight or flexuose, unbranched or occasionally loosely branched, sometimes geniculate, pale to medium- or olivaceous-brown, smooth-walled. *Conidiogenous cells* terminally integrated, occasionally intercalary, polyblastic, cylindrical, hyaline to pale brown, rachis with crowded, flat to slightly prominent, faintly pigmented, unthickened scars, smooth-walled. *Conidia* solitary cylindrical to pyriform, rounded at the apex and truncate at the base, subhyaline to pale brown, 1(–2)-septate, conidial secession schizolytic. *Exophiala*-type budding cells absent in culture (Arzanlou et al. 2007).

Type species – *Veronaea botryosa* Cif. & Montemart., Atti Ist. bot. Univ. Lab. crittog. Pavia, sér. 5 15: 68 (1957) Fig. 33

Index Fungorum number: IF307734

Type material – Italy, from olive slag (holotype).

Notes – Ciferri & Montemartini (1957) established *Veronaea* Cif. & Montemart. with *V. botryosa* Cif. & Montemart. as the type species. The genus is characterized by rachides with straight, slightly geniculate conidiophores, flat, barely prominent, unthickened, slightly darkened conidiogenous cells and cylindrical to pyriform, 1(–2)-septate conidia. *Veronaea* resembles *Rhinochloidiella* Nannf., but can be distinguished by the absence of exophiala-like budding cells, flat, barely prominent conidiogenous cells and predominantly 1-septate conidia. Phylogenetically, *Veronaea botryosa* resides in Herpotrichiellaceae (Fig. 1).

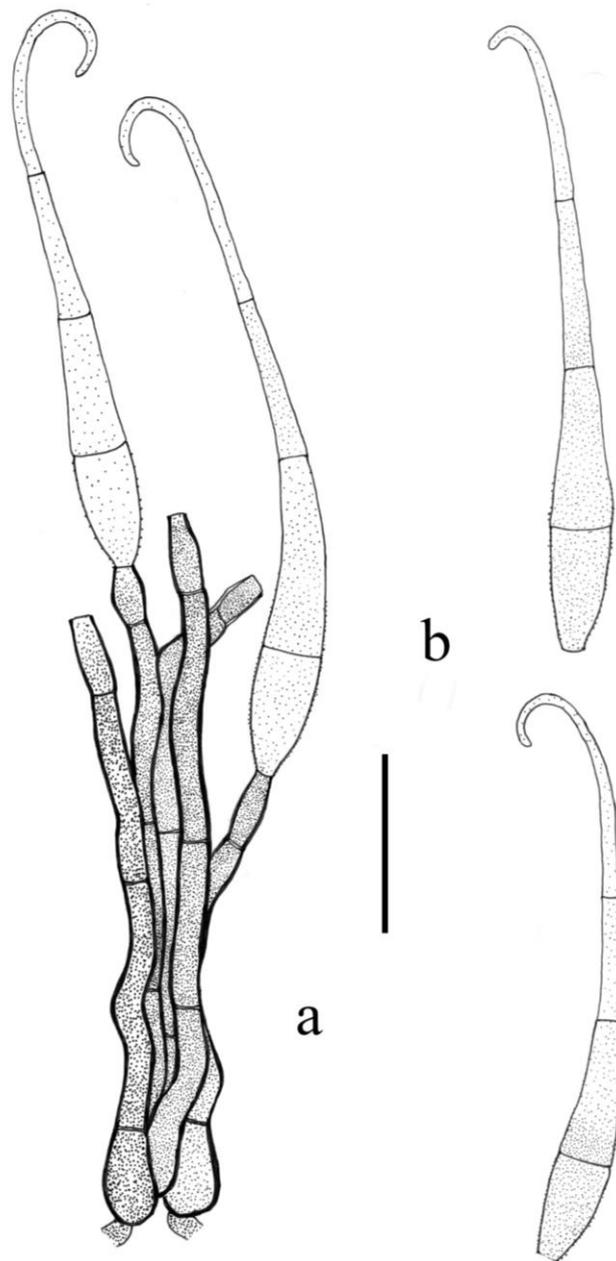


Figure 32 – *Uncispora harroldiae* (YMF 1.04038, holotype, redrawn from Sinclair & Morgan-Jones 1979). a Conidiophores and Conidiogenous cells with conidia. b Conidia. Scale bars: a, b = 10 µm.

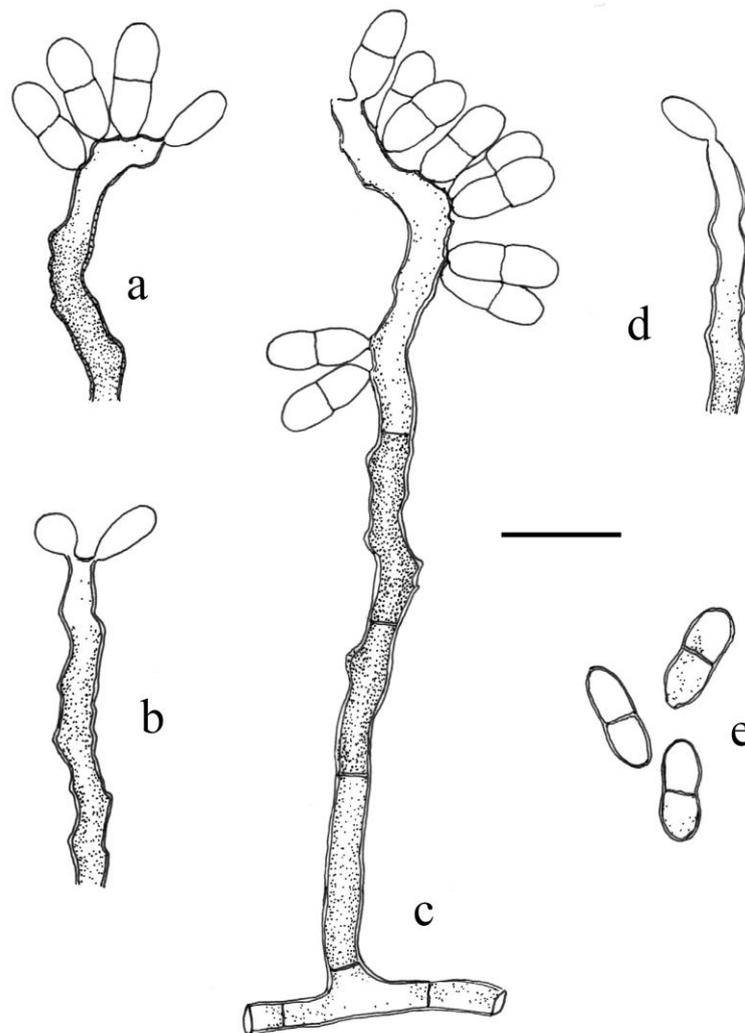


Figure 33 – *Veronaea botryosa* (redrawn from Seifert et al. 2011). a–d Conidiophores and Conidiogenous cells with conidia. e Conidia. Scale bars: a–e = 10 μ m.

Ecological and economic significance of Herpotrichiellaceae

Herpotrichiellaceae is a species-rich family with a worldwide distribution occupying diverse ecological habitats, such as being ant-associated, epilithic, epiphytic, human and animal pathogens causing infections of the blood, organs and skin, soil inhabiting, environmental and saprobes of plant material (Untereiner et al. 1995, Prenafeta-Boldú et al. 2001, Matos et al. 2002, Ruibal et al. 2008, Sudhadham et al. 2008, de Hoog et al. 2011, Isola et al. 2013, Vicente et al. 2014, Raghupathi et al. 2018, Quan et al. 2020).

Lyrommataceae Lücking, Fl. Neotrop., Monogr. 103: 184 (2008)

Index Fungorum number: IF538320; Facesoffungi number: FoF 10387

Thallus foliicolous, crustose. *Photobiont* trentepohlioid. Sexual morph: *Ascomata* perithecioid, globose to shortly barrel-shaped, sessile, setose. *Excipulum* thin-walled, composed of several layers of dark brown, irregular hyphae. *Involucrellum* absent. *Hamathecium* comprising unbranched paraphyses in young ascomata, but in mature ascomata often aparaphysate, I-, KI-. *Asci* 8-spored, fissitunicate, obclavate to saccate, I-, KI-. *Ascospores* hyaline, septate. Asexual morph: *Conidiomata* pycnidia, sessile, elongate, barrel-shaped to ellipsoid, setose or glabrous. *Wall of conidiomata* comprising a thin layer of distinctly parallel hyphae, dark brown. *Conidiophores* filamentous, unbranched, septate. *Conidiogenous cells* acropleurogenous, holoblastic, with the

lateral formation of conidia. *Conidia* filiform, hyaline, aseptate (Lücking 2008).

Type – *Lyromma* Bat. & H. Maia

Notes – Lyrommataceae Lücking, contains a single genus *Lyromma* Bat. & H. Maia and has ascomata with antler-shaped appendages and sessile, setose pycnidia with filiform conidia (Lücking 2008, Flakus & Farkas 2013). Lücking (2008) classified the lichenized Lyrommataceae in Chaetothyriales based on the close relationship among Chaetothyriales, Verrucariales Mattick ex D. Hawksw. & O.E. Erikss. and Pyrenulales Fink ex D. Hawksw. & O.E. Erikss. which appear on a clade with the bulk of the lichenized Discomycetes (Ostropales, Lecanorales) as a sister group and distant from the Dothideales (Lutzoni et al. 2001, 2004, Eriksson et al. 2004, Del Prado et al. 2006). However, no sequence data of any species of Lyrommataceae are available, thus we tentatively accept these opinions and retain Lyrommataceae in Chaetothyriales pending further studies.

Lyromma Bat. & H. Maia, Atas Inst. Micol. Univ. Pernambuco 2: 359 (1965)

Index Fungorum number: IF88008, morphological species (Species Fungorum 2021), molecular data unavailable.

Description – see Lücking (2008).

Type species – *Lyromma nectandrae* Bat. & H. Maia, Atas Inst. Micol. Univ. Recife 2: 360 (1965) Fig. 34

Index Fungorum number: IF345286

Type material – Pernambuco, on leaves of *Nectandra* sp. (Lauraceae) (URM 18764, holotype; URM 69375, epitype).

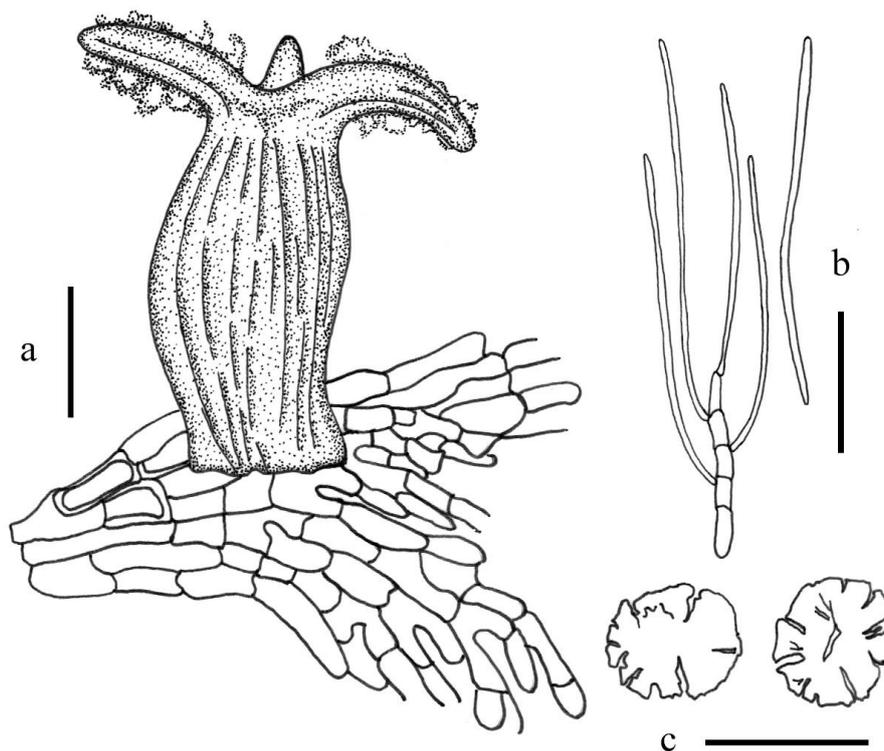


Figure 34 – *Lyromma nectandrae* (URM 18764, holotype, redrawn from Batista & Silva Maia 1965). a Pycnidium. b Conidia. c Base crystals conidia. Scale bars: a = 50 μ m, b, c = 20 μ m.

Microtheliopsidaceae O.E. Erikss., Op. bot. Soc. bot. Lund 60: 97 (1981)

Index Fungorum number: IF81007; Facesoffungi number: FoF 10388

Thallus foliicolous, crustose. *Photobiont* trentepohlioid. Sexual morph: *Ascomata* perithecioid, scattered or aggregated, lens-shaped to conical with rounded to radiantly elongate

base. *Excipulum* thin-walled, composed of layers of dark brown, irregular, intricate, wavy hyphae. *Involucrum* formed by algal cells surrounded by dark brown hyphae. *Hamathecium* paraphysate, J+, KI+. *Asci* 8-spored, fissitunicate, obclavate, J-, KI-. *Ascospores* submuriform hyaline to greyish brown, septate. Asexual morph: Undetermined.

Type – *Microtheliopsis* Müll. Arg.

Notes – Microtheliopsidaceae O.E. Erikss. was introduced with the type genus *Microtheliopsis* Müll. Arg. by Eriksson (1981). Microtheliopsidaceae is characterized by perithecioid ascomata without paraphyses, fissitunicate asci, and greyish brown ascospores. Eriksson (1981) considered the Microtheliopsidaceae to be close to Herpotrichiellaceae in Chaetothyriales (Eriksson et al. 2004, Eriksson 2006, Lücking 2008). Currently, the family contains *Microtheliopsis*, which is foliicolous lichen communities.

Microtheliopsis Müll. Arg., Flora, Regensburg 73: 195 (1890)

Index Fungorum number: IF3200, 4 morphological species (Species Fungorum 2021), molecular data unavailable.

Type species – *Microtheliopsis uleana* Müll. Arg., Flora, Regensburg 73: 195 (1890)

Index Fungorum number: IF395632; Facesoffungi number: FoF 04616

Thallus crustose, continuous or dispersed into rounded to irregular patches, smooth or rarely thinly setose, ochraceous yellow to yellowish brown or green. *Setae* formed by single, unbranched, dark brown, septate hyphae. *Photobiont cells* rectangular, setose, pale zoosporangia and gametangia. Sexual morph: *Ascomata* 0.12–0.2 mm diam., perithecioid, scattered or aggregated, lens-shaped to conical, dark brown, smooth-walled, ostiolate. *Ostiole* indistinct. *Excipulum* 7–12 µm thick, paraplectenchymatous, inner part multi-layered, composed of narrow, thin-walled and periclinally elongate, almost hyaline cells, outermost part composed of irregular, thin-walled, dark brown cells. *Involucrum* 5–10 µm thick, dark brown. *Hamathecium* lacking paraphyses, gel J+, very faintly bluish, KI+, faintly bluish. *Asci* 18–34 × 6–9 µm (\bar{x} = 25 × 8 µm, n = 10), fissitunicate, broadly clavate to saccate, J-, KI-, but lumen I+ yellow and KI+ pale yellow (colour of iodine itself). *Ascospores* 9–15 × 2–5 µm (\bar{x} = 12 × 3.6 µm, n = 10) 8-spored, overlapping 2-seriate, ellipsoid to fusiform, tapering towards both ends, pale to dark grayish brown, 3-septate, not constricted or slightly constricted at the septa, thin-walled, without a gelatinous sheath. Asexual morph: Undetermined.

Material examined – Costa Rica, Puntarenas Province, Reserva Biológica Carara, c.15 km SSW of Orotina, Alt. m. 50 m, 84° 37' W, 9° 47' N, Disturbed primary, c. 40 m tall forest, along trail near warden's house, on leaves of unidentified plant, foliicolous in undergrowth, 20 November 1988, H. Sipman & P. Döbbeler (B 60 0178769).

Paracladophialophoraceae Crous, Persoonia 40: 373 (2018)

Index Fungorum number: IF825430; Facesoffungi number: FoF 10389

Pathogenic on leaves in terrestrial habitats. *Mycelium* comprising branched, pale brown, septate, smooth-walled hyphae. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* reduced to conidiogenous cells or macronematous, solitary, erect, grey-brown, straight or curved, septate, apical apparatus tuft-like due to extremely long conidial chains. *Conidiogenous cells* terminal and lateral, mono- and polyblastic, proliferating sympodially, subcylindrical, pale brown, smooth-walled. *Conidia* ellipsoid to fusoid-ellipsoid, subcylindrical, aseptate, pale brown, smooth-walled, guttulate, in long branched chains, ramoconidia subcylindrical, septate (Crous et al. 2016).

Type – *Paracladophialophora* Crous

Notes – Paracladophialophoraceae Crous was established to accommodate *Paracladophialophora* Crous with two species isolated from living leaves (Crous et al. 2016, 2018). Based on phylogenetic analyses, Paracladophialophoraceae formed a distinct clade sister to Cyphellophoraceae in Chaetothyriales, while species in Cyphellophoraceae are recognized by solitary conidia arising from phialides and aggregating in a mucoid droplet.

Paracladophialophora Crous, Persoonia 37: 299 (2016)

Index Fungorum number: IF819058, Facesoffungi number: FoF 10390, 2 morphological species (Species Fungorum 2021), 2 species with molecular data.

Pathogenic on leaves. *Mycelium* comprising branched, pale brown, septate, smooth-walled hyphae. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* macronematous, solitary, erect, grey- brown, straight or curved, septate, apical apparatus tuft-like due to extremely long conidial chains. *Conidiogenous cells* terminal and lateral, mono- and polyblastic, proliferating sympodially, subcylindrical, pale brown, smooth-walled. *Conidia* ellipsoid to fusoid-ellipsoid, aseptate, pale brown, smooth-walled, guttulate, in long branched chains, ramoconidia subcylindrical, septate.

Type species – *Paracladophialophora carceris* Crous & Roets, Persoonia 37: 299 (2016)

Fig. 35

Index Fungorum number: IF819059

Type material – South Africa, Robben Island, prison courtyard, on leaves of *Aloe* sp. (Asphodelaceae), 23 May 2015, P.W. Crous (CBS H-22865, holotype; CPC 27596 = CBS 142068, ex-type).

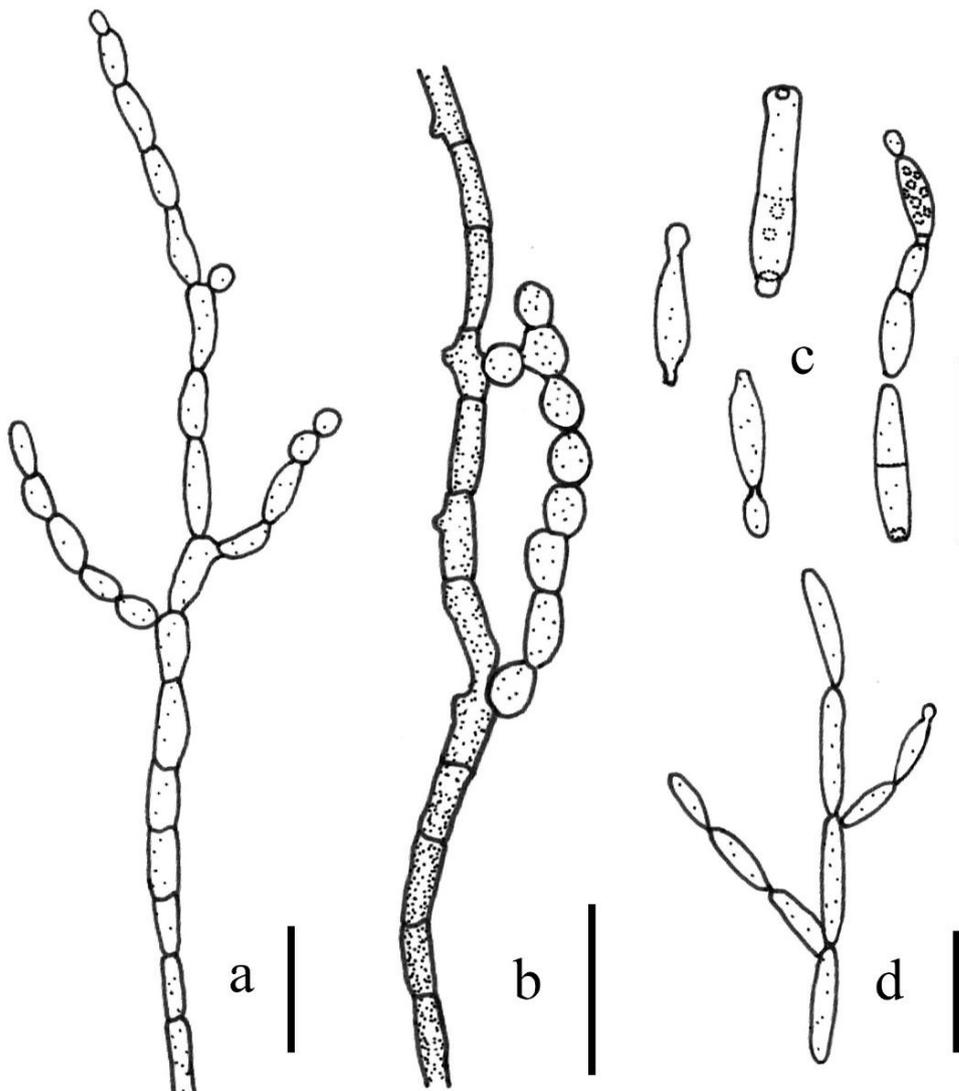


Figure 35 – *Paracladophialophora carceris* (CBS 142068, ex-type, redrawn from Crous et al. 2016). a, b, d Conidiophores. c Conidia and ramoconidia. Scale bars: a–d = 10 µm.

Notes – *Paracladophialophora* Crous was introduced by Crous et al. (2016) with the yeast-like species *P. carceris* Crous & Roets, isolated from the living leaves of *Aloe* sp. (Asphodelaceae). This genus is characterized by mono- and polyblastic, subcylindrical conidiogenous cells and ellipsoid to fusoid-ellipsoid, aseptate conidia in long branched chains (Crous et al. (2016). *Paracladophialophora* resembles *Cladophialophora*, because some *Cladophialophora* species have also been found associated with living plants (Crous et al. 2007, 2013, de Hoog et al. 2007, Badali et al. 2011, Park & Shin 2011, Feng et al. 2014), while *Cladophialophora* has flask-shaped or funnel-shaped phialides, collarettes occasionally present, and hyaline, subspherical, aseptate phialoconidia. Phylogenetically, *Paracladophialophora* constitutes a distinct clade in Chaethyiales.

Pyrenotrichaceae Zahlbr., (1926)

Index Fungorum number: IF92179; Facesoffungi number: FoF 10391

Thallus corticolous or foliicolous, composed of densely arranged, but not conglutinated, appressed filaments, filaments formed by unbranched or falsely branched photobiont threads wrapped in a sheath of fungal hyphae, hyphae branched and anastomosing, formed by elongate, often strongly curved and terminally inflated, pale brownish cells. *Photobiont cyanobacterial*. Sexual morph: *Ascomata* perithecioid, sessile or immersed between thallus filaments, globose to pear-shaped with a short neck, glabrous. *Ostiole* indistinct, with rather long, hyaline periphysoids. *Excipulum* thin, paraplectenchymatous, composed several layers of narrow to broader, thin-walled to thick-walled and hyaline to strongly pigmented cells. *Involucrum* absent. *Hamathecium* paraphysate, J+, KI+. *Asci* fissitunicate, broadly clavate to saccate, J-, KI-, but lumen I+ yellow and KI+ pale yellow. *Ascospores* 8-spored, transversally septate to muriform, pale to dark grayish brown. Asexual morph: Undetermined.

Type – *Pyrenothrix* Riddle

Notes – Engler & Prantl (1926) established Pyrenotrichaceae Zahlbr. to accommodate *Pyrenothrix* Riddle with two foliicolous species presently accepted (Riddle 1917, Herrera-Campos et al. 2005). Henssen (1964) referred *Pyrenothrix* to Pleosporales because it has perithecia. Eriksson (1981) contradicted Henssen's placement for this genus and suggested *Pyrenothrix* was closely related to the sooty molds, in particular Coccodiniaceae, now placed in Chaetothyriales by filamentous thallus and perithecia. Herrera-Campos et al. (2005) proposed including the genus in Chaetothyriales. Molecular sequences for species of Pyrenotrichaceae are lacking, and therefore we place this family in Chaetothyriales, consistent with the opinion of Herrera-Campos et al. (2005), Lücking (2008) and Wijayawardene et al. (2020), pending further study.

Pyrenothrix Riddle, Bot. Gaz. 64: 513 (1917)

= *Lichenothrix* Henssen, Ber. dt. bot. Ges. 77: 318 (1964)

Index Fungorum number: IF4608, 2 morphological species (Species Fungorum 2021), molecular data unavailable.

Type species – *Pyrenothrix nigra* Riddle, Bot. Gaz. 64: 513 (1917)

Fig. 36

For synonyms see Species Fungorum

Index Fungorum number: IF153614; Facesoffungi number: FoF 10392

Thallus corticolous or foliicolous, composed of densely arranged, but not conglutinated, appressed filaments, filaments formed by unbranched or falsely branched photobiont threads wrapped in a sheath of fungal hyphae, hyphae branched and anastomosing, formed by elongate, often strongly curved and terminally inflated, pale brownish cells. *Photobiont cyanobacterial*. Sexual morph: *Ascomata* 12–15 mm diam., perithecioid, sessile or immersed between thallus filaments, globose to pear-shaped with a short neck, glabrous. *Ostiole* indistinct, with rather long, hyaline periphysoids. *Excipulum* 22–35 µm wide, thin, paraplectenchymatous, composed several layers of narrow to broader, thin-walled to thick-walled and hyaline to strongly pigmented cells. *Involucrum* absent. *Hamathecium* paraphysate (but empty asci resembling paraphyses often present), gel I+ very faintly bluish, KI+ faintly bluish. *Asci* 40–55 × 15–25 µm (\bar{x} = 48 × 20 µm, n = 10), 8-spored, fissitunicate, broadly clavate to saccate, J-, KI-, but lumen I+ yellow and KI+ pale

yellow (colour of iodine itself). *Ascospores* 25–34 × 10–12 μm (\bar{x} = 25 × 8 μm, n = 10), uni- or bi-seriate, broadly fusiform, tapering towards both ends, pale to dark grayish brown, transversally septate to muriform, constricted at the septa, thin-walled, without a gelatinous sheath. Asexual morph: Undetermined.

Material examined – USA, Florida, West Palm Beach, on bark of scrub oaks, December 1897, R. Thaxter (FH00259851, holotype).



Figure 36 – *Pyrenothrix nigra* (FH00259851, holotype). a Envelop, collection information and herbarium material of *Pyrenothrix nigra*. b Appressed filamentous thallus with perithecia. c Squash mount of ascoma. d Vertical section through ascoma. e Vertical section through ascoma wall. f Ascospores. g, h Asci with ascospores. Scale bars: b = 500 μm, c, d = 50 μm, e, f = 25 μm g = 10 μm, h = 5 μm.

Other genera included:

Neophaeococcomyces Crous & M.J. Wingf., Persoonia 35: 287 (2015)

Index Fungorum number: IF814935; Facesoffungi number: FoF 10393; 4 morphological species (Species Fungorum 2021), with molecular data.

Saprobic on dead bark of plants in terrestrial habitats. *Colonies* lacking mycelium but comprising a globular mass of chlamydospore-like cells. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Chlamydospore-like cells* globose, hyaline to brown, covered in mucus, aseptate, thin-walled, remaining attached to one another, through younger end cells at the colony margin. *Conidia* ellipsoid to globose, hyaline, thin-walled, covered in mucus, smooth-walled (Crous et al. 2015a).

Type species – *Neophaeococcomyces aloes* (Crous & M.J. Wingf.) Crous & M.J. Wingf., Persoonia 35: 287 (2015) Fig. 37

≡ *Phaeococcomyces aloes* Crous & M.J. Wingf., Persoonia 31: 237 (2013)

Index Fungorum number: IF814936, 2 morphological species (Species Fungorum 2021) with molecular data.

Type Material – South Africa, Western Cape Province, Clanwilliam, on dark lesions on dead bark of *Aloe dichotoma* Masson (Xanthorrhoeaceae), September 2012, M.J. Wingfield (CBS H-21441, holotype; CPC 21873 = CBS 136431, ex-type).

Notes – *Neophaeococcomyces* Crous & M.J. Wingf. was introduced by Crous et al. (2015a) with the type species *N. aloes* (Crous & M.J. Wingf.) Crous & M.J. Wingf. based on phylogenetic analysis and unique morphological characters as compared to *Phaeococcomyces* de Hoog. The colonies of *Neophaeococcomyces* have chains of brown, budding cells that frequently remain attached (Moreno-Rico et al. 2014, Crous et al. 2015a).

Trichomeriaceae Chomnunti & K.D. Hyde, Fungal Diversity 56: 66 (2013)

Index Fungorum number: IF800935; Facesoffungi number: FoF 10394

Epiphytes on living trees or saprobes on honeydew insect excretions. *Thallus* comprised of mycelium on host surface with septate, brown hyphae. Sexual morph: *Ascstromata* sessile, spherical, brown, uniloculate, ostiolate, surrounded by setae, smooth-walled. *Setae* brown to dark brown or olivaceous, erect, straight or curved, septate or continuous. *Peridium* comprising several layers of hyaline, pale brown to brown or olivaceous cells of *textura angularis*. *Asci* apparently bitunicate, cylindrical to clavate, with an apical ring. *Ascospores* 8-spored, overlapping 2-seriate, fusiform, round at ends, hyaline, 2–3-septate, with or without a mucilaginous sheath. Asexual morph: hyphomycetous.

Type – *Trichomerium* Speg.

Notes – Trichomeriaceae was introduced by Chomnunti et al. (2012b) represented by an epitype of *T. foliicola* Chomnunti & K.D. Hyde. The family is characterized by sessile, setiferous ascomata, with ostioles, bitunicate asci with an apical ring and 2–3-septate, hyaline ascospores. Recently, several authors revealed that some asexual morph taxa were phylogenetically related to *Trichomerium*, viz., *Arthrocladium*, *Bradomyces*, *Knufia*, and *Lithophila* (Tsuneda et al. 2011, Réblová et al. 2013, Hubka et al. 2014, Isola et al. 2015, Nascimento et al. 2016). Most members of these genera inhabit bare rock, soil, air and are even pathogens of humans (Tsuneda et al. 2011, Réblová et al. 2013, Hubka et al. 2014, Isola et al. 2015, Nascimento et al. 2016). The taxonomic position of the non-sporulating taxa is ambiguous and they have been assigned to Trichomeriaceae and Chaetothyriaceae based on sequence similarity (Isola et al. 2015, Nascimento et al. 2016).

Trichomerium Speg., Physis, Rev. Soc. Arg. Cienc. Nat. 4(no. 17): 284 (1918)

Index Fungorum number: IF5560, Facesoffungi number: FoF 10395, 30 morphological species (Species Fungorum 2021), 14 species with molecular data.

Epiphytic on the upper surface of leaves. *Hyphae*, branched, septate, slightly constricted at the septa, pale brown to dark brown, hyphal networks covering the surface of hosts. Sexual morph: *Ascomata* superficial, solitary to aggregated, subglobose to globose, brown to dark brown,

sometimes setose. *Setae* brown to dark brown or olivaceous, erect, straight or curved, septate or continuous. *Peridium* two layered, the outer layer of brown to dark brown cells of *textura prismatica*, the inner layer composed of pale brown to hyaline flattened cells. *Hamathecium* lacking paraphyses. *Asci* 8-spored, bitunicate, ellipsoidal to cylindrical, clavate, with a short pedicel, with an apical ring. *Ascospores* overlapping 2-seriate, hyaline, fusoid, rounded at the ends, 2–3-septate, guttulate, with or without a mucilaginous sheath. Asexual morph: hyphomycetous. *Conidiophores* reduced to conidiogenous cells, conidia arising directly from hyphae. *Conidia* solitary, hyaline to pale brown, or grayish, giving rise to 3–4 lateral arms from a central cell. *Conidial arms* subcylindrical, tapering to the apex, with rounded ends, pale brown to grayish, 2–5-septate, not constricted or slightly constricted, darker at the septa, smooth-walled (Hongsanan et al. 2016).

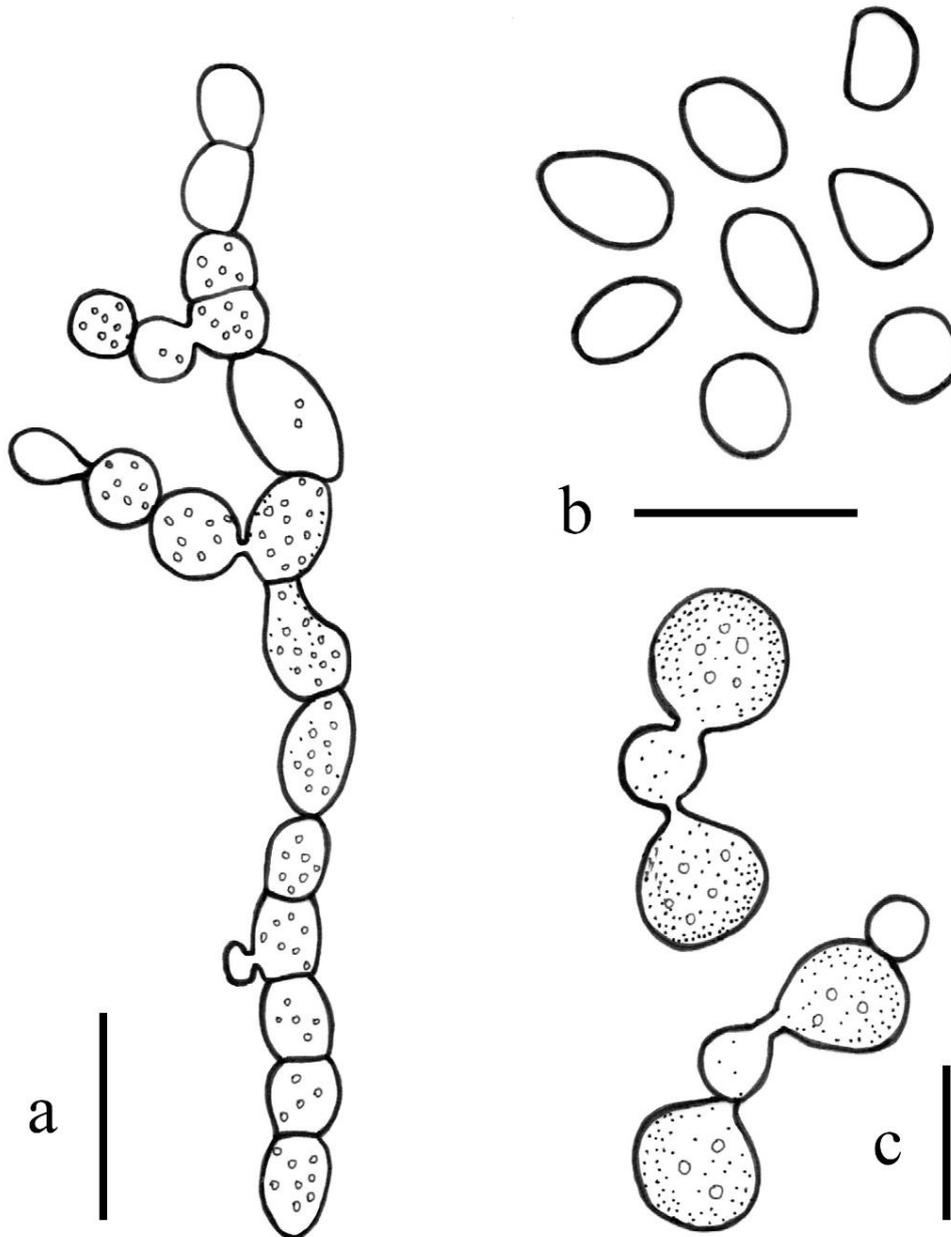


Figure 37 – *Neophaeococcomyces aloes* (CBS 136431, ex-type. redrawn from Crous et al. 2015a). a–c Conidia and chlamydospore-like cells remaining attached to one another. Scale bars: a–c =10 μ m.

Type species – *Trichomerium coffeicola* (Puttemans) Speg.

Notes – *Trichomerium* Speg. was introduced by Spegazzini (1918), with its type species *T. coffeicola* (Puttemans) Speg. However, because of the lack of holotype for *T. coffeicola* and lack of molecular data, Chomnunti et al. (2012) used *T. foliicola* as the type species of *Trichomerium*. The foliar epiphyte genus *Trichomerium* occurs superficially on living leaves of a variety of plants (Chomnunti et al. 2012b, Hongsanan et al. 2016, Maharachchikumbura et al. 2018). Crous et al. (2015) introduced a new species *Trichomerium dioscoreae* Crous & C. Nakash. with tripospermum-like morphs. Subsequently, Hongsanan et al. (2016) introduced the asexual morph of *Trichomerium gloeosporum* Chomnunti & K.D. Hyde with tripospermum-like morphs, which was confirmed with on phylogenetic analysis. Yang et al. (2021) reported three sexual morphic species, viz. *T. multisetosum*, *T. xishuangbannaense* and *T. yunnanense*, associated with plant leaves from China based on distinct morphologically characters and phylogenetic analyses of ITS and LSU combined sequences.

Trichomerium coffeicola (Puttemans) Speg., Physis, Rev. Soc. Arg. Cienc. Nat. 4(no. 17): 284 (1918) Fig. 38

≡ *Limacinia coffeicola* Puttemans, Bull. Soc. mycol. Fr. 20: 153 (1904)

For synonyms see Species Fungorum

Index Fungorum number: IF340357; Facesoffungi number: FoF 10396

Epiphytic on the upper surface of leaves. *Hyphae*, branched, septate, slightly constricted at the septa, pale brown to dark brown, hyphal networks cover the surface of hosts. Sexual morph: *Ascomata* 70–95 high diam. (\bar{x} = 83 μ m, n = 5), superficial, solitary to aggregated, subglobose to globose, brown to dark brown. *Peridium* 12–18 μ m wide (\bar{x} = 12 μ m, n = 10), two layered, outer layer of brown to dark brown cells of *textura prismatica*, inner layer composed of pale brown to hyaline flattened cells. *Hamathecium* lacking paraphyses. *Asci* 35–45 \times 10–12 μ m (\bar{x} = 40 \times 11 μ m, n = 10), 8-spored, bitunicate, ellipsoidal to cylindrical, clavate, with a short pedicel, with an apical ring. *Ascospores* 8–12 \times 2.5–3.5 μ m (\bar{x} = 10 \times 3 μ m, n = 10), 2-seriate, hyaline, fusoid, rounded at the ends, 2–3-septate, guttulate, with a mucilaginous sheath. Asexual morph: Undetermined.

Material examined – Cuba, Habana, on leaves of *Eugenia axillaris* (Sw.) Willd. (Myrtaceae), 1 February 1922, Reginald Hart. & Charles H. Ballou (BPI 699599A-C).

Other genera included:

Arthrocladium Papendorf, Trans. Br. mycol. Soc. 52(3): 483 (1969)

Index Fungorum number: IF7220, Facesoffungi number: FoF 10397, 4 morphological species (Species Fungorum 2021), 4 species with molecular data.

Biotrophic, saprobic, pathogenic on plant tissue, ant domatium and humans. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Hyphae* septate, light smoky brown, *Conidiophores* terminally, distinct, light brown-olivaceous. *Conidia* solitary, filamentous with proximal articulate spore-body, septate, tapering to the apex, with tail-like extensions, light brown-olivaceous, smooth-walled (Papendorf 1969).

Type species – ***Arthrocladium caudatum*** Papendorf, Trans. Br. mycol. Soc. 52(3): 483 (1969) Fig. 39

Index Fungorum number: IF326486

Type material – South African, Northern Province, from soil (PRE 43727, holotype).

Notes – Papendorf (1969) introduced *Arthrocladium* Papendorf to accommodate the type species *A. caudatum* Papendorf from leaf litter of *Acacia* in South Africa. The genus is characterized by obsolete or distinct, light brown-olivaceous conidiophores and light brown-olivaceous conidia with tail-like extensions. Sequencing of the type strain of *Arthrocladium caudatum* revealed that the genus is related to *Knufia* within Trichomeriaceae. Nascimento et al. (2016) introduced three non-sporulating species of *Arthrocladium*, but the conidia description did not agree with those of Papendorf (1969). They described structures as irregular fragmentation of swollen hypha. Due to their nondescript morphology, *Arthrocladium* species may have been overlooked in ecological studies.

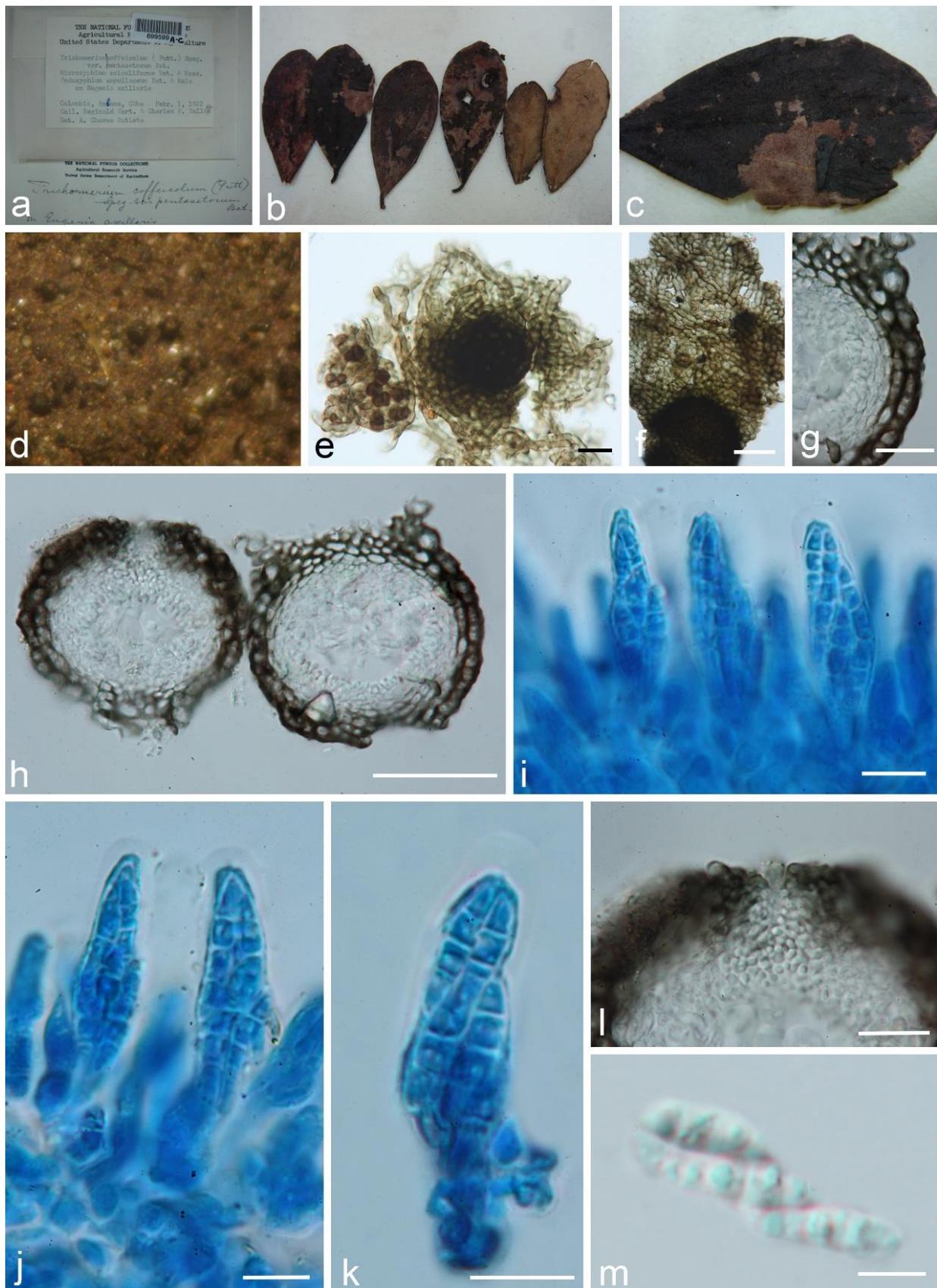


Figure 38 – *Trichomerium coffeicola* (BPI 699599A-C). a Envelop and collection information of *Trichomerium coffeicola*. b, c Herbarium material. d Appearance of ascomata superficial on the host. e, f Squash mount of ascoma. g Vertical section through ascoma wall. h Vertical section of ascomata. i–k Asci with ascospores, stained in lactophenol cotton blue. l Vertical section through ostiole. m Ascospores. Scale bars: e–g, l = 20 µm, h = 50 µm, i–k = 10 µm, m = 5 µm.

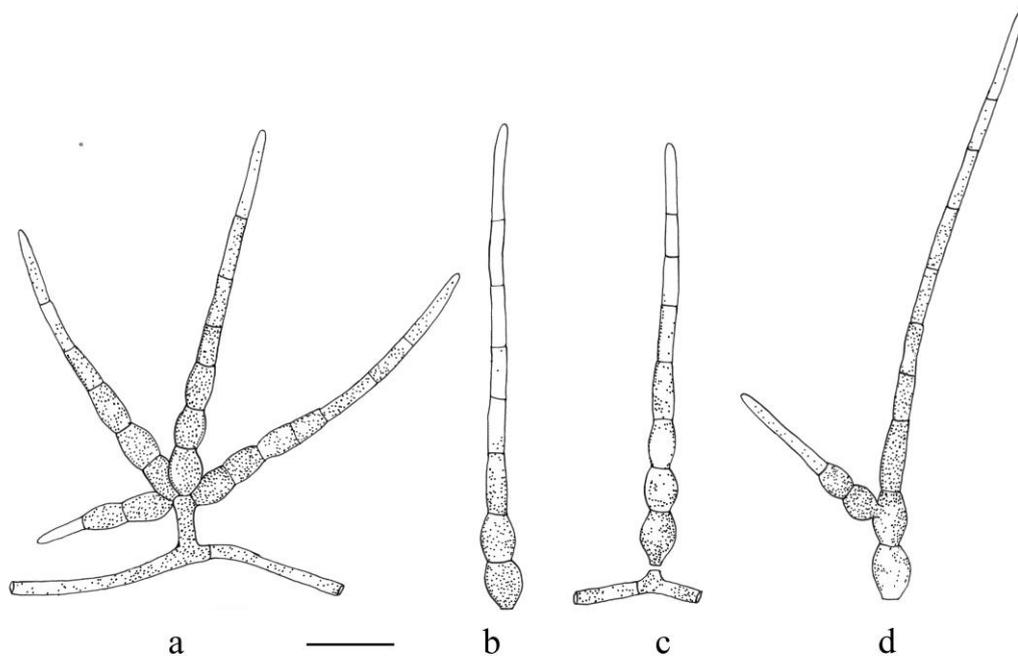


Figure 39 – *Arthrocladium caudatum* (PRE 43727, holotype, redrawn from Papendorf 1969). a, d Conidiophores with single and grouped conidia. b, c Lateral conidia showing stipitate and truncate base and septate basal cell. Scale bars: a–d =10 µm.

Bradymyces Hubka, Réblová, Selbmann & M. Kolařík, *Antonie van Leeuwenhoek* 106(5): 983 (2014)

Index Fungorum number: IF808780, Facesoffungi number: FoF 10398, 3 morphological species (Species Fungorum 2021), 3 species with molecular data.

Biotrophic, hemibiotrophic or saprobic on leaves and stems of various plants in terrestrial habitats. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Mycelium* comprising branched, melanized, cylindrical or moniliform, septate hyphae. *Blastic proliferation* formed at the ends of moniliform hyphae, terminal cells swollen with umbonate apices and conspicuously larger than the subterminal cells. *Bodies* uni- or multi-cellular, dark brown, develop in an intercalary and terminal position on the hyphae with longitudinal as well as vertical septa. *Endoconidia* rare, unicellular, globose or subglobose, in terminal or intercalary cells. *Vegetative hyphae* may disintegrate into one-celled or multicellular fragments. *Uni- or multi-cellular bodies* are present in the centre of older colonies, sometimes with dark-brown crusts and excoriations on the surface (Hubka et al. 2014).

Type species – ***Bradymyces oncorhynchi*** Hubka, Řehulka, Réblová & M. Kolařík, *Antonie van Leeuwenhoek* 106(5): 985 (2014) Fig. 40

Index Fungorum number: IF808781

Type material – Czech Republic, isolated from a hyperaemic focus near the enlarged spleen of *Oncorhynchus mykiss* Walbaum (Salmoninae), 2011, J. Řehulka (PRM 861507, holotype; CCF 4369T = CBS 133066T = CCFEE 6134T, ex-type).

Notes – *Bradymyces* Hubka et al. was introduced by Hubka et al. (2014) to accommodate two species, viz., *B. alpinus* Hubka et al. and *B. oncorhynchi* Hubka et al., isolated from a hyperaemic focus near the enlarged spleen of *Oncorhynchus mykiss* and rocks respectively. The genus is characterized by moniliform hyphae, blastic proliferation, endoconidia, multicellular and muriform bodies, and bodies with dark fragmented incrustations on the surface (Hubka et al. 2014). *Bradymyces* can be distinguished from the majority of the Trichomeriaceae by morphology. Based on phylogenetic, ecophysiological and morphological data, *Bradymyces* is presently classified in Trichomeriaceae (Fig. 1).

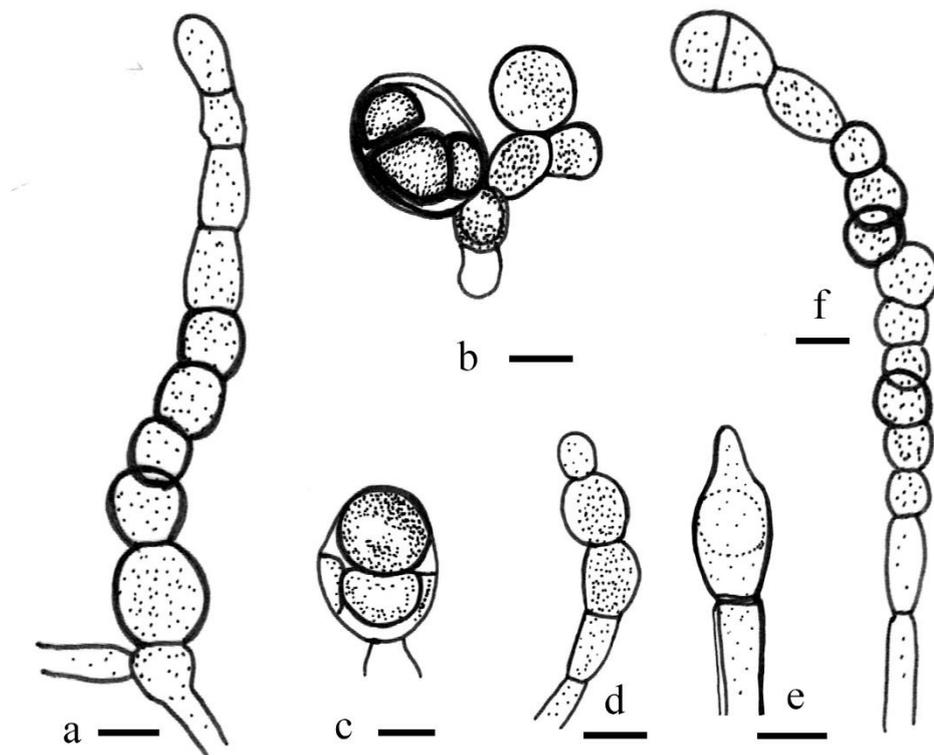


Figure 40 – *Bradymyces oncorhynchi* (redrawn from Hubka et al. 2015). a, f Moniliform hyphae. b Multicellular bodies. c Endoconidia. d, e Blastic proliferation from terminal cell by yeast like budding. Scale bars: a–f = 5 µm.

Knufia L.J. Hutchison & Unter., Mycologia 87(6): 903 (1996) [1995]

Index Fungorum number: IF27605, Facesoffungi number: FoF 10399, 19 morphological species (Species Fungorum 2021), 12 species with molecular data.

Pathogenic on humans or *saprobic* on leaves and insects, lichenicolous, rock-inhabiting in terrestrial habitats. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Colonies* in axenic culture black, slow-growing. *Hyphae* cylindrical to moniliform, subhyaline to brown, septate, smooth-walled. *Conidiogenous cells* holoblastic, terminal or lateral, produced on undifferentiated hyphae. *Conidia* obovate to cylindrical, subhyaline to brown, aseptate to multiseptate. *Phialides* obclavate. *Phialoconidia* cylindrical to pyriform, hyaline, aseptate.

Type species – ***Knufia cryptophialidica*** L.J. Hutchison & Unter., Mycologia 87(6): 903 (1996) [1995] Fig. 41

Index Fungorum number: IF434448

Type material – Alberta, isolated from black gall on stems and branches of *Populus tremuloides* Michx. (Salicaceae) (TRTC 51492, holotype).

Notes – The black-yeast genus *Knufia* L.J. Hutchison & Unter. was introduced by Hutchison & Untereiner (1995) to accommodate *K. cryptophialidica* L.J. Hutchison & Unter. The diagnostic features of *Knufia* are that they have the black, slow-growing colonies and undifferentiated, holoblastic, conidiogenous cells on the hyphae. Darkly pigmented, enlarged multicellular bodies are reliable characteristics to differentiate species, as well as the phialides (Hutchison & Untereiner 1995, Tsuneda et al. 2004, 2005, 2011, Sun et al. 2020). Only the ex-type species has phialidic conidia. *Knufia peltigerae* (Fuckel) Réblová & Unter. and *K. perfecta* Mehrabi, Asgari & Hemmati, are the sexual morph species of this genus (Untereiner et al. 2011, Réblová et al. 2013, Mehrabi et al. 2018) with superficial, dark, setose ascomata, bitunicate, sessile asci and hyaline, septate, ellipsoidal to fusiform ascospores (Untereiner et al. 2011, Mehrabi et al. 2018). Tsuneda & Currah (2005) suggested discontinuing the characters of phialidic conidia in the genus. *Knufia* are black-

yeasts in Trichomeriaceae. Some allied species, are congeneric and have been transferred to *Knufia* because of their close phylogenetic relationships (Hawksworth et al. 1987, Tsuneda et al. 2011, Réblová et al. 2013, He et al. 2014, Crous et al. 2019b, Sun et al. 2020) shown based on multi-genes phylogenetic analyses.

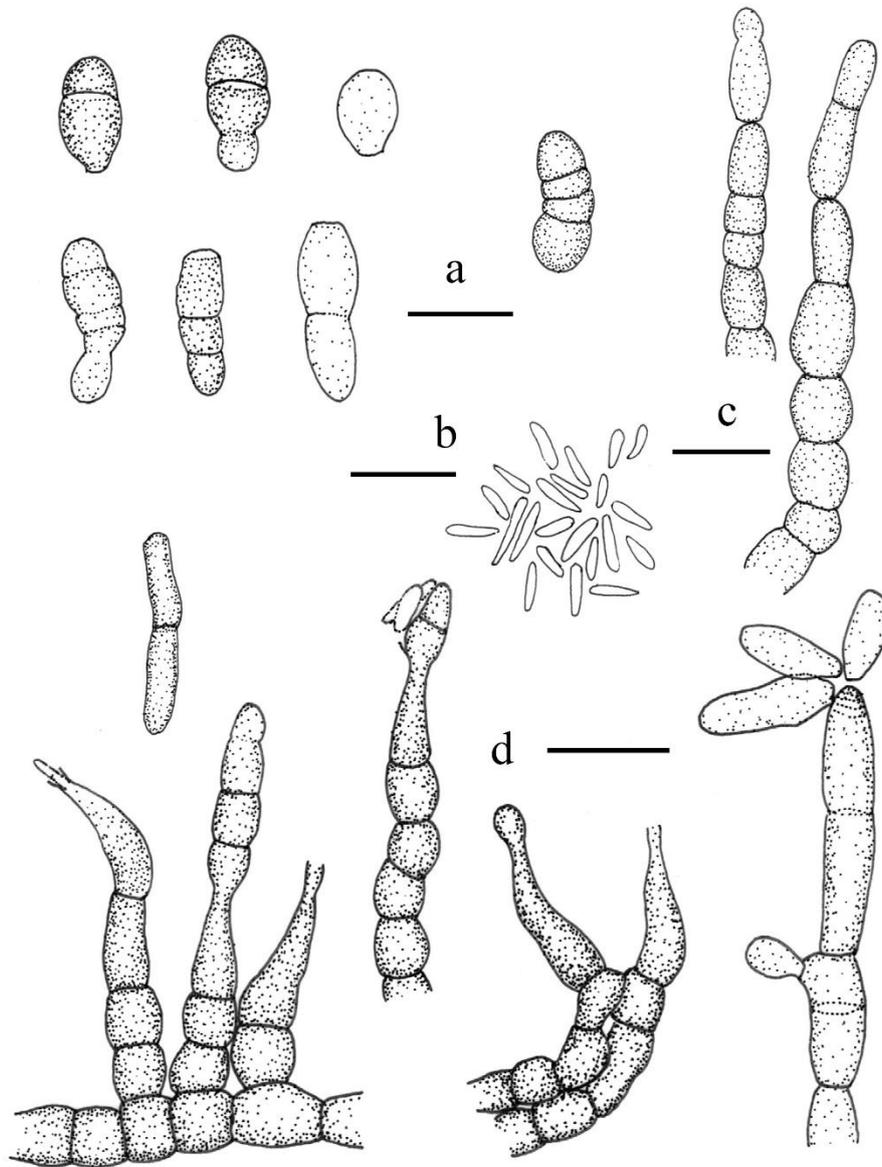


Figure 41 – *Knufia cryptophialidica* (redrawn from Hutchison et al. 1995). a Conidia. b Phialides and phialoconidia from MEA (DAOM 216555). c Conidiogenous cells on MLA (DAOM 216555). d Conidiogenous cells on MEA (DAOM 216554). Scale bars: a–d = 10 µm.

Lithohypha Selbmann & Isola, Fungal Diversity 86(1): 258 (2017)

Index Fungorum number: IF819853, Facesoffungi number: FoF 10400, 3 morphological species (Species Fungorum 2021), 3 species with molecular data.

Isolated from marble stone or ornamental limestone. Sexual morph: Undetermined. Asexual morph: *Colonies* growing slowly, cauliflower-shaped, dark brown, velvety with irregularly lobate margin from above, black from below. *Hyphae* branched, pale brown, composed of simple to multi-septate, catenate cells produced by enteroblastic proliferation. *Globose cells* frequently produced intercalarily, terminarily or laterally, 1-multicellular, sometimes with endoconidia (Isola et al. 2016, Crous et al. 2019b).

Type species – *Lithohypha guttulata* Selbmann & Isola, Fungal Diversity 86(1): 258 (2017)

For synonyms see Species Fungorum

Index Fungorum number: IF819854

Notes – *Lithohypha* Selbmann & Isola was introduced by Wijayawardene et al. (2017) to revise the illegitimate and unavailable name *Lithophila* Selbmann & Isola. Isola et al. (2016) introduced *Lithophila* Selbmann & Isola in Trichomeriaceae, which is a later homonym of *Lithophila* Sw., a name previously and validly published for a genus of Amaranthaceae. *Lithohypha* is characterized by slow growing, cauliflower-shaped colonies, branched, irregularly-shaped, simple to multiseptate, catenate hyphal cells and globose, dark cells generally enlarged to form multicellular bodies which probably function as resistance structures. Currently, *L. aloicola* Crous, *L. catenulata* L. Su et al. and *L. guttulata* Selbmann & Isola (type species) are included in this genus (Wijayawardene et al. 2017, Crous et al. 2019a, Sun et al. 2020). Phylogenetic analysis showed *Lithohypha* forms a sister group to *Strelitziana* and is aligned in Trichomeriaceae (Fig. 1).

Neostrelitziana Crous & M.J. Wingf., Persoonia 34: 187 (2015)

Index Fungorum number: IF812428, Facesoffungi number: FoF 10401, 1 morphological species (Species Fungorum 2021), 1 species with molecular data.

Pathogenic on leaves causing leaf spots. Sexual morph: Undetermined. Asexual morph: *Mycelium* comprising branched, pale brown, septate, smooth-walled hyphae. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* solitary on hyphae, phialidic, subcylindrical, pale brown, smooth, curved. *Conidia* solitary, subcylindrical to slightly clavate, with a slight taper in the basal third of collarette, pale brown, straight to curved, septate, smooth, granular, base with long, curved, to S-curved collarette, cylindrical, pale brown (adapted from Crous et al. 2015a).

Type species – *Neostrelitziana acaciigena* Crous & M.J. Wingf., Persoonia 34: 187 (2015)

Fig. 42

Index Fungorum number: IF811417

Type material – Malaysia, Sabah, on leaf spots of *Acacia mangium* Willd. (Leguminosae), May 2014, M.J. Wingfield (CBS H-22232, holotype; CPC 24873 = CBS 139903, ex-type).

Notes – *Neostrelitziana* Crous & M.J. Wingf. was introduced by Crous et al. (2015a) with the type species *N. acaciigena* Crous & M.J. Wingf. from leaf spots of *Acacia mangium*. *Neostrelitziana acaciigena* fits the characters with *Strelitziana*, while *Neostrelitziana acaciigena* formed a distinct clade away from *Strelitziana* (Crous et al. 2015a and Fig. 1). *Neostrelitziana acaciigena* has curved, to S-shaped collarettes, but *Strelitziana* has short and straight collarettes. It is therefore a distinct genus.

Strelitziana Arzanlou & Crous, Fungal Planet 8: [1] (2006)

Index Fungorum number: IF501009, Facesoffungi number: FoF 10402, 8 morphological species (Species Fungorum 2021), 8 species with molecular data.

Pathogenic or *saprobic* on stems, fruits and leaf spots of various plants. Sexual morph: Undetermined. Asexual morph: hyphomycetous. *Conidiophores* erect, solitary, arising from aerial and submerged mycelium, subcylindrical, straight to geniculous-sinuuous, pale brown. *Conidiogenous cells* terminal, integrated, phialidic, rejuvenating percurrently, proliferating apically via several short, denticles conspicuous, conidiogenesis rhexolytic. *Conidia* pale obclavate, long, brown, multi-euseptate, smooth-walled. Microcyclic conidiation present in culture (Arzanlou & Crous 2006).

Type species – *Strelitziana africana* Arzanlou & Crous, Fungal Planet, A Global Initiative to Promote the Study of Fungal Biodiversity 8: [1] (2006)

Fig. 43

Index Fungorum number: IF501010

Type material – South Africa, KwaZulu-Natal, Durban, Botanical Garden near Reunion, on leaves of *Strelitzia* sp. (Strelitziaceae), 5 February 2005, W. Gams & H. Glen (CBS-H 19776, holotype; X1039 = CBS 120037, ex-type).

Notes – *Strelitziana africana* Arzanlou & Crous was isolated from leaves of *Strelitzia* sp. Based on its distinct morphology and phylogenetic analysis, currently eight species are accepted in *Strelitziana* (Trichomeriaceae) (Arzanlou & Crous 2006).

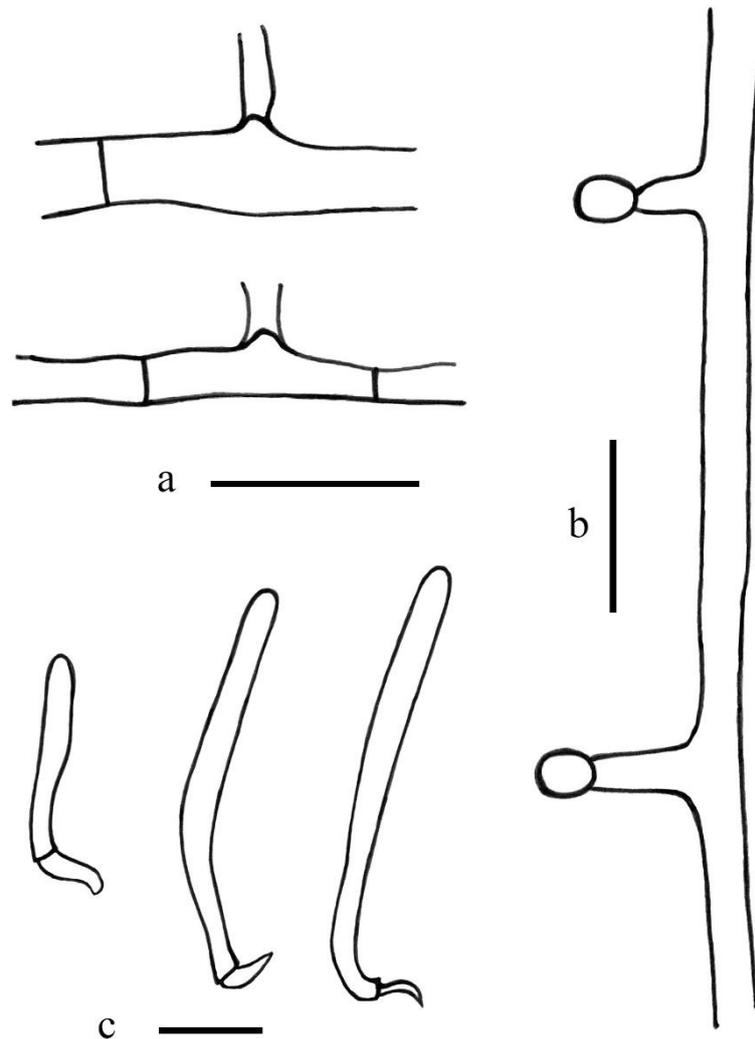


Figure 42 – *Neostrelitziana acaciigena* (redrawn from Crous et al. 2015a). a, b Conidiogenous cells. c Conidia. Scale bars: a–c = 10 μ m.

Chaetothyriales genera *incertae sedis*

Bacillicladium Hubka, Réblová & Thureborn, PLoS ONE 11(10): e0163396, 14 (2016)

Index Fungorum number: IF816983, Facesoffungi number: FoF 10403, 2 morphological species with molecular data.

Saprobic on a branch of *Clematis vitalbae* and bare granite walls in terrestrial habitats. Sexual morph: Undetermined. *Mycelium* immersed to superficial, composed of branched, pale brown, septate, swollen and constricted at septa in the conidiogenous region, with smooth-walled hyphae, individual cells ellipsoid and clavate to globose in the conidiogenous region. Asexual morph: hyphomycetous. *Conidiophores* reduced to conidiogenous cells, phialidic, pale brown, with inconspicuous collarette, not flared, smooth-walled. *Conidia* solitary, acrogenous, ellipsoid, obtuse towards the apex, truncate at the base, pale brown, aseptate, straight, guttulate, smooth-walled, older conidia undergoing microcyclic conidiation. Uni- or multicellular bodies are formed in culture, single or in chains.

Type – *Bacillicladium lobatum* Hubka, Réblová & Thureborn, PLoS ONE 11(10): e0163396, 17 (2016) Fig. 44

Index Fungorum number: IF816984

Type material – Sweden, Stockholm, Kungsträdgårdens metro station, bare granite walls, 15 July 2015, O. Thureborn, S1K1 (PRM 935094, holotype; CCF 5200 = CBS 141179, ex-type).

Notes – *Bacillicladium lobatum* Hubka et al. was isolated from bare granite walls and has three different growth modes *in vitro*, dependent on cultivation medium, temperature and colony age. *Bacillicladium clematidis* Crous & R.K. Schumach was associated with a branch of *Clematis vitalbae* and has black yeast-like growth in culture (Réblová et al. 2016, Crous et al. 2019b). *Bacillicladium* formed a monophyletic clade close to Trichomeriaceae with low bootstrap support. The morphology does not fit any genera in Trichomeriaceae or other families in Chaetothyriales, thus, the placement of *Bacillicladium* is uncertain.

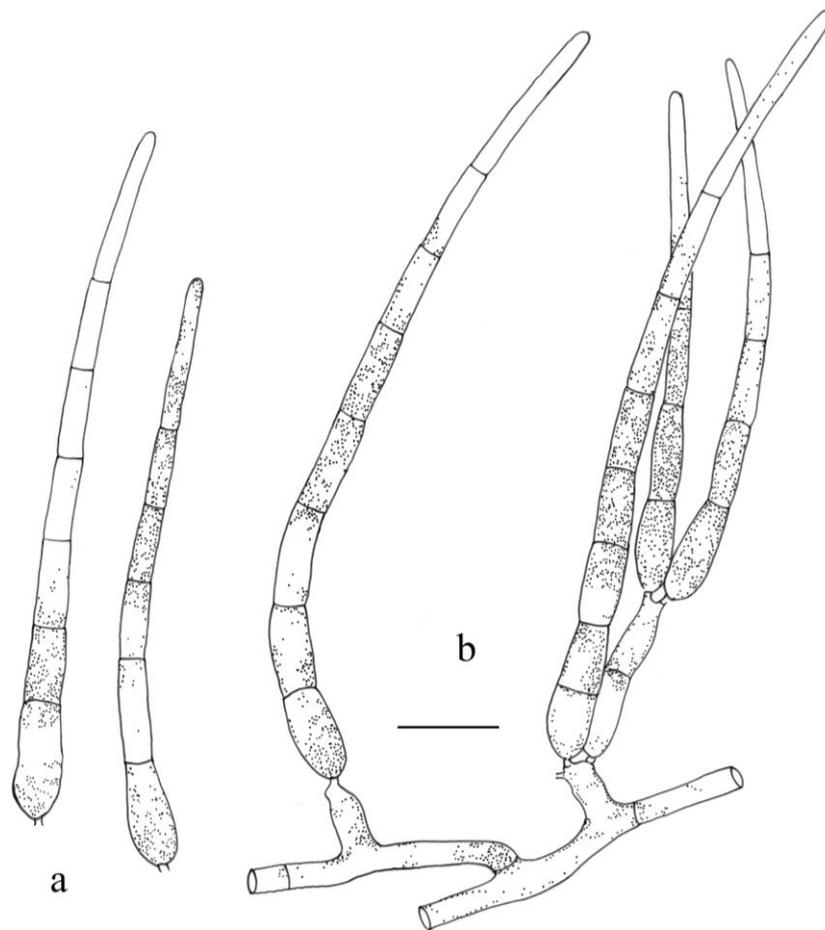


Figure 43 – *Strelitziana africana* (PRE 43727, holotype, redrawn from Papendorf 1969). a Conidia. b Conidiogenous cell giving rise to conidia. Scale bars: a, b =10 μ m.

Eucерamia Bat. & Cif., Beih. Sydowia 3: 121 (1962)

Index Fungorum number: IF1915, Facesoffungi number: FoF 10346, 1 morphological species (Species Fungorum 2021), molecular data unavailable.

Type species – *Eucерamia palmicola* Bat. & Cif.

Epiphytic on leaves in terrestrial habitats. Colonies effuse, superficial. Mycelium composed of superficial, branched, septate, brown to dark brown hyphae. Sexual morph: *Ascomata* perithecial, superficial, covering the leaf surface with dark mycelium without penetrating host tissues, multi-locular, globose to subglobose, brown to dark brown, membranaceous, pseudo-ostiolate, glabrous, smooth-walled. *Ostiole* inconspicuous. *Wall of ascoma* comprising two cell types, externally comprising

pigmented, dark brown, thick-walled cells of *textura globulosa* and inner layer thinner, composed of lightly pigmented to hyaline, thin-walled cells of *textura angularis*. *Hamathecium* comprising filiform, hyaline, septate, branched paraphyses. *Asci* 8-spored, unitunicate, sessile. *Ascospores* irregularly arranged, clavate-fusoid to cylindrical, hyaline, pluriseptate, 4–6-septate, constricted at the septa, smooth-walled, lacking a gelatinous sheath or appendages. Asexual morph: Undetermined (Batista & Ciferri 1962).

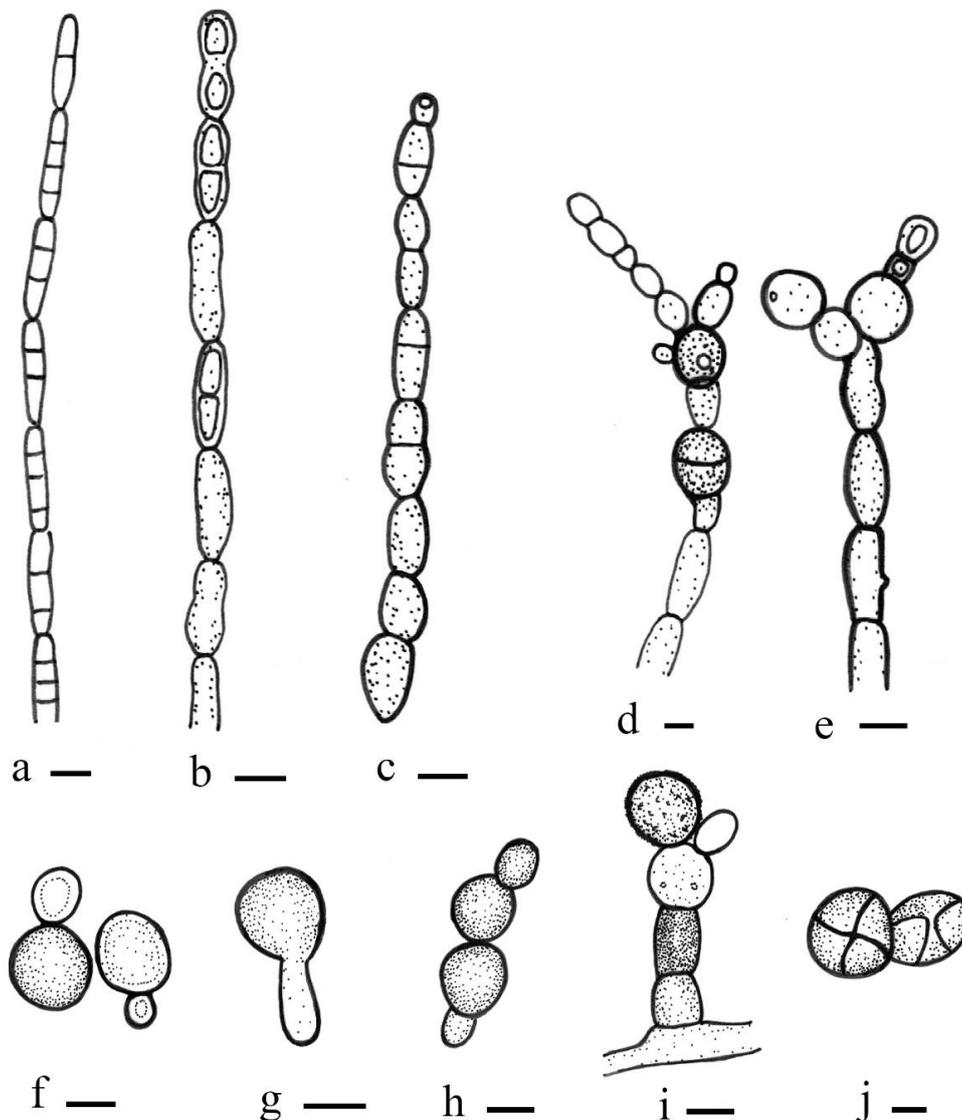


Figure 44 – *Bacillicladium lobatum* (CBS 141179, ex-type, redrawn from Réblová et al. 2016). a–c Unbranched hyphae. d, e Unbranched or sparsely branched vegetative hyphae from the deeper parts of the colonies. f–h Yeast-like stage, budding and forming short chains. i Fungal elements from the inner parts of the colony with incrustations on their surface. j Multicellular bodies. Scale bars: a–j = 5 μ m.

Notes – *Euceramia* Bat. & Cif. was introduced to represent the monotypic family Euceramiaceae Bat. & Cif., with the species *E. palmicola* Bat. & Cif. It is characterized by having plurilocular perithecia, filiform paraphyses, unitunicate asci and cylindrical ascospores. Lumbsch & Huhndorf (2010) and Kirk et al. (2013) listed *Euceramia* to Chaetothyriaceae. Consistent with their conclusion, Chomnunti et al. (2012a, 2014) referred *Euceramia* as sooty moulds because of their morphological and ecological similarity which fits the description of Chaetothyriaceae. Considering the unique unitunicate

asci, *Euceramia* is not accepted in Chaetothyriaceae. Hence, we place it as Chaetothyriales genera, *incertae sedis*, pending epitypification or neotypification of fresh collections and DNA sequences.

Euceramia palmicola Bat. & Cif., Beih. Sydowia 3: 123 (1962)

Fig. 45

Index Fungorum number: IF330710; Facesoffungi number: FoF 10347

Description: see Batista and Ciferri (1962)

Type material – Brazil, on leaves of *Cocos nucifera* L. (Arecaceae), 1 May 1956, Washington Amorim (Institute of Mycology, University of Recife, Type 4572, holotype).

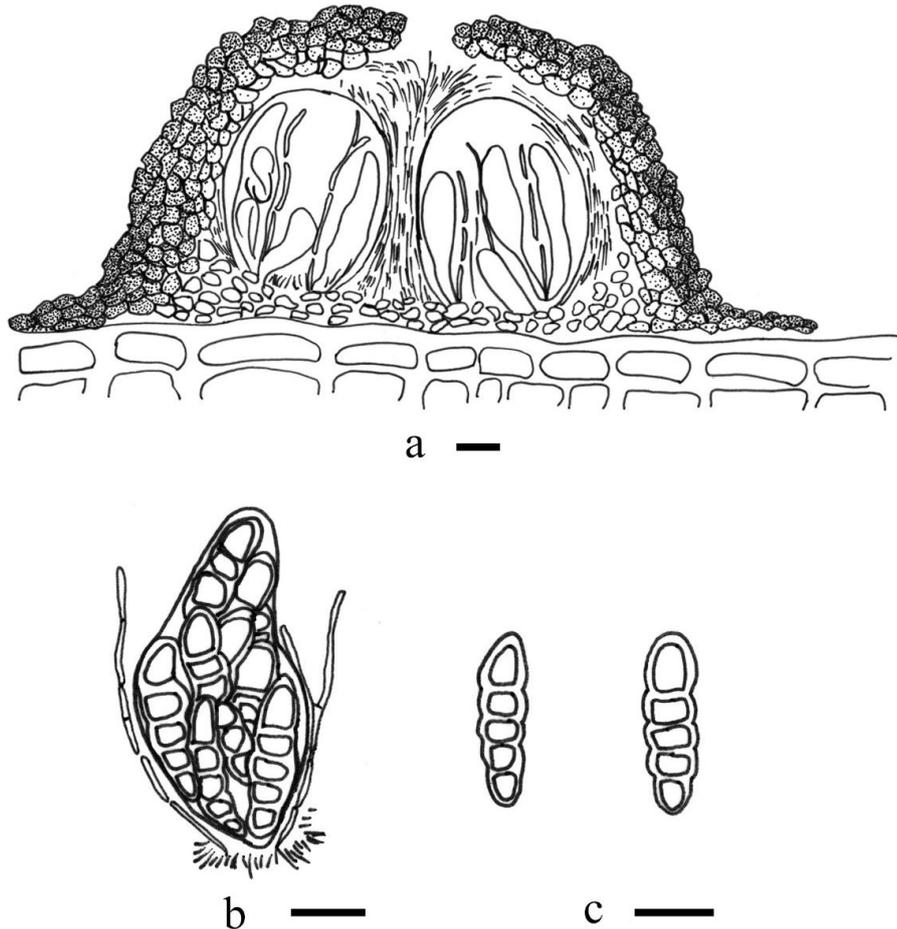


Figure 45 – *Euceramia palmicola* (Type 4572, holotype, redrawn from Batista & Ciferri 1962). a Vertical section of ascoma. b Ascus. c Ascospores. Scale bars: 10 μ m.

Lichenodiplis Dyko & D. Hawksw., Lichenologist 11(1): 51 (1979)

Index Fungorum number: IF8773, Facesoffungi number: FoF 10404, 14 morphological species (Species Fungorum 2021), 1 species with molecular data.

Saprobic on dead twigs of various plants in terrestrial habitats. Sexual morph: Undetermined. Asexual morph: Coelomycetous. *Conidiomata* pycnidial, scattered, immersed to erumpent, unilocular, globose to subglobose or slightly obpyriform, black, opening by an irregular pore. *Conidiomata wall* several layers, composed of hyaline to brown paraplectenchymatous cells. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* integrated, terminal, determinate, phialidic, simple to strongly branched, lageniform to cylindrical, pale olivaceous brown to brown, smooth-walled. *Conidia* solitary, acrogenous, ellipsoidal, with truncate base and a persistent marginal frill, subhyaline to pale brown, 1-septate, straight or curved, smooth-walled or verrucose-walled at maturity (Hawksworth & Dyko 1979).

Type species – *Lichenodiplis lecanorae* (Vouaux) Dyko & D. Hawksw., Lichenologist 11(1): 52 (1979)

Index Fungorum number: IF316910

Notes – *Lichenodiplis* Dyko & D. Hawksw. was originally assigned to Sphaeropsidales Bessey (Hawksworth & Dyko 1979), an order traditionally used for asexual taxa with pycnidial conidiomata. The lichenicolous genera, *Lichenodiplis* and *Muellerella* may be sexual and asexual morphs. *Lichenodiplis lecanorae* formed a monophyletic clade, sister to *Epibryon* (Epibryaceae) in Chaetothyriales (Fig. 1). The morphology of *Lichenodiplis* does not fit with other related families and therefore we place this lichenized coelomycetous genus in Chaetothyriales.

Melanina Grube, Muggia & de Hoog, Mycol. Progr. 20(7): 921 (2021)

Index Fungorum number: IF838740, 1 morphological species with molecular data.

Description: see Muggia et al. (2021).

Type species – ***Melanina gundecimermaniae*** Grube, Muggia & de Hoog, Mycol. Progr. 20(7): 922 (2021)

Index Fungorum number: IF838767

Notes – *Melanina* Grube et al. was introduced by Muggia et al. (2021) isolated from epilithic, crust-forming lichens in subalpine habitats. The endolichenic genus is characterized by toruloid hyphae, a yeast-like growth in the central internal part of the colony and pale, pigmented, conidia in chains (Muggia et al. 2021). *Melanina* is supported as a distinct lineage within the order Chaetothyriales, while the morphological characters cannot fit any family in Chaetothyriales, thus, Muggia et al. (2021) placed the genus in an uncertain placement in Chaetothyriales based on phylogenetic analysis.

Genera excluded from Chaetothyriales

Microcallis Syd., Annls mycol. 24(5/6): 337 (1926)

Index Fungorum number: IF3157, Facesoffungi number: FoF 10348, 9 morphological species (Species Fungorum 2021), molecular data unavailable.

Epiphytic on the lower surface of leaves, appearing as black dots scattered, hypophyllous. *Mycelium* composed of branched-reticulate, septate, olivaceous to blackish-brown hyphae. Sexual morph: *Ascomata* scattered, developing beneath the mycelial pellicle, globose-depressed, attaching it to the leaf surface, olivaceous-brown, membranous, pseudo-ostiolate. *Setae* scattered, dark brown to black, erect, obtuse. *Wall of ascoma* pseudoparenchymatous, composed of *textura angularis* outside, becoming light brown and flattened in the inner region. *Asci* 8-spored, bitunicate, clavate to ellipsoid, subsessile or sessile. *Ascospores* overlapping bi-seriate or multi-seriate, oblong-clavate, hyaline, 1-septate, constricted at the septum, thick-walled, smooth-walled, without a mucilaginous sheath. Asexual morph: Undetermined.

Type species – ***Microcallis phoebes*** Syd.

Notes – *Microcallis* Syd. is characterized by globose-depressed ascomata with dark brown to black setae, developing beneath a mycelial pellicle, bitunicate asci, and oblong-clavate, 1-septate ascospores (Sydow 1926, Batista & Ciferri 1962). It was initially placed in Chaetothyriaceae (Sydow 1926, Hansford 1946). Hansford (1946) proposed that the ascomata are too flat, which may be an inaccurate description initially, but he confirmed the position of *Microcallis* in Chaetothyriaceae, rather than Micropeltidaceae Clem. & Shear. Petrak & Sydow (1934) transferred four species, including the type species *M. phoebes* Syd., *M. amadelpa* Syd., *M. consociata* Syd., and *M. megalospora* Petrak & Cif. to *Chaetothyrina* Theiss. (Micropeltidaceae, Microthyriales, Dothideomycetes). *Microcallis phoebes* shares similar characters with species in *Chaetothyrina*, hence, we excluded *Microcallis* from Chaetothyriaceae and assign this genus to Micropeltidaceae.

Microcallis phoebes Syd., Annls mycol. 24(5/6): 338 (1926)

Fig. 46

Index Fungorum number: IF274276; Facesoffungi number: FoF 10349

Epiphytic on the lower surface of leaves, appearing as black dots scattered. *Mycelium* 2–3.5 µm, composed of branched-reticulate, septate, olivaceous to blackish-brown hyphae. Sexual morph: *Ascomata* 75–180 × 30–50 µm (\bar{x} = 148 × 43 µm, n = 10), scattered, developing beneath a mycelial

pellicle, globose-depressed, attaching it to the leaf surface, olivaceous-brown, membranous, pseudo-ostiolate. *Setae* 140–250 × 2–5 μm, wider at the base and tapering to the apex, scattered, dark brown to black, erect, obtuse. *Wall of ascoma* up to 50 μm thick, pseudoparenchymatous, composed of cells of *textura angularis* at the outside, becoming light brown and flattened in the inner region. *Hamathecium* 1–2.5 μm, comprising filiform, hyaline, septate, branched paraphyses. *Asci* 28–55 × 12–18 μm (\bar{x} = 42 × 15 μm, n = 10), 8-spored, bitunicate, clavate to ellipsoid, subsessile or sessile. *Ascospores* 15–22 × 5–7 μm (\bar{x} = 19 × 6 μm, n = 10), overlapping bi-seriate or multi-seriate, oblong-clavate, hyaline, 1-septate, constricted at the septum, thick-walled, smooth-walled, without a mucilaginous sheath. Asexual morph: Undetermined.



Figure 46 – *Microcallis phoebes* (E00429570, syntype). a Envelop and collection information of *Microcallis phoebes*. b Herbarium material. c–e Ascomata on the host surface. f–h Squash mount of ascoma. Note upper wall of radiating cells at the margin. i–k Vertical section of ascoma. l–r Asci.

s–u Ascospores. Scale bars: c = 1000 μm , d = 200 μm , e = 100 μm , f, g, i = 50 μm , h, j = 20 μm , k–r = 10 μm , s–u = 5 μm .

Material examined – Costa Rica, San Pedro de San Ramon, on leaves of *Phoebe* sp. (Lauraceae), 23 January 1925, H. Sydow (E00429570, syntype).

Yatesula Syd. & P. Syd., *Annl. mycol.* 15(3/4): 237 (1917)

Index Fungorum number: IF5858, Facesoffungi number: FoF 10350; 2 morphological species (Species Fungorum 2021), molecular data unavailable.

Saprobic on leaves in terrestrial habitats. *Mycelium* lacking. Sexual morph: *Ascomata* superficial, gregarious, or some solitary, slightly raised, circular, black, coriaceous. *Wall of ascoma* thick at the apex and thin at the base, single layer, comprising pigmented, thick-walled cells. *Hamathecium* lacking paraphyses. *Asci* mainly 4–8-spored, bitunicate, fissitunicate, dehiscence not observed, obclavate to cylindrical, with short pedicel, ocular chamber not observed. *Ascospores* overlapping 2–3-seriate, oblong, fusiform to clavate, hyaline, slightly yellowish-brown, straight or curved, 1–4-septate, constricted at the septa, straight or slightly curved, smooth-walled, with a gelatinous sheath. Asexual morph: Undetermined.

Type species – *Yatesula calami* Syd. & P. Syd.

Notes – *Yatesula* Syd. & P. Syd. is characterized by circular, coriaceous ascomata with superficial mycelium, bitunicate, obclavate to cylindrical asci and oblong, fusiform to clavate, 1–4-septate ascospores with a gelatinous sheath. *Yatesula* lacks setae and periphyses (Sydow & Sydow 1917, Pereira-Carvalho et al. 2009). The obclavate to cylindrical asci and fusiform to clavate, hyaline, 1–4-septate ascospores are more typical of Dothideomycetes in Mycosphaerellaceae Lindau. However, the ascomata lack trabeculate pseudoparaphyses (*sensu* Liew et al. 2000) which excludes *Yatesula* from this family and order. We, therefore, exclude this genus pending fresh collection and DNA sequence data.

Yatesula calami Syd. & P. Syd., *Annl. mycol.* 15(3/4): 237 (1917)

Fig. 47

Index Fungorum number: IF248195; Facesoffungi number: FoF 10351

Saprobic on leaves of *Calamus* sp. in terrestrial habitats. *Mycelium* lacking. Sexual morph: *Ascomata* 170–220 μm diam. (\bar{x} = 205 μm , n = 10), superficial, gregarious, or some solitary, slightly raised, circular, black, coriaceous. *Wall of ascoma* 18–25 μm wide, thick at the apex and thin at the base, single layer, comprising pigmented, thick-walled cells. *Hamathecium* lacking paraphyses. *Asci* 37–55 \times 8–15 μm (\bar{x} = 45 \times 9 μm , n = 10), mainly 8-spored, bitunicate, fissitunicate, dehiscence not observed, obclavate to cylindrical, with short pedicel, ocular chamber not observed. *Ascospores* 12–16 \times 3–5 μm (\bar{x} = 14 \times 4 μm , n = 10), overlapping 2–3-seriate, fusiform to clavate, hyaline, straight or curved, 1–4-septate, constricted at the septa, smooth-walled, with a gelatinous sheath. Asexual morph: Undetermined.

Material examined – Philippines, Province of Rizal, Luzon, on leaves of *Calamus* sp. (Arecaceae), September 1915, H. S. Yates (S F5690, holotype).

Discussion

In this paper, we have revisited most genera of Chaetothyriales listed in Wijayawardene et al. (2020). Examination of herbarium specimens, morphology and phylogenetic analyses are used to revise and discuss placements of genera and the new classification is listed at the beginning of the results. The outcomes of this work are an updated account of Chaetothyriales and a basis for future work.

Chaetothyriales comprises a rich variety of asexual morphs, with only a few (16) sexual morphs found in the sooty mould families, *viz.*, Chaetothyriaceae, Coccodiniaceae, Trichomeriaceae and lichenized families *viz.*, Microtheliopsidaceae and Pyrenotrichaceae. Asexual genera of Chaetothyriales are dispersed in the monotypic families Cyphellophoraceae, Epibryaceae, Herpotrichiellaceae, Lyrommataceae, Paracladophialophoraceae and Trichomeriaceae, of which only



Figure 47 – *Yatesula calami* (S-F5690, holotype). a Envelop and collection information of *Yatesula calami*. b Herbarium specimen. c, d Appearance of black ascomata on the host. e Squash mount of ascoma. f, g Section of ascomata. h Vertical section through ascoma wall. i–m Asci with ascospores. n–p Ascospores. Scale bars: c = 500 μm , d = 200 μm , e = 50 μm , f–g = 20 μm , h, j–p = 5 μm , i = 10 μm .

Vonarxia in Chaetothyriaceae and *Lyromma* in Lyrommataceae are coelomycetous with pycnidial conidiomata with subulate setae. Others are hyphomycetous with a variety of morphological characteristics of asexual conidiogenous structures and mostly filiform or globose conidia. Asexually typified genera in Herpotrichiellaceae are mostly yeast-like species with acrogenous conidia adhering in chains and integrated yeast-like budding cells. Sexual morphs of Chaetothyriales species have dark, globose to subglobose and setose ascomata colonizing the surface of living leaves with mycelium appressed to the plant cuticle without penetrating host tissues. Ascomata of *Beelia*,

Ceramothyrium, *Ceratocarpia*, *Chaetothyriomyces*, *Phaeosaccardinula* and *Pyrenothrix* have a smooth surface, without setae. The hamathecium is aparaphysate or has pseudoparaphyses embedded in a gelatinous matrix, but some species in Chaetothyriales, such as *Actinocymbe*, *Coccodinium* and *Herpotrichiella* have internally ostioles lined with paraphyses. von Arx & Müller (1975) stated that paraphyses should be illustrated as an important character to identify species in Chaetothyriaceae. However, as more genera were accepted in Chaetothyriaceae, this seems to have become less important. The asci of Chaetothyriales are bitunicate, broadly clavate, mostly short pedicellate, and contain hyaline, aseptate to multi-septate or muriform ascospores. Therefore, the key characters to identify species in Chaetothyriales are setose ascomata with mycelium appressed to the host tissues, lack of hamathecium, bitunicate, short pedicellate asci, and hyaline, aseptate to multi-septate or muriform ascospores. Black yeast-like, cyphellophora-like, phialophora-like and cladophialophora-like species are also considered as Chaetothyriales but need phylogenetic analyses.

Common genera of sooty moulds occur with sap-feeding insects, such as aphids, whiteflies, soft scales, mealy bugs, leafhoppers and psyllids on the surface of leaves (Barr 1987, Chomnunti et al. 2014). The sooty mould members in Chaetothyriales are fairly harmless saprobes living on honeydew, but reduce plant photosynthesis, therefore, they cannot be considered as a true pathogen. Whether there is obligate symbiosis between the fungi, plants and insects are one of the research questions that need to be answered in future studies. Members of Epibryaceae and Trichomeriaceae are often rock colonizers while Trichomeriaceae are also sooty moulds on plant leaves that appear to grow in extreme environments and may be xerophilic. Xerophilic organisms may have biotechnological potential in enzyme production or bioremediation, while any novel antibiotics will have medical potential (Pickard et al. 1991, Faull et al. 2002, Herath et al. 2012).

The order as a whole is poorly studied and future studies are needed to collect species throughout the order and provide new sequence data to modify the understanding of the group. Quan et al. (2020) published an ecological appraisal of the group. The present study deals with classification and does not add to the ecological account, thus the ecology is not discussed further here. Saxena et al. (2021) indicated that *Phialophoronites* has similar spore-bearing bodies of *Phialophora*, with the species *P. magnus* evolved from Miocene (Neyveli Lignite) which is approximately equal to 25–05 MYA. Quan et al. (2020) included *Meliola centellae*, *Cordyceps agriota*, and *Colletotrichum agaves-caricis* in Sordariomycetes and species in Capnodiales as a calibration point, and concluded that Chaetothyriales evolved 387 MYA (end of Devonian). The order has existed for a very long time and numerous genera and species are likely to have evolved. Speciation events occurred in 201–145 MYA (Jurassic). In future work, the first species *Phialophoronites magnus* should be included to provide divergence times for Chaetothyriales.

The order Chaetothyriales presently contains ten families, 55 genera and 667 species, although most sexual morphs of Chaetothyriales lack molecular data. Of the 55 genera, almost half (24 genera) comprise only one or two species. This is likely to reflect the lack of collection and studies in the group, since many are tropical genera (Hyde et al. 2020). We do not believe these genera comprise so few species and expect that future studies will increase the numbers of taxa in the genera significantly and reveal new genera and possibly families.

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