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Article
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Global diversity and phylogeny of *Fuscoporia* (Hymenochaetales, Basidiomycota)

Chen Q[1,2], Du P[3], Vlasák J[4], Wu F[1*] and Dai YC[1,2*]

[1]*School of Ecology and Nature Conservation, Beijing Forestry University, Beijing 100083, China*
[2]*Beijing Advanced Innovation Center for Tree Breeding by Molecular Design, Beijing Forestry University, Beijing 100083, China*
[3]*College of Life Science and Technology, Yangtze Normal University, Chongqing 408100, China*
[4]*Biology Centre, Czech Academy of Sciences, Institute of Plant Mol. Biol., Branišovská 31, CZ-370 05 České Budějovice, Czech Republic*

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Abstract

The genus *Fuscoporia* is characterized by annual to perennial, resupinate to pileate basidiocarps, a dimitic hyphal system with generative hyphae bearing crystals, presence of hymenial setae in most species, and hyaline, thin-walled, smooth basidiospores. To explore the phylogenetic positions of *Fuscoporia* species, we performed a comprehensive study by using molecular data based on global specimens: a total of 105 specimens including 41 species of *Fuscoporia* were analyzed, ITS (95 with 46 new), nLSU (94 with 49 new), RPB2 (49 with 34 new) and TEF1 (73 with 52 new) sequences were used to reconstruct *Fuscoporia* phylogeny. According to our phylogenetic analyses inferred from the nLSU and ITS+nLSU+RPB2+TEF1 datasets, *Fuscoporia* comprises six distinct groups (*F. contigua* group, *F. ferrea* group, *F. ferruginosa* group, *F. gilva* group, *F. torulosa* group and *F. viticola* group) and three ungrouped species (*F. acutimarginata*, *F. discipes* and *F. insolita*). Nine new species, *Fuscoporia australasica*, *F. australiana*, *F. bambusae*, *F. chinensis*, *F. eucalypti*, *F. karsteniana*, *F. plumeriae*, *F. shoreae* and *F. subchrysea*, are described. Two new combinations, *Fuscoporia bambusicola* and *F. roseocinerea*, are proposed. A key to 49 accepted species of *Fuscoporia* in worldwide is provided.

Key words – Nine new species – Hymenochaetaceae – Phylogeny – Taxonomy – Wood-rotting fungi

Introduction

Fuscoporia Murrill was introduced by Murrill (1907) with *F. ferruginosa* (Schrad.) Murrill selected as type species. The genus has been considered as a synonym of *Phellinus* Quél. *sensu lato* by many scientists for a long time (Overholts 1953, Lowe 1966, Ryvarden & Johansen 1980, Cunningham 1948, Larsen & Cobb-Poulle 1990, Ryvarden & Gilbertson 1994). *Phellinus* is the largest genus in the family of Hymenochaetaceae and has a worldwide distribution in the world (Larsen & Cobb-Poulle 1990). Many important forest pathogens, but also valuable medicinal fungi are currently included in *Phellinus sensu lato* (Dai et al. 2007, 2010, Wu et al. 2019). Fiasson & Niemelä (1984) defined *Fuscoporia* as a monophyletic genus which differs from *Phellinus sensu*

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Corresponding Author: Wu F. – e-mail – fangwubjfu2014@yahoo.com,
Dai Y.C. – e-mail – yuchengd@yahoo.com

stricto by thin-walled basidiospores and encrusted generative hyphae at dissepiments. The genus was re-confirmed as an independent genus (Wagner & Fischer 2001, 2002), and this conclusion has been widely accepted by Niemelä et al. (2001), Groposo et al. (2007), Baltazar et al. (2009), Dai (2010), Baltazar & Gibertoni (2010), Raymundo et al. (2013a, b), Spirin et al. (2014), Pires et al. (2015), Chen & Yuan (2017), Chen et al. (2019) and Chen & Dai (2019). *Fuscoporia* is characterized by annual to perennial and resupinate to pileate basidiocarps, a dimitic hyphal system with encrusted generative hyphae at dissepiments and in trama, presence of hymenial setae, presence or absence of mycelial setae, and hyaline, thin-walled, smooth basidiospores (Fiasson & Niemelä 1984, Dai 2000, 2010). To date, thirty-eigh species are accepted in the genus (Index Fungorum 2020, MycoBank 2020).

Recent studies demonstrated that some traditional species of *Fuscoporia* are species complexes. For example, *Fuscoporia contigua* (Pers.) G. Cunn. was defined as a species with variable shape of basidiospores (oblong ellipsoid or cylindric), but some Asian specimens were confirmed as different species based on morphological examinations and phylogenetic analyses. So, *F. sinica* Y.C. Dai, Q. Chen & J. Vlasák and *F. monticola* Y.C. Dai, Q. Chen & J. Vlasák were segregated from *F. contigua* (Chen et al. 2019). Similarly, *F. ferrea* (Pers.) G. Cunn. was considered as a single species occurring in temperate forests of North Hemisphere, but *F. ramulicola* Y.C. Dai & Q. Chen, *F. subferrea* Q. Chen & Y. Yuan and *F. yunnanensis* Y.C. Dai were derived from *F. ferrea* (Dai 2010, Chen & Yuan 2017). It is therefore likely that the diversity of *Fuscoporia* is underestimated.

In this study, we aimed to investigate the diversity and taxonomy of *Fuscoporia* based on samples from Asia, Europe, Oceania, and America. Nine new species are described and two new combinations are proposed. A phylogeny based on the combined ITS, nLSU, RPB2 and TEF1 DNA sequence data was analysed with a total of 105 specimens including 41 species of *Fuscoporia*. Six distinctive groups within the *Fuscoporia* are recovered, *viz. F. contigua* group, *F. ferrea* group, *F. ferruginosa* group, *F. gilva* group, *F. torulosa* group, and *F. viticola* group. A key to all 49 accepted species of *Fuscoporia* is provided.

Materials & Methods

Morphological studies

The studied specimens are deposited in the herbarium of the Institute of Microbiology, Beijing Forestry University (BJFC), Royal Botanic Gardens Victoria (MEL), and the private herbarium of Josef Vlasák (JV) which will be sent to National Museum Prague (PRM). Morphological descriptions are based on field notes and herbarium specimens. Microscopic analyses follow Song & Cui (2017). In the description: KOH = 5% potassium hydroxide, CB– = acyanophilous in Cotton Blue, IKI– = neither amyloid nor dextrinoid in Melzer's reagent, the microscopical measurements and drawings were made from slide preparations stained with Cotton Blue, L = arithmetic average of all spore length, W = arithmetic average of all spore width, Q = L/W ratios, n = number of spores/measured from given number of specimens. Special color terms are cited from Anonymous (1969) and Petersen (1996).

DNA extraction, PCR and sequencing

Total genomic DNA was extracted from dried specimens by CTAB rapid plant genome extraction kit (Aidlab Biotechnologies Company, Limited, Beijing, China) according to the manufacturer's instructions with some modifications (Chen et al. 2016). To generate PCR amplicons, the following primer pairs were used: ITS4 and ITS5 (White et al. 1990) for the internal transcribed spacer (ITS), and 983F and 1567R (Rehner & Buckley 2005) for a region of the translation elongation factor (TEF1), LR0R and LR7 (Vilgalys & Hester 1990) for the 28S gene region (nLSU) and bRPB2-6F and bRPB2-7.1R (Matheny 2005) for partial RNA polymerase II, second largest submit (RPB2). The PCR procedures followed Song & Cui (2017) and Zhu et al. (2019). PCR products were purified and sequenced at the Beijing Genomics Institute with the same

primers and the sequences were deposited in GenBank and listed in Table 1.

Phylogenetic analyses

In this study, 181 new sequences, *viz.* 46 ITS, 49 nLSU, 34 RPB2 and 52 TEF1, were generated (Table 1). To explore the phylogenetic position of *Fuscoporia* in Hymenochaetaceae, 90 sequences (not shown in Table 1 except for *Fuscoporia*) of representatives of 27 genera of Hymenochaetaceae were included in nLSU dataset (Fig. 1). The genus *Fuscoporia* was represented by 38 species and other genera were represented by a few known species (mainly the generic type). *Oxyporus populinus* (Schumach.) Donk and *Hyphodontia pallidula* (Bres.) J. Erikss. were used as outgroup taxa based on previous studies (Larsson et al. 2006, Zmitrovich & Malysheva 2014, Zhou et al. 2016, Chen et al. 2019).

To explore the phylogenetic relationships to species-level of *Fuscoporia*, 133 sequences in 30 species (shown in Table 1) in the ITS+nLSU+RPB2+TEF1 datasets (Fig. 2) were downloaded from GenBank based on Chen & Dai (2019) and Chen et al. (2019) and analysed. *Coniferiporia weirii* (Murrill) L.W. Zhou & Y.C. Dai and *Phellinidium fragrans* (M.J. Larsen & Lombard) Nuss were selected as outgroup for the ITS+nLSU+RPB2+TEF1 analysis, because they were shown to be sister groups of *Fuscoporia* based on the nLSU phylogenetic analysis (Fig. 1) and as outgroup in previous studies (Zhou et al. 2016, Chen et al. 2019). Sequences were aligned with BioEdit (Hall 1999) and the alignments generated in ClustalX were used to construct phylogenetic analyses (Thompson et al. 1997). GTR+I+G was the selected substitution model for each partition of the two alighments.

Maximum parsimony (MP) analysis was used for the nLSU and the ITS+nLSU+RPB2+TEF1 datasets in PAUP* 4.0b10 (Swofford 2002). All characters were equally weighted and gaps treated as missing data. Trees were inferred using the heuristic search option with tree bisection reconnection (TBR) branch swapping and 1000 random sequence additions. The maxtrees parameter was set to 5000, branches of zero length were collapsed, and all parsimonious trees were saved. Clade robustness was assessed by a bootstrap analysis with 1000 replicates (Felsenstein 1985). Descriptive tree statistics such as tree length (TL), consistency index (CI), retention index (RI), rescaled consistency index (RC), and homoplasy index (HI) were calculated (Swofford 2002).

Maximum likelihood (ML) methods were also used for both datasets. Substitution models suitable for each partition, including ITS and nLSU, and introns and codons of the RPB2 and TEF1 gene, were determined using the Akaike information criterion implemented in MrModeltest 2.3 (Posada & Crandall 1998, Nylander 2004). RaxmlGUI 1.2 (Stamatakis 2006, Silvestro & Michalak 2012) was used for ML analysis. All parameters in the ML analysis used default settings. Statistical support values were obtained using nonparametric bootstrapping with 1000 replicates. MP and ML methods were adopted to perform phylogenetic analysis of the two aligned datasets. The two phylogenetic methods produced a similar topology for each dataset, so, only the topology of the MP tree is presented along with statistical values of the MP/ML algorithm (simultaneous MP and ML not less than 50%) at the nodes. DNA alignments have been deposited at TreeBase (25546).

The nLSU dataset comprised 92 sequences and an alignment of 1435 positions, of which 1026 were constant, 93 variables but parsimony-uninformative, and 316 parsimony-informative. Maximum Parsimony yielded four equally most parsimonious trees (TL = 1878, CI = 0.325, RI = 0.717, RC = 0.233, HI = 0.675). The four-gene dataset included sequences from 105 specimens representing 41 species of *Fuscoporia* and two species of related genera. This alignment contained 3686 sites: 900 positions from ITS, 1400 from nLSU, 821 from RPB2 and 566 from TEF1. In this aligment 2215 characters were constant, 180 variables but parsimony-uninformative, and 1291 parsimony-informative. MP analysis yielded four similar topologies (TL = 6400, CI = 0.434, RI = 0.837, RC = 0.363, HI = 0.566). Maximum Likelihood analysis resulted in a similar consensus tree as the MP analysis in two phylogenetic analyses, so MP trees are shown here (Figs 1–2) and all the other topologies are provided as supplemental materials.

Results

Fuscoporia is strongly supported (96/99) within the Hymenochaetaceae family by phylogenetic analysis inferred from the nLSU rDNA-based phylogeny (Fig. 1). The combined ITS, nLSU, RPB2, and TEF1 sequences (Fig. 2) including 41 species of *Fuscoporia* shows that nine new species formed nine independant lineages indicating that they are phylogenetically distinct from the species currently known in the genus. Two species, *Fuscoporia bambusicola* and *F. roseocinerea*, previously treated in *Phellinus* are nested in *Fuscoporia*. Six distinctive groups (highlighted in Fig. 2) are defined within *Fuscoporia*, *viz. F. contigua* group, *F. ferrea* group, *F. ferruginosa* group, *F. gilva* group, *F. torulosa* group, and *F. viticola* group. Three species, *Fuscoporia acutimarginata*, *F. discipes* and *F. insolita*, are nested in three subclades (Fig. 2) without enough support, and they do not belong to any distinct group.

Table 1 Species, specimens and GenBank accession number of sequences used in this study.

Taxa	Voucher specimens	GenBank accession numbers			
		ITS	nLSU	RPB2	TEF1
Fuscoporia acutimarginata	Dai 15137	MH050751	MH050765	MN848788*	MN848821*
F. acutimarginata	Dai 16892	MH050752	MH050766	MH079393	MN848822*
F. americana	JV 1209/3-J	–	MG008466	v	–
F. americana	JV 1209/100	KJ940022	MG008467	–	MH636384
F. americana	JV1309/13-J	–	MG008463	–	MH636385
F. atlantica	SP 445618	KP058515	KP058517	–	–
F. atlantica	SP 465829	KP058514	KP058516	–	–
F. australasica	**Dai 15625**	**MN816726***	**MN810018***	**MN848775***	**MN848829***
F. australasica	**Dai 15636**	**MG008397**	**MG008450**	**MH079402**	**MH636408**
F. australasica	**Dai 15659**	**MG008398**	**MG008451**	**MH079403**	**MH636409**
F. australiana	**Dai 18587A**	**MN816723***	**MN810013***	**MN848765***	**MN848849***
F. australiana	**Dai 18672**	**MN816703***	**MN810014***	**MN848766***	**MN848848***
F. australiana	**Dai 18879**	**MN816705***	**MN810015***	**MN848767***	**MN848850***
F. bambusae	**Dai 16599**	**MN816711***	**MN809999***	–	**MN848808***
F. bambusae	**Dai 16607**	**MN816713***	**MN810000***	**MN848797***	**MN848809***
F. bambusae	**Dai 16615**	**MN816715***	**MN810001***	–	**MN848810***
F. bambusicola	**Cui 8692**	**MN816739***	**MT032486***	–	**MN848813***
F. callimorpha	JV 1408/11	–	MN809991*	–	MN848839*
F. callimorpha	Dai 17388	MN121765	MN121824	–	–
F. callimorpha	Doll 868	MN816701*	MN809992*	–	MN848840*
F. chinensis	**Dai 15713**	**MN816721***	**MN810008***	**MN848771***	**MN848846***
F. chinensis	**Cui 11209**	**MN121767**	**MN121826**	**MN159388**	–
F. chinensis	**Dai 17282**	**MN816710***	**MN810009***	**MN848772***	**MN848847***
F. chrysea	JV 1607/106-J	MN816736*	MN810027*	MN848773*	MN848818*
F. centroamericana	JV 1607/93	MG008444	MG008460	–	MH636389
F. centroamericana	O 908267	MG008443	–	–	–
F. contigua	Dai 16025	MG008401	MG008454	MH079406	MH636386
F. contigua	Dai 13567A	MG008402	MG008455	MN159386	MN848817*
F. contigua	Cui 9760	–	MG478452	–	–
F. costaricana	JV 1407/92	MG008446	MG008461	–	MH636400
F. costaricana	JV 1504/85	MG008413	MG478454	–	MH636401
F. discipes	Wei 4947	–	HQ328524	–	–
F. eucalypti	**Dai 18634A**	**MN816729***	**MN810020***	**MN848777***	**MN848830***
F. eucalypti	**Dai 18783**	**MN816730***	**MN810021***	**MN848776***	**MN848832***

Table 1 Continued.

Taxa	Voucher specimens	GenBank accession numbers			
		ITS	nLSU	RPB2	TEF1
F. eucalypti	**Dai 18792**	**MN816731***	**MN810022***	**MN848778***	**MN848831***
F. ferrea	JV 1606/2.2-J	KX961100	KY189100	MH079394	MH636402
F. ferrea	MUCL 45984	KX961112	KY189112	–	MH636403
F. ferrea	Cui 11801	KX961101	KY189101	MN159387	MN848823*
F. formosana	TFRI 799	–	AY059034	–	–
F. ferruginosa	JV 0408/28	KX961103	KY189103	–	MH636397
F. ferruginosa	JV 1507/11-CN	MG008400	MG008453	MH079404	MH636399
F. ferruginosa	Dai 13200	MN816702*	MN809993*	MN848793*	MN848802*
F. ferruginosa	Dai 16030	MN816704	MN809994	MN848790	MN848803
F. ferruginosa	Cui 9244	MN816706	MN809995	MN848791	MN848804
F. ferruginosa	JV 0509/151	MN816707	MN809996	MN848792	–
F. gilva	Dai 17922	–	MN810005*	–	–
F. gilva	JV 1209/65	MN816719*	MN810006*	MN848768*	MN848851*
F. gilva	JV 0709/75	MN816720*	MN810007*	–	MN848852*
F. insolita	Spirin 5251	KJ677113	–	–	–
F. insolita	Spirin 5208	MN816724*	MN810016*	–	MN848800*
F. karsteniana	**Dai 16552**	**MN816716***	**MN810002***	**MN848794***	**MN848806***
F. karsteniana	**Dai 11403**	**MN816717***	**MN810003***	**MN848795***	**MN848807***
F. karsteniana	**Dai 15717**	**MN816718***	**MN810004***	–	**MN848805***
F. latispora	JV 1109/48	MG008439	MG008468	MN848799*	MH636395
F. latispora	JV 0610/VII-Kout	MG008436	MG008469	–	MH636396
F. monticola	Dai 10909	MG008410	–	–	–
F. monticola	Dai 11860	MG008406	MG008457	–	MH636390
F. palomari	JV 1004/5-J	MN816737*	–	–	–
F. palomari	JV 1305/3-J	MN816738*	MN810028*	–	MN848801*
F. plumeriae	**Dai 17814**	**MN816714***	**MN810011***	–	**MN848845***
F. plumeriae	**Dai 18858**	**MN816712***	**MN810010***	**MN848769***	**MN848843***
F. plumeriae	**Dai 18820**	**MN816722***	**MN810012***	**MN848770***	**MN848844***
F. punctatiformis	Dai 17443	MH050755	MH050764	–	–
F. punctatiformis	Doll#872a	MH050753	–	–	–
F. ramulicola	Dai 15723	MH050749	MH050762	MH079398	MN848824*
F. ramulicola	Dai 16155	MH050750	MH050763	MH079399	MN848825*
F. rhabarbarina	Cui 11357	–	MN810034*	MN848782*	MN848837*
F. rhabarbarina	Dai 16226	MN816743*	MN810035*	MN848784*	MN848838*
F. rhabarbarina	Dai 16550	MN816744*	MN810036*	MN848785*	MN848836*
F. roseocinerea	**JV 1407/84**	**MN816740***	**MN810030***	**MN848774***	**MN848819***
F. roseocinerea	**JV 1408/31**	**MN816741***	**MN810031***	–	–
F. roseocinerea	**JV 1109/78-J**	**MN816742***	**MN810032***	–	**MN848820***
F. rufitincta	JV 1008/25	KJ940029	KX058575	–	–
F. rufitincta	JV 0904/142	KJ940030	KX058574	–	–
F. senex	Dai 15775	MN816746*	MN810038*	MN848787*	MN848834*
F. senex	Dai 17043	MN816747*	MN810039*	MN848786*	MN848835*
F. senex	MEL2382630	KP012992	–	–	–
F. senex	KAUNP MK41	KP794600	–	–	–
F. septiseta	Dai 12820	MG008405	MN810033*	–	MH636394
F. septiseta	JV 0509/78	MG008404	–	–	–
F. septiseta	TENN 046808	MG008434	MG570133	–	–

Table 1 Continued.

Taxa	Voucher specimens	GenBank accession numbers			
		ITS	**nLSU**	**RPB2**	**TEF1**
F. setifera	Dai 15710	MH050758	MH050767	MN159390	MN848841*
F. setifera	Dai 15706	MH050759	MH050769	MN159391	MN848842*
F. shoreae	**Dai 17800**	**MN816733***	**MN810024***	–	**MN848814***
F. shoreae	**Dai 17806**	**MN816734***	**MN810025***	–	**MN848815***
F. shoreae	**Dai 17818**	**MN816735***	**MN810026***	–	**MN848816***
F. sinica	Dai 15468	MG008412	MG008459	–	MH636392
F. sinica	Dai 15489	MG008407	MG008458	MN848798*	MH636393
F. sinica	Cui 9454	MG008411	–	–	MH636391
F. subchrysea	**Dai 16201**	**MN816708***	**MN809997***	**MN848796***	**MN848811***
F. subchrysea	**Dai 17656**	**MN816709***	**MN809998***	–	**MN848812***
F. subferrea	Dai 16326	KX961097	KY053472	MH079400	MN848826*
F. subferrea	Dai 16327	KX961098	KY053473	MH079401	–
F. torulosa	JV 1405/2	KX961106	KY189106	MN848779*	MH636405
F. torulosa	JV 1312/19-Kout	KX961107	KY189107	MN848780*	MH636406
F. torulosa	Dai 15518	MN816732*	MN810023*	MN848781*	MN848827*
F. viticola	JV 0911/6	KX961110	–	–	–
F. viticola	He 2081	MN121770	MN121829	–	–
F. viticola	He 2123	MN816725*	MN810017*	–	–
F. wahlbergii	JV 1312/20-Kout	MN816727*	MG008462	–	–
F. wahlbergii	Dai 18673	–	MN810019*	–	MN848828*
F. wahlbergii	JV 0709/169-J	MN816728*	–	–	–
F. wahlbergii	89-922	–	AF311045	–	–
F. yunnanensis	Cui 8182	MH050756	MN810029*	MN848789*	–
F. yunnanensis	Dai 15637	MH050757	MH050768	–	–
Outgroups					
Coniferiporia weirii	CFS 504	AY829341	AY829345	–	–
Phellinidium fragrans	CBS 202.90	AY558619	AY059027	–	–

* Newly generated sequences for this study. New species and new combinations are in bold

Taxonomy

Fuscoporia australasica Q. Chen, F. Wu & Y.C. Dai, sp. nov. Figs 3a, b, 4

MycoBank number: MB 833958; Facesoffungi number: FoF 07995.

Etymology – *Australasica* (Lat.): referring to the species found in Southern Asia.

Holotype – China, Yunnan Province, Jingdong County, Ailaoshan Nature Reserve, on dead angiosperm tree, 24 Aug 2015, Y.C. Dai 15636 (BJFC 019740).

Basidiocarps – Perennial, pileate, solitary to imbricate, without odor or taste when fresh, hard corky when dry. Pilei mostly dimidiate, rarely circular, projecting up to 6 cm long, 8 cm wide and 1.8 cm thick at the base. Pilear surface reddish brown, concentrically sulcate with zones, velutinate to glabrous; margin obtuse to slightly acute, yellowish brown, up to 5 mm wide. Pore surface honey-yellow to olivaceous buff, glancing, margin narrow, yellowish, up to 2 mm wide; pores circular, 6–8 per mm; dissepiments thin, entire, abundant hymenial setae in tube cavities (under anatomical lens). Context clay-buff, hard corky, about 1 mm thick. Tubes concolorous with pores, hard corky, up to 1.7 cm long.

Hyphal structure – Hyphal system dimitic; generative hyphae simple septate; tissue darkening but otherwise unchanged in KOH.

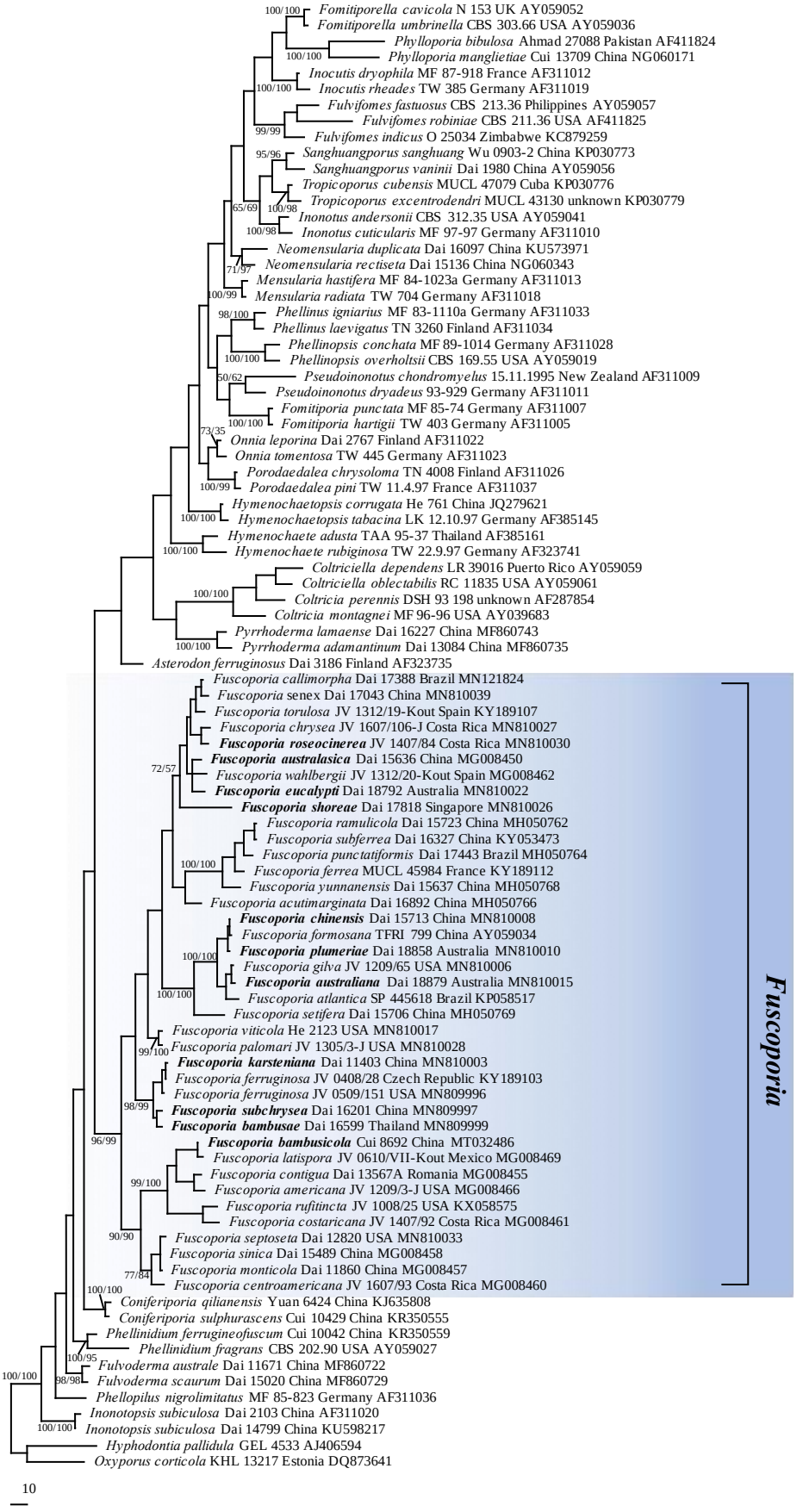

Figure 1 – Phylogenetic position of *Fuscoporia* within the Hymenochaetaceae inferred from the nLSU rDNA dataset. The topology is from one of the four MP trees. Statistical values (MP/ML) are indicated for each node that received bootstrap support from ML and MP ≥50%. Names of new species are in bold.

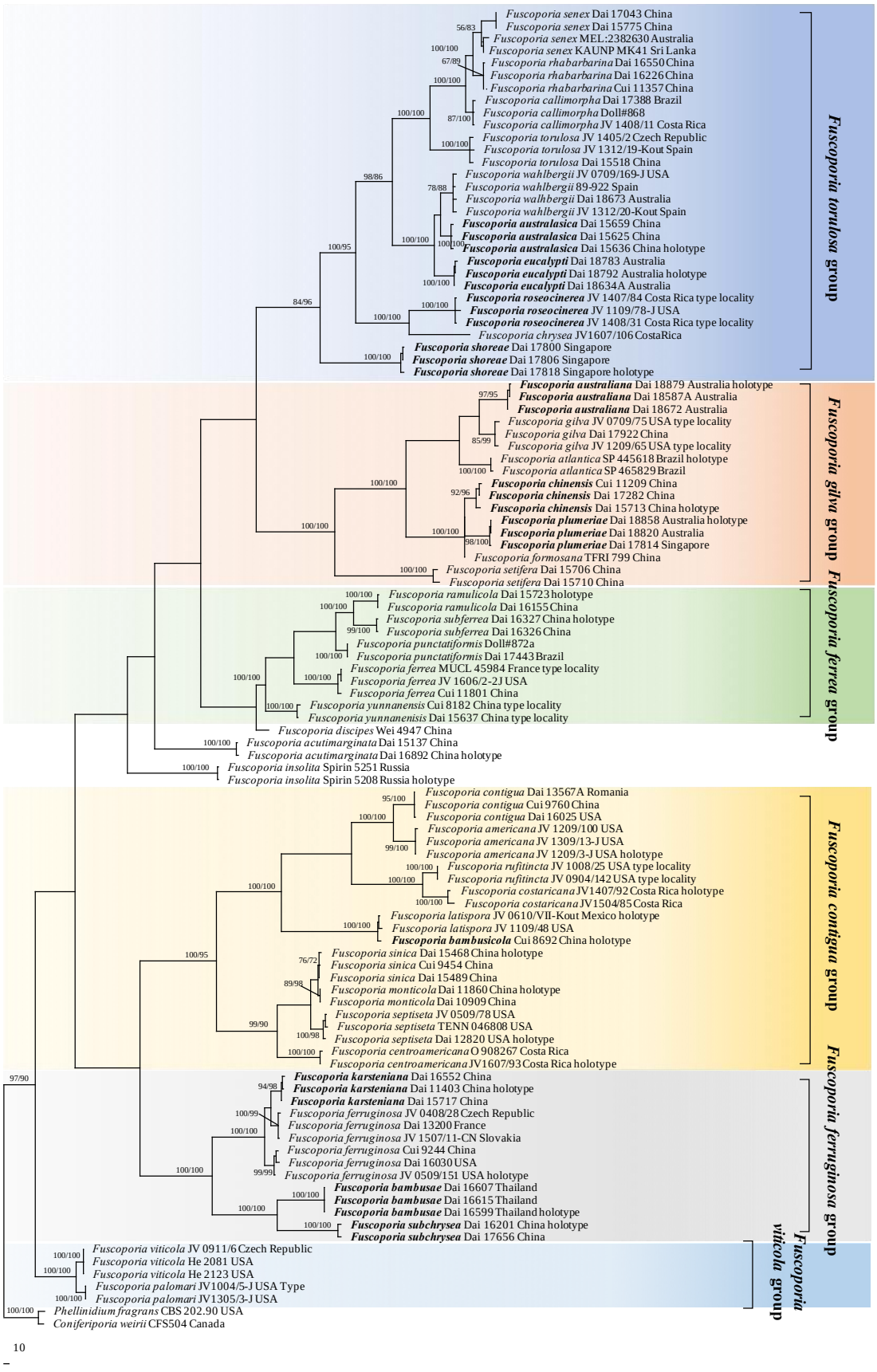

Figure 2 – Phylogeny of *Fuscoporia* species inferred from ITS+28S+RPB2+TEF1 dataset. The topology is one of the four MP trees. Statistical values (MP/ML) are indicated for each node that received bootstrap support from ML and MP ≥50%. Names of new species are in bold.

Context – Generative hyphae rare, hyaline, thin- to slightly thick-walled, unbranched, frequently simple septate, 2–2.5 μm in diam.; skeletal hyphae dominant, rust-brown, thick-walled with a medium to wide lumen, unbranched, occasionally septate, straight, regularly arranged, 3–3.5 μm in diam.

Tubes – Generative hyphae rare, mostly present at dissepiment edges and subhymenium, hyaline, thin-walled, frequently branched and simple septate, 1.5–2.5 μm in diam., some of them encrusted at dissepiment edges and in the hymenium; skeletal hyphae dominant, yellowish brown, thick-walled with a medium to wide lumen, frequently septate, more or less straight, subparallel along the tubes, 2.5–3.5 μm in diam. Hymenial setae subulate, occasionally hooked, mostly originating from tramal hyphae, dark brown, thick-walled, 30–45 × 6–9 μm; fusoid cystidioles hyaline and thin-walled, 9.5–12 × 4–5.5 μm; basidia short clavate to barrel-shaped, with four sterigmata and a simple septum at the base, 9–11 × 5–6.5 μm; basidioles dominating the hymenium, in shape similar to basidia, but slightly smaller.

Spores – Basidiospores broadly ellipsoid to subglobose, hyaline, thin-walled, smooth, IKI–, CB–, some of them bearing a guttule, (3.8–)4–5 × (3.2–)3.3–4(–4.5) μm, L = 4.40 μm, W = 3.88 μm, Q = 1.12–1.15 (n = 90/3).

Other materials examined (paratypes) – China, Hainan Province, Lingshui County, Diaoluoshan Forest Park, on fallen angiosperm trunk, 13 Nov 2015, Y.C. Dai 16127 (BJFC 020221); Yunnan Province, Jingdong County, Ailaoshan Nature Reserve, on angiosperm stump, 15 Oct 2013, Y.C. Dai 13552 (BJFC 015014), 24 Aug 2015, Y.C. Dai 15635 (BJFC 019739); on dead angiosperm tree, 24 Aug 2015, Y.C. Dai 15625 (BJFC 019729); Yongde County, Daxueshan Nature Reserve, on rotten angiosperm stump, 27 Aug 2015, Y.C. Dai 15659 (BJFC 019763). Vietnam, Lam Dong Province, Lac Duong District, Bidoup Nui Ba National Park, on dead angiosperm tree, 15 Oct 2017, Y.C. Dai 18362 (BJFC 025885).

Note – *Fuscoporia australasica* grows on angiosperm wood in tropical Asia and is characterized by pileate basidiocarps, small pores (6–8 per mm), occasionally hooked hymenial setae and broadly ellipsoid to subglobose basidiospores, 4–5 × 3.2–4 μm. In our phylogeny, three specimens of *Fuscoporia australasica* form a lineage with strong support (100/100, Fig. 2). *Fuscoporia australasica* is closely related to *F. eucalypti* sp. nov. and *F. wahlbergii* (Fr.) T. Wagner & M. Fisch. (Figs 1–2). Morphologically, these species share the hooked hymenial setae and broadly ellipsoid to subglobose basidiospores; but basidiospores are wider in *F. eucalypti* than in *F. australasica* (4–4.5 μm vs. 3.3–4 μm) and *F. wahlbergi* has globose spores (3.5–4 μm, Reid 1975).

Fuscoporia australiana Q. Chen, F. Wu & Y.C. Dai, sp. nov. Figs 3c, 5

MycoBank number: MB 833960; Facesoffungi number: FoF 07996.

Etymology – *Australiana* (Lat.): referring to the species found in Australia.

Holotype – Australia, Sydney, Sydney Botanical Garden, on stump of *Combretum*, 20 May 2018, Y.C. Dai 18879 (BJFC 027347, isotype in MEL).

Basidiocarps – Usually annual, occasionally biennial, pileate, solitary to imbricate, sometimes effused-reflexed, without odor or taste and corky when fresh, becoming hard corky and light-weight when dry. Pilei mostly dimidiate to conchate, sometimes laterally fused, projecting up to 5 cm long, 10 cm wide and 1.5 cm thick at the base. Pilear surface olivaceous buff to clay-buff, indistinctly concentrically sulcate with zones, hispid to rugose; margin obtuse, honey-yellow. Pore surface grayish brown to olivaceous buff, slightly glancing; margin narrow, honey-yellow, paler than pore surface, up to 1 mm wide; pores more or less round, 7–9 per mm; dissepiments thin, entire to slightly lacerate, sometimes sinuous or irregular, abundant setae seen in tube cavities (under anatomical lens). Context honey-yellow to curry-yellow, hard corky, zonate, up to 0.5 cm thick. Tubes olivaceous buff, paler than pore surface, hard corky up to 1 cm long.

Context – Generative hyphae rare, hyaline, thin-walled, occasionally branched, frequently simple septate, 2–3 μm in diam.; skeletal hyphae dominant, yellowish brown, thick-walled with a wide lumen, unbranched, aseptate, straight, regularly arranged, 3.5–5 μm in diam.

Tubes – Generative hyphae rare, mostly present at dissepiment edges and subhymenium, hyaline, thin-walled, frequently branched and septate, 1.5–2.5 μm in diam., some of them encrusted at dissepiment edges and in the hymenium; skeletal hyphae dominant, yellowish brown, thick-walled with a wide lumen, unbranched, aseptate, straight, subparallel along the tubes, 2.5–3.5 μm in diam. Setae frequent, mostly originating from tramal hyphae, ventricose to subulate, dark brown, thick-walled, 20–35 × 5–7 μm; fusoid cystidioles hyaline, thin-walled, sometimes bearing crystals, 15–22 × 3–4 μm; basidia short clavate to barrel-shaped, with four sterigmata and a simple septum at the base, 12–16 × 4–6 μm; basidioles dominating in hymenium, in shape similar to basidia, but slightly smaller.

Figure 3 – Basidiocarps of *Fuscoporia* species. a–b *Fuscoporia australasica* (paratype, Dai 15625). c *Fuscoporia australiana* (holotype, Dai 18879). d *Fuscoporia bambusae* (holotype, Dai 16599). e–f *Fuscoporia chinensis* (e paratype, Dai 17282, f paratype, Dai 17583). g *Fuscoporia eucalypti* (paratype, Dai 18642A). h *Fuscoporia karsteniana* (paratype, Dai 17925). Scale Bars = 10 mm.

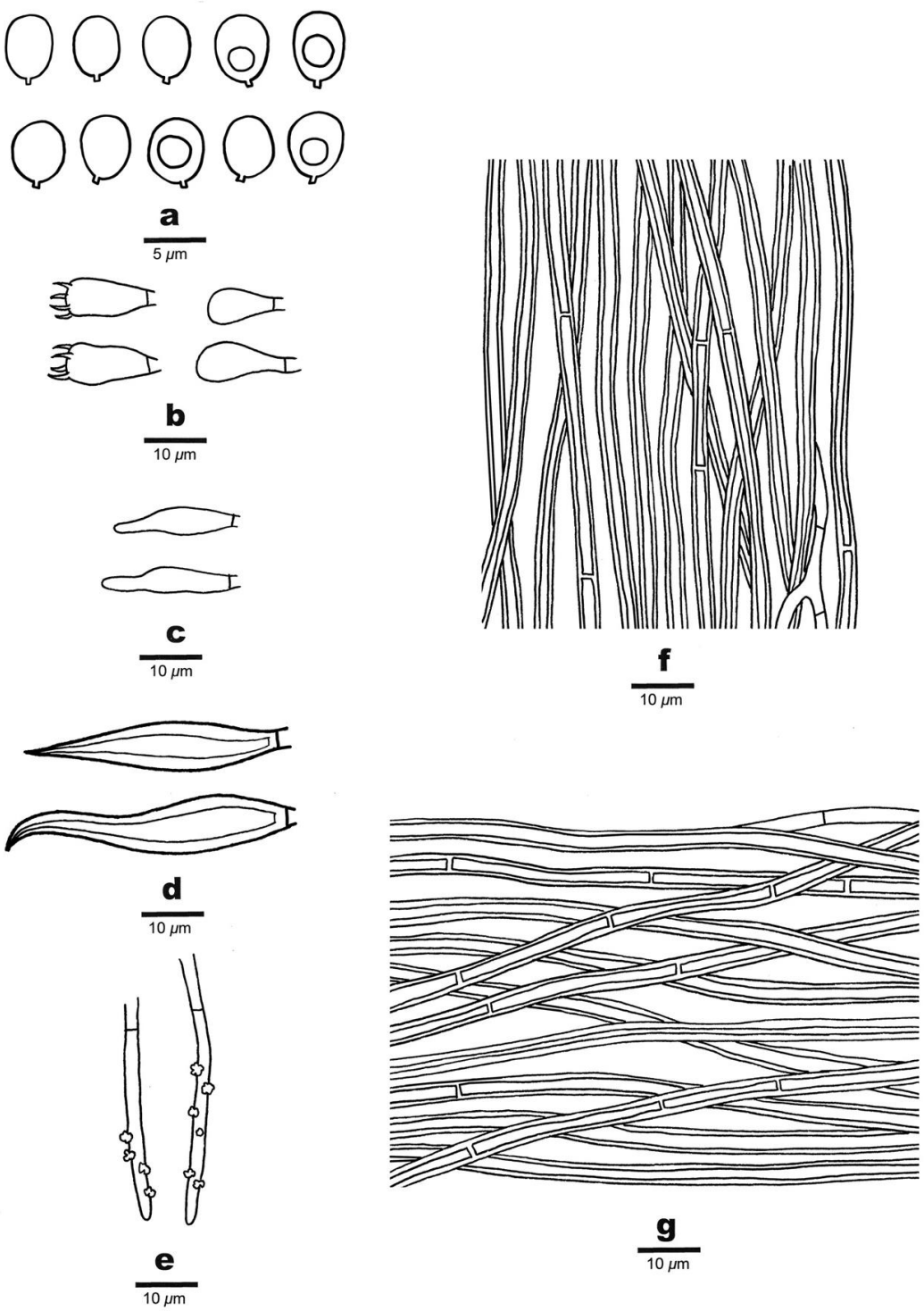

Figure 4 – Microscopic structures of *Fuscoporia australasica* (holotype, Dai 15636). a Basidiospores. b Basidia and basidioles. c Cystidioles. d Hymenial setae. e Generative hyphae at dissepiment edge. f Hyphae from trama. g Hyphae from context.

Hyphal structure – Hyphal system dimitic; generative hyphae simple septate; tissue darkening but otherwise unchanged in KOH.

Spores – Basidiospores ellipsoid, hyaline, thin-walled, smooth, IKI–, CB–, usually bearing a small guttule, (3.8–)4–4.8(–5) × (2–)2.5–3(–3.5) μm, L = 4.28 μm, W = 2.73 μm, Q = 1.56–1.64 (n = 60/2).

Other materials examined (paratypes) – Australia, Melbourne, Dandenong Ranges Botanical

Garden, on fallen trunk of *Eucalyptus*, 12 May 2018, Y.C. Dai 18672 (BJFC 027141); Royal Botanic Gardens, on angiosperm stump, 8 May 2018, Y.C. Dai 18587A (BJFC 027056).

Note – *Fuscoporia australiana* was discovered in Australia, and the species is characterized by the annual to biennial, pileate basidiocarps with indistinctly concentrically sulcate, hispid to rugose pileal surface, small pores (7–9 per mm), ellipsoid basidiospores measuring 4–4.8 × 2.5–3 μm. *F. atlantica* Motato-Vásq., R.M. Pires & Gugliotta, *F. chinensis* sp. nov., *F. formosana* (T.T. Chang & W.N. Chou) T. Wagner & M. Fisch., *F. gilva* and *F. plumeriae* sp. nov. clustered together with *F. australiana* into a group with strong support (100/100, Figs 1–2). All these species share similar morphological characteristics as effused-reflexed to pileate basidiocarps with lacerate dissepiments and ellipsoid basidiospores. However, they formed six independent lineages in our phylogeny (Fig. 2). Morphologically, *F. atlantica* distinguishes itself from *F. australiana* by dark brown crusted pilear surface, hooked hymenial setae and wider basidiospores (3–3.5 μm vs. 2.5–3 μm, Pires et al. 2015). Both, *F. australiana* and *F. plumeriae* occur in Australia, but *F. plumeriae* has smaller basidiospores measuring 3–3.8 × 2.2–2.8 μm. *F. chinensis* differs from *F. australiana* by its septate hymenial setae and smaller basidiospores (3–4 × 2–2.5 μm vs. 4–4.8 × 2.5–3 μm). *F. gilva* is different from *F. australiana* by the presence of lacerate to dentate dissepiments, septate skeletal hyphae and shorter basidiospores (3.3–4.2 μm vs. 4–4.8 μm, Dai 2010). *F. formosana* is distinguished from *F. australiana* by larger pores (3–5 per mm) and smaller basidiospores measuring 3.5–4 × 1.5–2.5 μm (Chang & Chou 1998, Ryvarden 2005). Both *F. australiana* and *F. eucalipti* sp. nov. are from Australia and can grow on *Eucalyptus*, but the latter differs from the former by hooked setae and sugbglobose basidiospores which are distinctly wider (4–4.5 μm in *F. eucalipti* vs. 2.5–3 μm in *F. australiana*). In addition, they are not phylogenetically related (Fig. 2).

Fuscoporia bambusae Q. Chen, F. Wu & Y.C. Dai, sp. nov. Figs 3d, 6

MycoBank number: MB 833963; Facesoffungi number: FoF 07997.

Etymology – *Bambusae* (Lat.): referring to the species growing on Bambusaceae.

Holotype – Thailand, Rai Empress, Dowager University Campus, on rotten bamboo, 21 Jul 2016, Y.C. Dai 16599 (BJFC 022710).

Basidiocarps – Annual, resupinate, inseparable, without odor or taste when fresh, corky and light-weight when dry, up to 15 cm long, 3 cm wide and less than 1 mm thick at centre. Pore surface grayish brown, more or less fawn, uncracked when dry, sterile margin curry-yellow, paler than pore surface, usually with abundant mycelial setae, up to 2 mm wide; pores more or less circular, sometimes sinuous or irregular, 5–7 per mm; dissepiments thin, entire to slightly lacerate, abundant hymenial setae seen in tube cavities (under anatomical lens). Subiculum fawn, corky, thin to almost lacking, up to 0.1 mm thick. Tubes honey-yellow, paler contrasting with subiculum, hard corky, up to 0.9 mm long.

Hyphal structure – Hyphal system dimitic; generative hyphae simple septate; tissue darkening but otherwise unchanged in KOH.

Subiculum – Generative hyphae very rare, hyaline, thin-walled, occasionally branched, frequently simple septate, 2.5–3.8 μm in diam.; skeletal hyphae dominant, rust-brown, thick-walled with a medium to wide lumen, unbranched, aseptate, flexuous, interwoven, 3–3.8 μm in diam.; mycelial setae frequent, dark reddish brown, thick-walled, septate, tapering to apex, present in the subiculum and in the rotten bamboo cavities, sometimes locally abundant, often in bundles, up to 240 μm long and 5–9 μm in the widest part.

Tubes – Generative hyphae rare, mostly present at dissepiment edges and subhymenium, hyaline, thin-walled, frequently branched and simple septate, 2–3.5 μm in diam, some of them encrusted at dissepiment edges and in hymenium; skeletal hyphae dominant, yellowish brown, thick-walled with a narrow to medium lumen, unbranched, aseptate, flexuous, interwoven, 2.8–4 μm in diam. Hymenial setae frequent, narrowly subulate, mostly originating from tramal hyphae, dark brown, thick-walled, occasionally septate, 45–96 × 5–9 μm; fusoid cystidioles frequent, hyaline and thin-walled, 14–23 × 3–4.2 μm; basidia short clavate to barrel-shaped, with four

sterigmata and a simple septum at the base, occasionally bearing a medium size guttule, 12–16 × 4.5–7.2 μm; basidioles dominating in hymenium, barrel-shaped, smaller than basidia.

Spores – Basidiospores ellipsoid, hyaline, thin-walled, smooth, usually glued in tetrads, bearing a small guttule, IKI–, CB–, (4.2–)4.3–5.3(–5.8) × (2.7–)2.8–3.6(–3.8) μm, L = 4.87 μm, W = 3.24 μm, Q = 1.47–1.54(n = 60/2).

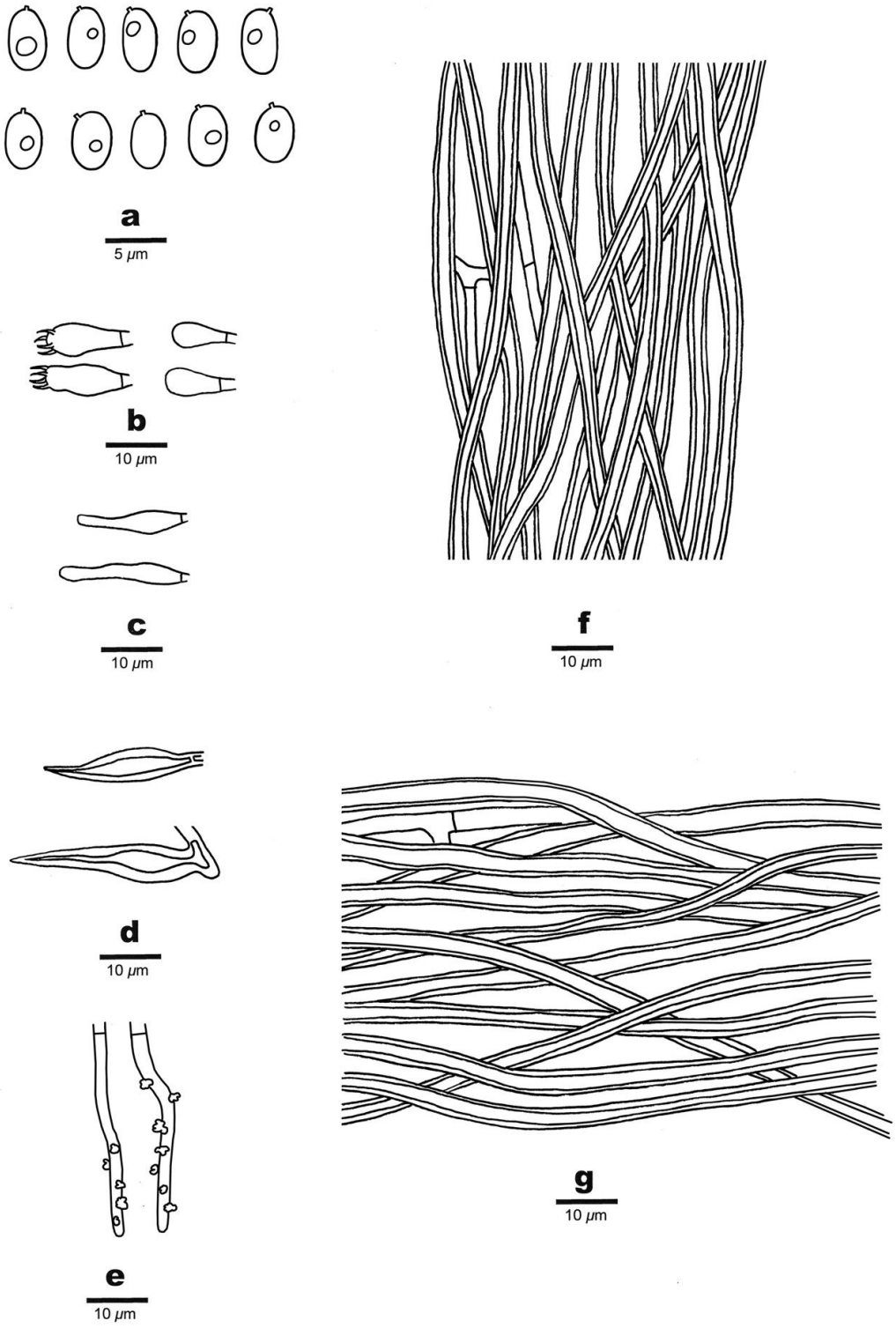

Figure 5 – Microscopic structures of *Fuscoporia australiana* (holotype, Dai 18879). a Basidiospores. b Basidia and basidioles. c Cystidioles. d Hymenial setae. e Generative hyphae at dissepiment edge. f Hyphae from trama. g Hyphae from context.

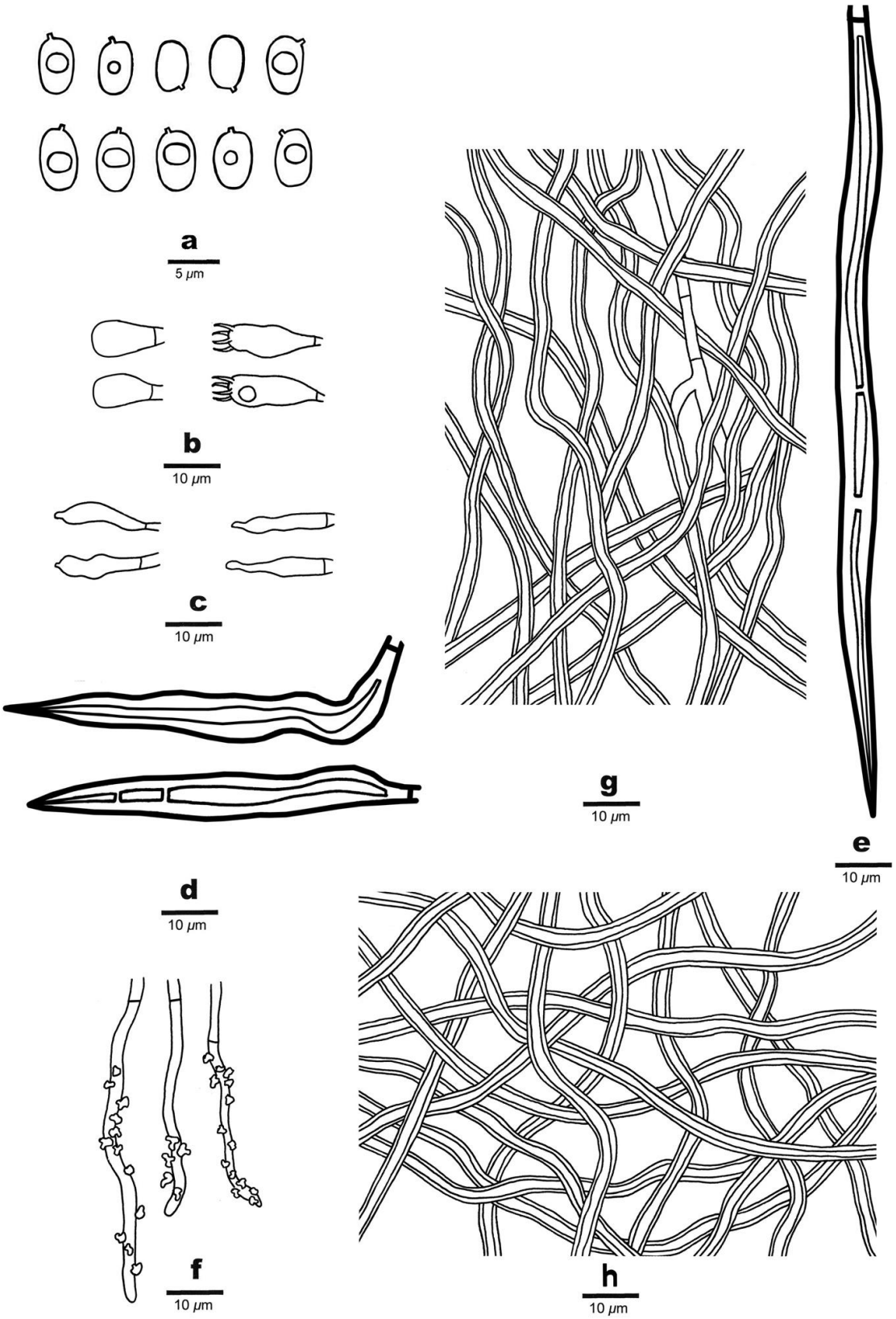

Figure 6 – Microscopic structures of *Fuscoporia bambusae* (holotype, Dai 16599). a Basidiospores. b Basidia and basidioles. c Cystidioles. d Hymenial setae. e Mycelial setae. f Generative hyphae at dissepiment edge. g Hyphae from trama. h Hyphae from subiculum.

Other materials examined (paratypes) – Thailand, Rai Empress, Dowager University Campus, on rotten bamboo, 21 Jul 2016, Y.C. Dai 16607 (BJFC 022718); on dead bamboo, 21 Jul 2016, Y.C. Dai 16615 (BJFC 022725).

Note – *Fuscoporia bambusae* is a tropical species growing on bamboo, differs from other species in *Fuscoporia* by its septate hymenial setae and mycelial setae. Three species of *Fuscoporia* grow on bamboo, *F. bambusae*, *F. bambusicola*, and *F. subchrysea*, they share resupinate basidiocarps and presence of mycelial setae; but *F. bambusicola* can be easily distinguished from *F. bambusae* by its larger pores (3–5 per mm, Zhou & Jia 2010); *F. subchrysea* is closely related phylogenetically to *F. bambusae* (Figs 1–2), but differs by its smaller pores (8–9 per mm) and shorter basidiospores (3.8–4.4 μm long).

Fuscoporia chinensis Q. Chen, F. Wu & Y.C. Dai, sp. nov. Figs 3e, f, 7

MycoBank number: MB 833956; Facesoffungi number: FoF 07998.

Etymology – *Chinensis* (Lat.): referring to the species found in China.

Holotype – China, Yunnan Province, Binchuan County, Jizushan Park, on fallen angiosperm branch, 30 Aug 2015, Y.C. Dai 15713 (BJFC 019817).

Basidiocarps – Annual, effused-reflexed to pileate, broadly attached, imbricate, without odor or taste and corky when fresh. Pilei dimidiate or conchate, often laterally fused, projecting up to 2 cm long, 5 cm wide and 5 mm thick at the base. Pilear surface yellowish brown to dark reddish, indistinctly concentrically sulcate, velutinate to rugose with age; margin obtuse, yellowish brown. Pore surface grayish brown to dark reddish brown, glancing; margin distinct, yellowish, paler than pore surface, up to 2 mm wide; pores circular to angular, 7–8 per mm; dissepiments thin, slightly lacerate, abundant setae seen in tube cavities (under anatomical lens). Context yellowish brown, corky, up to 2 mm thick. Tubes yellowish brown, paler than context, corky, up to 3 mm long.

Hyphal structure – Hyphal system dimitic; generative hyphae simple septate; tissue darkening but otherwise unchanged in KOH.

Context – Generative hyphae rare, hyaline, thin-walled, occasionally branched and simple septate, 2.5–4 μm in diam.; skeletal hyphae dominant, yellowish brown, thick-walled with a wide lumen, unbranched, aseptate, interwoven, 3.5–5 μm in diam.

Tubes – Generative hyphae common, hyaline, thin-walled, frequently simple septate, occasionally branched, 2–4 μm in diam., some of them encrusted at dissepiment edges; skeletal hyphae dominant, yellowish brown, thick-walled with a wide lumen, unbranched, aseptate, straight, subparallel along the tubes, 3–4.5 μm in diam. Hymenial setae mostly originating from tramal hyphae, subulate, frequently septate, dark brown, thick-walled, 20–40 × 4–8 μm; fusoid cystidioles frequent, hyaline, thin-walled, sometimes covered with crystals, 14–20 × 4–6 μm; basidia short clavate to barrel-shaped, with four sterigmata and a simple septum at the base, 10–14 × 4–6 μm; basidioles in shape similar to basidia, but slightly smaller.

Spores – Basidiospores ellipsoid, hyaline, thin-walled, smooth, sometimes bearing a small guttule, IKI–, CB–, (2.9–)3–4(–4.3) × (1.8–)2–2.5(–2.8) μm, L = 3.55 μm, W = 2.26 μm, Q = 1.42–1.65 (n = 90/3).

Other materials examined (paratypes) – China, Hainan Province, Lingshui County, Diaoluoshan Forest Park, on fallen angiosperm branch, 13 Nov 2015, Y.C. Dai 16096 (BJFC 020189); Y.C. Dai 16119 (BJFC 020212); Heilongjiang Province, Heihe, Shengshan Nature Reserve, on fallen trunk of *Quercus*, 25 Aug 2014, Y.C. Dai 14246 (BJFC 017737); Hubei Province, Xiangfan, Xiangyang District, on fallen trunk of *Castanea*, 17 Oct 2016, Y.C. Dai 17282 (BJFC 023381); Wufeng County, Chaibuxi Park, on dead angiosperm tree, 14 Aug 2017, Y.C. Dai 17926 (BJFC 025455), Y.C. Dai 17936 (BJFC 025465), on dead tree of *Prunus*, 14 Aug 2017, Y.C. Dai 17913 (BJFC 025442); Houhe Nature Reserve, on angiosperm branch, 16 Aug 2017, Y.C. Dai 17960 (BJFC 025489); Y.C. Dai 17961 (BJFC 025490); Shanxi Province, Pingli County, Hualongshan Nature Reserve, on dead angiosperm tree, 14 Sept 2013, B.K. Cui 11209 (BJFC 015324); Sichuan Province, Qionglai County, Tiantaishan Forest Park, on dead angiosperm tree, 23 Oct 2012, B.K. Cui 10872 (BJFC 013794); Yunnan Province, Baoshan, Longyang District, Baihualing, on stump of angiosperm tree, 30 Nov 2015, Y.C. Dai 16386 (BJFC 020474); Nanhua County, Dazhongshan Nature Reserve, on dead angiosperm tree, 14 Jul 2013, B.K. Cui 11117 (BJFC 015232); Xinping County, Shimenxia Park, on stump of *Alnus*, 16 Jun 2017, Y.C. Dai 17583

(BJFC 025115); Yongde County, Daxueshan Nature Reserve, on rotten angiosperm wood, 28 Aug 2015, Y.C. Dai 15681 (BJFC 019785).

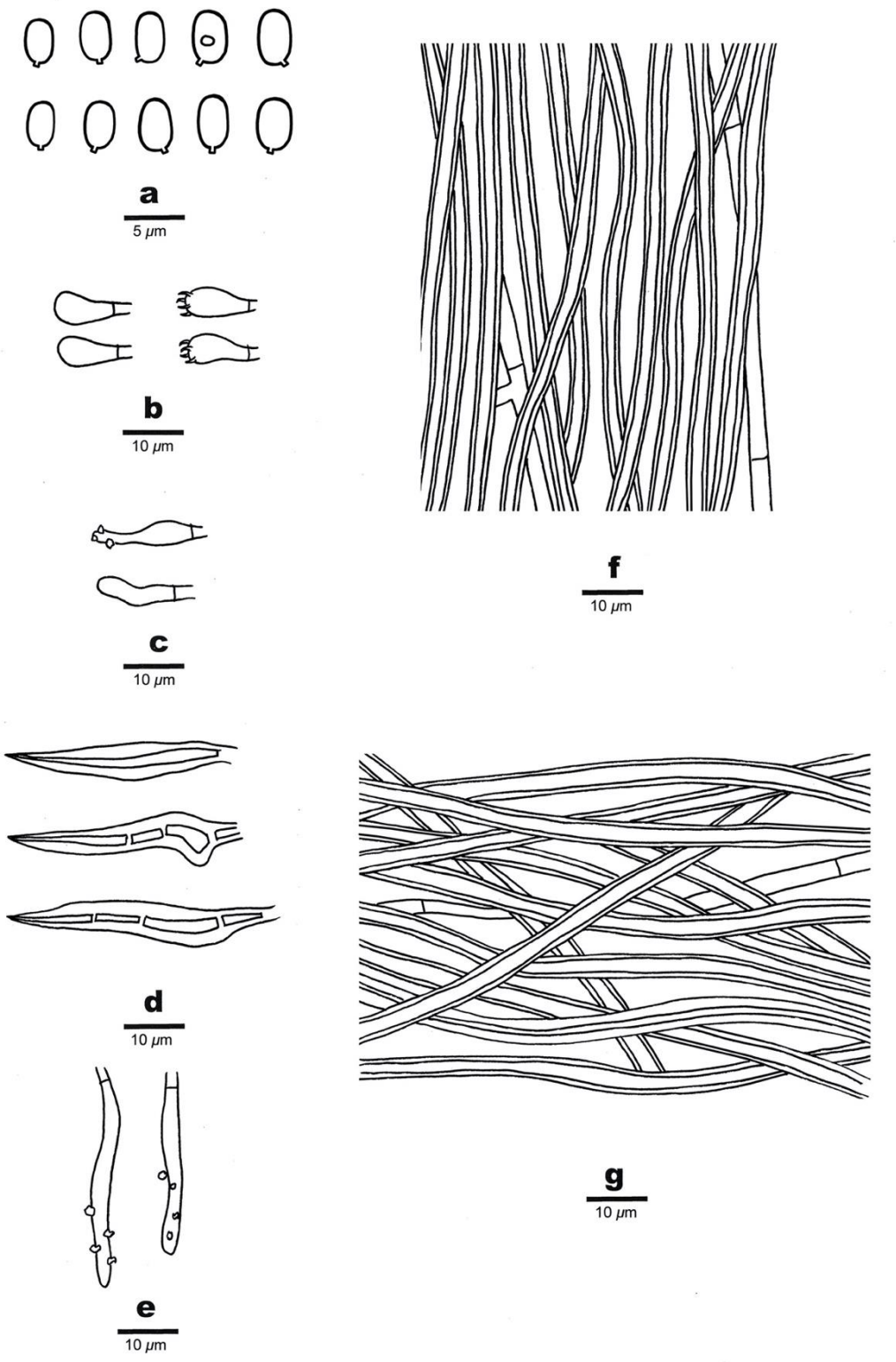

Figure 7 – Microscopic structures of *Fuscoporia chinensis* (holotype, Dai 15713). a Basidiospores. b Basidia and basidioles. c Cystidioles. d Hymenial setae. e Generative hyphae at dissepiment edge. f Hyphae from trama. g Hyphae from context.

Note – *Fuscoporia chinensis* is a common species in China. Morphologically, it is characterized by annual, effused-reflexed to pileate basidiocarps with indistinctly concentrically

sulcate, velutinate to radially rugose pilear surface, small pores (7–8 per mm), septate hymenial setae, and small, ellipsoid basidiospores measuring 3–4 × 2–2.5 μm. Almost all specimens of *F. chinensis* were previously identified as *F. gilva* (Dai 1999, 2010, Chen & Dai 2019, Chen et al. 2019), and now they are confirmed as different species and segregated from *F. gilva*, which has septate skeletal hyphae and larger basidiospores (4–5 × 3–3.5 μm, Gilbertson 1979). *Fuscoporia chinensis* is closely related to *F. plumeriae* sp. nov. and *F. formosana*, but *F. plumeriae* has smaller pores (8–10 per mm), aseptate hymenial setae, septate skeletal hyphae; *F. formosana* is distinguished from *F. chinensis* by larger pores (3–5 per mm, Chang & Chou 1998).

Fuscoporia eucalypti Q. Chen, F. Wu & Y.C. Dai, sp. nov. Figs 3g, 8

MycoBank number: MB 833959; Facesoffungi number: FoF 07999.

Etymology – *Eucalypti* (Lat.): referring to the species growing on *Eucalyptus.*

Holotype – Australia, Tasmania, Arve River, Streamside Nature Reserve, on base of living *Eucalyptus*, 15 May 2018, Y.C. Dai 18792 (BJFC 027260, isotype in MEL).

Basidiocarps – Perennial, effused-reflexed to pileate, laterally fused, solitary to imbricate, without odor or taste and corky when fresh, light-weight and hard corky when dry. Pilei mostly dimidiate, projecting up to 5 cm long, 8 cm wide and 3 cm thick at the base. Pilear surface blackish brown to black, concentrically sulcate with zones, velutinate to glabrous; margin yellowish brown, distinctly paler than the pilear surface, obtuse. Pore surface grayish brown to fawn, more or less glancing, uncracked when dry, margin narrow, yellowish, up to 3 mm wide; pores more or less circular, 6–8 per mm; dissepiments thin, entire, abundant hymenial setae in tube cavities (under anatomical lens). Context clay-buff, corky, about 2 mm thick. Tubes grayish brown to clay-buff, hard corky, up to 2.8 cm long, tube layers distinct.

Hyphal structure – Hyphal system dimitic; generative hyphae simple septate; tissue darkening but otherwise unchanged in KOH.

Context – Generative hyphae rare, hyaline, thin- to slightly thick-walled, frequently branched and simple septate, 2–3 μm in diam.; skeletal hyphae dominant, rust-brown, thick-walled with a narrow lumen, unbranched, moderately septate, straight, regularly arranged, 2.5–3 μm in diam.

Tubes – Generative hyphae rare, mostly present at dissepiment edges and subhymenium, hyaline, thin-walled, frequently branched and simple septate, 2–2.5 μm in diam, some of them encrusted at dissepiment edges and in hymenium; skeletal hyphae dominant, yellowish brown, thick-walled with a narrow lumen, septate, more or less straight, subparallel along the tubes, 2–3 μm in diam. Hymenial setae occasionally present, subulate, occasionally hooked, mostly originating from tramal hyphae, dark brown, thick-walled, 25–45 × 5–8 μm; fusoid cystidioles hyaline and thin-walled, 18–28 × 3–6 μm; basidia short clavate to barrel-shaped, with four sterigmata and a simple septum at the base, usually bearing a medium size guttule, 14–18 × 5.5–8 μm; basidioles dominating in hymenium, barrel-shaped, smaller than basidia.

Spores – Basidiospores subglobose, hyaline, thin-walled, smooth, usually bearing a small guttule, IKI–, CB–, (4–)4.3–5.5(–5.8) × (3.5–)4–4.5(–4.6) μm, L = 4.80 μm, W = 4.16 μm, Q = 1.16–1.22 (n = 90/3).

Other materials examined (paratypes) – Australia, Tasmania, Arve River, Streamside Nature Reserve, on stump of *Eucalyptus*, 15 May 2018, Y.C. Dai 18783 (BJFC 027251); on base of living *Eucalyptus*, 15 May 2018, Y.C. Dai 18791 (BJFC 027259), Y.C. Dai 18792 (BJFC 027260); Victoria, Yarra Ranges National Park, on base of living *Eucalyptus*, 10 May 2018, Y.C. Dai 18626A (BJFC 027095), Y.C. Dai 18634A (BJFC 027103); on dead tree of *Eucalyptus*, 10 May 2018, Y.C. Dai 18642A (BJFC 027111).

Note – *Fuscoporia eucalypti* grows on *Eucalyptus* sp. in South Australia. The species is characterized by fuscous to black brown pilear surface, occasionally hooked hymenial setae and subglobose basidiospores, 4.3–5.5 × 4–4.5 μm. *F. eucalypti* is similar to *F. atlantica* by effused-reflexed to pileate basidiocarps, small pores (7–9 per mm) and hooked hymenial setae, but *F. atlantica* has ellipsoid basidiospores (4–4.5 × 3–3.5 μm, Q = 1.5, Pires et al. 2015), and the two species are not closely related phylogenetically (Figs 1–2). *Fuscoporia eucalypti* is closely related

phylogenetically to *F. wahlbergii* and *F. australasica* (Figs 1–2). However, the latter two species have narrower basidiospores (3.3–4 μm and 3.3–4.2 μm, respectively, Dai 2010). In addition, a comparison of nucleotide differences in ITS region shows that *F. eucalypti* differs respectively from *F. australasica* and *F. wahlbergii* by 2.5 and 2%, and at least 1.5% nucleotide differences in the ITS regions was proposed as indicative of a new species (Jeewon & Hyde 2016).

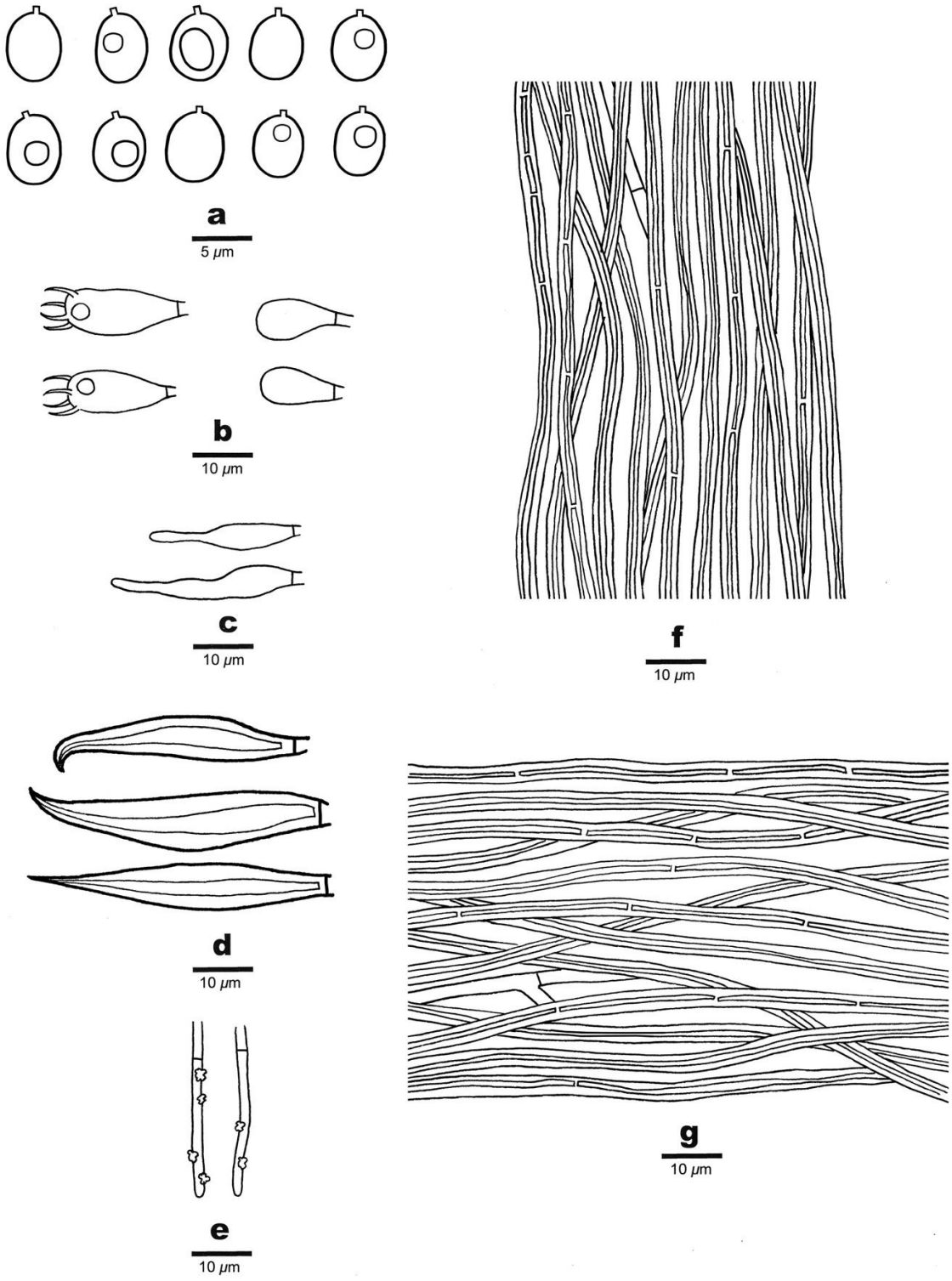

Figure 8 – Microscopic structures of *Fuscoporia eucalypti* (holotype, Dai 18792). a Basidiospores. b Basidia and basidioles. c Cystidioles. d Hymenial setae. e Generative hyphae at dissepiment edge. f Hyphae from trama. g Hyphae from context.

Fuscoporia karsteniana Q. Chen, F. Wu & Y.C. Dai, sp. nov. Figs 3h, 9

MycoBank number: MB 833962; Facesoffungi number: FoF 08000.

Etymology – *Karsteniana* (Lat.): in honor of the Finnish mycologist Petter Adolf Karsten.

Holotype – China, Jilin Province, Antu County, Changbaishan Nature Reserve, on *Populus*, 9 Oct 2009, Y.C. Dai 11403 (BJFC 007308).

Basidiocarps – Perennial, resupinate, inseparable, without odor or taste and soft corky when fresh, corky and light-weight when dry, up to 16 cm long, 5 cm wide and 7 mm thick at centre. Pore surface rusty brown, more or less fawn, occasionally cracked when dry, sterile margin narrow or almost lacking, up to 1 mm wide, honey-yellow, distinctly paler than pore surface, usually with mycelial setae; pores more or less circular, 5–7 per mm; dissepiments thin, entire, abundant hymenial setae seen in tube cavities (under anatomical lens). Subiculum cinnamon to reddish brown, corky, very thin, less 0.3 mm thick. Tubes grayish brown, paler contrasting with subiculum, hard corky, up to 6.7 mm long.

Hyphal structure – Hyphal system dimitic; generative hyphae simple septate; tissue darkening but otherwise unchanged in KOH.

Subiculum – Generative hyphae rare, hyaline, thin-walled, occasionally branched, frequently simple septate, 2–2.5 μm in diam.; skeletal hyphae dominant, rust-brown, thick-walled with a narrow to medium lumen, unbranched, aseptate, more or less straight, interwoven, 2.5–3 μm in diam.; mycelial setae frequent, dark reddish brown, thick-walled, tapering to apex, occasionally septate, present in the subiculum, sometimes locally abundant, often in bundles, up to 265 μm long and 5–9 μm in the widest part.

Tubes – Generative hyphae rare, mostly present at dissepiment edges and subhymenium, hyaline, thin-walled, frequently branched and simple septate, 1.5–2.2 μm in diam., some of them encrusted at dissepiment edges and in hymenium; skeletal hyphae dominant, yellowish brown, thick-walled with a narrow to medium lumen, unbranched, aseptate, more or less straight, subparallel along the tubes, 2.3–2.8 μm in diam. Hymenial setae frequent, narrowly subulate, mostly originating from tramal hyphae, dark brown, thick-walled, 34–45 × 5–7.5 μm; basidia barrel-shaped, with four sterigmata and a simple septum at the base, occasionally bearing a small guttule, 14–16 × 4–6 μm; basidioles dominating in hymenium, in shape similar to basidia, but slightly smaller.

Spores – Basidiospores ellipsoid, hyaline, thin-walled, smooth, usually glued in tetrads, bearing a small guttule, IKI–, CB–, 4.5–5.6(–5.8) × (2.8–)3–3.8(–3.9) μm, L = 5.05 μm, W = 3.37 μm, Q = 1.50–1.65 (n = 60/2).

Other materials examined (paratypes) – China, Guizhou Province, Libo County, Maolan Nature Reserve, on fallen trunk of *Prunus*, 15 Jun 2016, Y.C. Dai 16552 (BJFC 022664); Hubei Province, Yichang, Wufeng County, Chaibuxi Park, on dead angiosperm tree, 15 Aug 2017, Y.C. Dai 17925 (BJFC 025454); Shennongjia Park, on fallen angiosperm trunk, 16 Oct 2016, Y.C. Dai 17229 (BJFC 023327); Yunnan Province, Binchuan County, Jizushan Nature Reserve, on fallen trunk of *Quercus*, 30 Aug 2015, Y.C. Dai 15717 (BJFC 019821); Yuxi, Xinping County, Mopanshan Forest Park, on dead tree of *Schima*, 15 Jun 2017, Y.C. Dai 17618 (BJFC 025150); on dead angiosperm tree, 15 Jun 2017, Y.C. Dai 17629 (BJFC 025161).

Note – *Fuscoporia karsteniana* is widely distributed in China and characterized by perennial basidiocarps, septate mycelial setae, absence of cystidioles, and ellipsoid basidiospores measuring 4.5–5.6 × 3–3.8 μm. The new species is closely related to *F. ferruginosa sensu stricto* in our phylogenies (Figs 1–2), but *F. ferruginosa sensu stricto* has mostly annual and nodulose basidiocarps, very thick dissepiments (> pore diam.), presence of cystidioles, aseptate mycelial setae; while *F. karsteniana* has perennial, resupinate and even basidiocarps, thin dissepiments (< pore diam.), absence of cystidioles, some septate mycelial setae. *Fuscoporia chinensis* is another common species in China, it differs from *F. karsteniana* by effused-reflexed to pileate basidiocarps

and absence of mycelial setae.

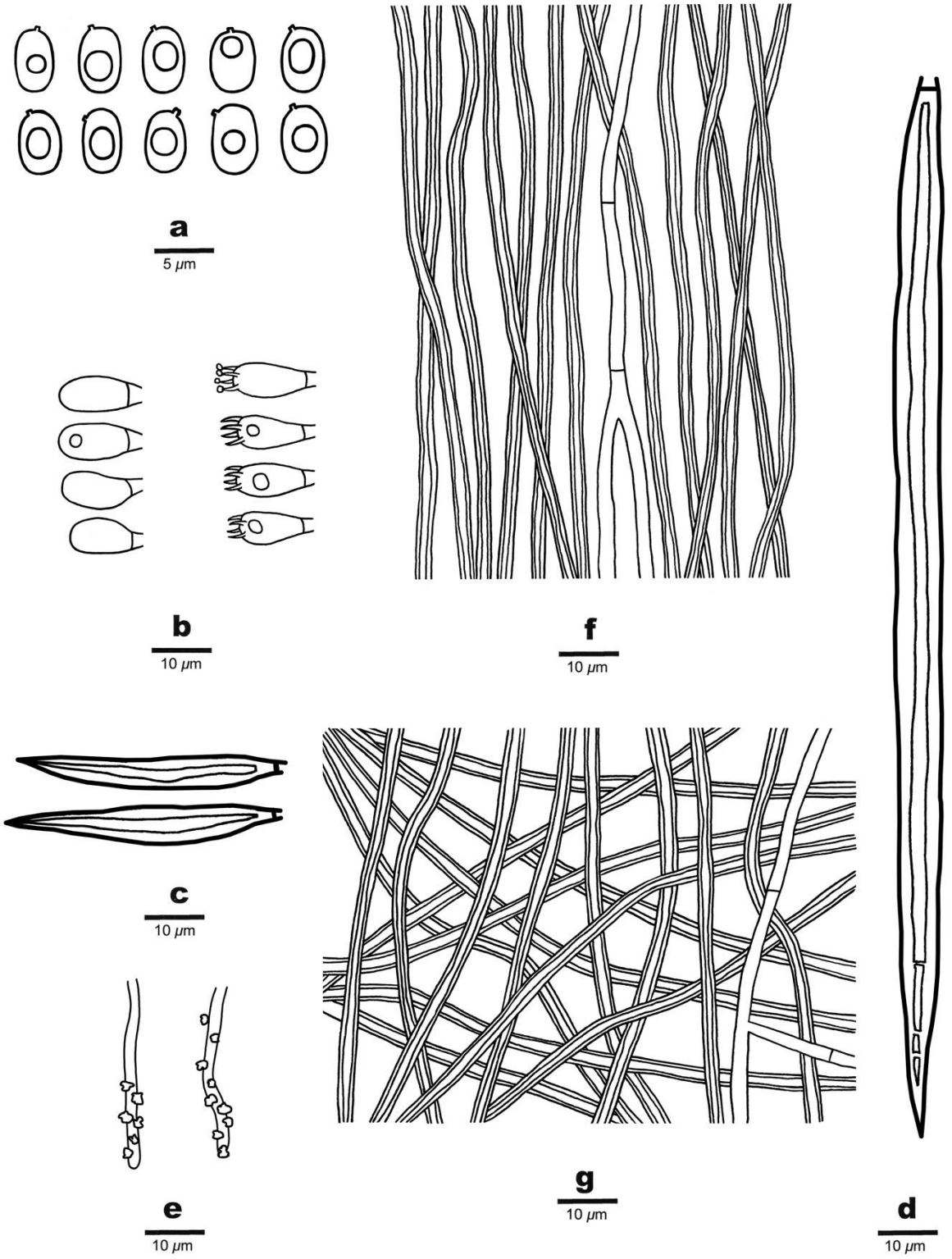

Figure 9 – Microscopic structures of *Fuscoporia karsteniana* (holotype, Dai 11403). a Basidiospores. b Basidia and basidioles. c Hymenial setae. d Mycelial setae. e Generative hyphae at dissepiment edge. f Hyphae from trama. g Hyphae from subiculum.

Fuscoporia plumeriae Q. Chen, F. Wu & Y.C. Dai, sp. nov. Figs 10a, b, 11

MycoBank number: MB 833957; Facesoffungi number: FoF 08001.

Etymology – *Plumeriae* (Lat.): referring to the species growing on *Plumeria*.

Holotype – Australia, Queensland, Cains, Crater Lake National Park, on dead tree of *Plumeria*, 18 May 2018, Y.C. Dai 18858 (BJFC 027326, isotype in MEL).

Basidiocarps – Annual, pileate, solitary, corky and without taste or odor when fresh, becoming hard corky and light-weight when dry. Pilei mostly dimidiate to conchate, projecting up to 7 cm long, 13 cm wide and 3.5 cm thick at the base. Pilear surface grayish brown to olivaceous buff, indistinctly concentrically zonate, nodulose; margin obtuse, honey-yellow. Pore surface fuscous, slightly glancing; margin narrow, honey-yellow, paler than pore surface, up to 1 mm; pores circular, 8–10 per mm; dissepiments thin, entire to slightly lacerate; abundant setae seen in tube cavities (under anatomical lens). Context honey-yellow, corky, zonate, up to 3 cm thick. Tubes grayish brown, paler than pore surface, hard corky up to 0.5 cm long.

Hyphal structure – Hyphal system dimitic; generative hyphae simple septate; tissue darkening but otherwise unchanged in KOH.

Context – Generative hyphae frequent, hyaline, thin- to slightly thick-walled, occasionally branched, frequently simple septate, 2–3 μm in diam.; skeletal hyphae dominant, yellowish brown, thick-walled with a wide lumen, unbranched, occasionally septate, straight, regularly arranged, 3–5 μm in diam.

Tubes – Generative hyphae frequent, mostly present at dissepiment edges and subhymenium, hyaline, thin-walled, frequently branched and septate, 2–3 μm in diam, some of them encrusted at dissepiment edges and in hymenium; skeletal hyphae dominant, yellowish brown, thick-walled with a wide lumen, unbranched, occasionally septate, straight, parallel along the tubes, 3–4 μm in diam. Hymenial setae frequent, mostly originating from tramal hyphae, ventricose to subulate, dark brown, thick-walled, 15–25 × 5–6 μm; fusoid cystidioles hyaline, thin-walled, sometimes covered by crystals, 12–18 × 2–3 μm; basidia short clavate to barrel-shaped, with four sterigmata and a simple septum at the base, 12–17 × 5–6.5 μm; basidioles dominating in hymenium, barrel-shaped to capitate, smaller than basidia.

Spores – Basidiospores ellipsoid, hyaline, thin-walled, smooth, IKI–, CB–, 3–3.8(–4) × (2–)2.2–2.8(–3) μm, L = 3.54 μm, W = 2.54 μm, Q = 1.31–1.40 (n = 60/2).

Other materials examined (paratypes) – Australia, Queensland, Cains, Crater Lake National Park, on fallen trunk of *Plumeria*, 17 May 2018, Y.C. Dai 18820 (BJFC 027288); Mt. Whitfield Coservation Park, on dead tree of *Plumeria*, 18 May 2018, Y.C. Dai 18861 (BJFC 027329). Singapore, Bukit Timah Nature Reserve, on fallen angiosperm trunk, 18 Jul 2017, Y.C. Dai 17814 (BJFC 025346).

Note – *Fuscoporia plumeriae* is characterized by annual and pileate basidiocarps with nodulose pilear surface, small pores (8–10 per mm), short hymenial setae (< 25 μm long), septate skeletal hyphae, small and ellipsoid basidiospores measuring 3–3.8 × 2.2–2.8 μm, and distributed in northern Australia and Singapore. It is a unique species in the genus that its context is thicker than the tubes. Macromorphologically *F. plumeria* resembles *F. gilva* and *F. australiana*, but *F. gilva* has larger pores (6–8 per mm) and larger basidiospores (4–5 × 3–3.5 μm, Gilbertson 1979, Ryvarden & Johansen 1980). On the other hand, *F. australiana* has acute margin, aseptate skeletal hyphae and longer basidiospores (4–4.8 μm).

Fuscoporia shoreae Q. Chen, F. Wu & Y.C. Dai, sp. nov. Figs 10c, d, 12

MycoBank number: MB 833969; Facesoffungi number: FoF 08002.

Etymology – *Shoreae* (Lat.): referring to the species growing on *Shorea* sp.

Holotype – Singapore, Bukit Timah Nature Reserve, on living tree of *Shorea*, 18 Jul 2017, Y.C. Dai 17818 (BJFC 025350).

Basidiocarps – Annual, pileate, solitary, corky and without odor or taste when fresh, hard corky when dry. Pilei mostly dimidiate, projecting up to 6 cm long, 9 cm wide and 1 cm thick at the base. Pilear surface grayish brown, concentrically sulcate with zones; margin obtuse, yellowish brown, distinctly paler than pilear surface. Pore surface curry-yellow to olivaceous buff, sterile margin distinct, yellowish, up to 3 mm wide; pores circular, 9–10 per mm; dissepiments thick, entire. Context curry-yellow, corky, about 0.8 cm thick. Tubes olivaceous buff, hard corky, up to

0.2 cm long.

Hyphal structure – Hyphal system dimitic; generative hyphae simple septate; tissue darkening but otherwise unchanged in KOH.

Context – Generative hyphae rare, hyaline, thin-walled, frequently branched and simple septate, 1.5–2 μm in diam.; skeletal hyphae dominant, rust-brown, thick-walled with a narrow lumen, unbranched, frequently septate, flexuous, interwoven, 2.5–3 μm in diam.

Figure 10 – Basidiocarps of *Fuscoporia* species. a–b *Fuscoporia plumeriae* (holotype, Dai 18858). c–d *Fuscoporia shoreae* (c holotype, Dai 17818, d paratype, Dai 17800). e *Fuscoporia subchrysea* (holotype, Dai 16201). f *Fuscoporia bambusicola* (holotype, Cui 8692). g *Fuscoporia roseocinerea* (holotype, JV 1407/85). Scale Bars = 10 mm.

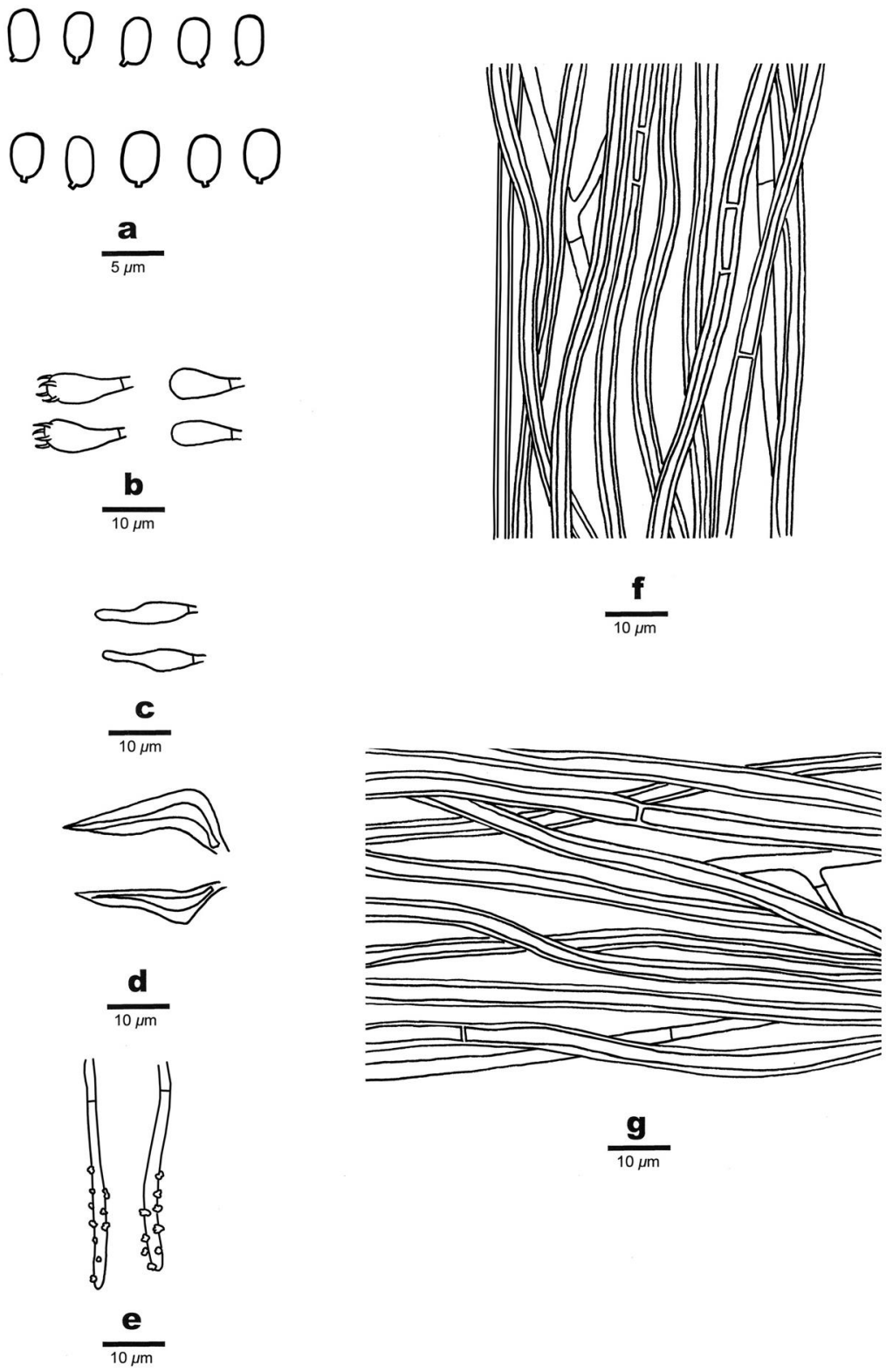

Figure 11 – Microscopic structures of *Fuscoporia plumeriae* (holotype, Dai 18858). a Basidiospores. b Basidia and basidioles. c Cystidioles. d Hymenial setae. e Generative hyphae at dissepiment edge. f Hyphae from trama. g Hyphae from context.

Tubes – Generative hyphae frequent, mostly present at dissepiment edges and subhymenium, hyaline, thin-walled, frequently branched and simple septate, 1.5–2 μm in diam.; skeletal hyphae dominant, yellowish brown, thick-walled with a narrow lumen, frequently septate, more or less straight, subparallel along the tubes, 2–2.5 μm in diam. Hymenial setae absent; fusoid cystidioles

hyaline and thin-walled, 16–22 × 3.5–5.5 μm; basidia barrel-shaped to capitate, with four sterigmata and a simple septum at the base, 12–15 × 4.5–6 μm; basidioles dominating in hymenium, in shape similar to basidia, almost the same size of basidia.

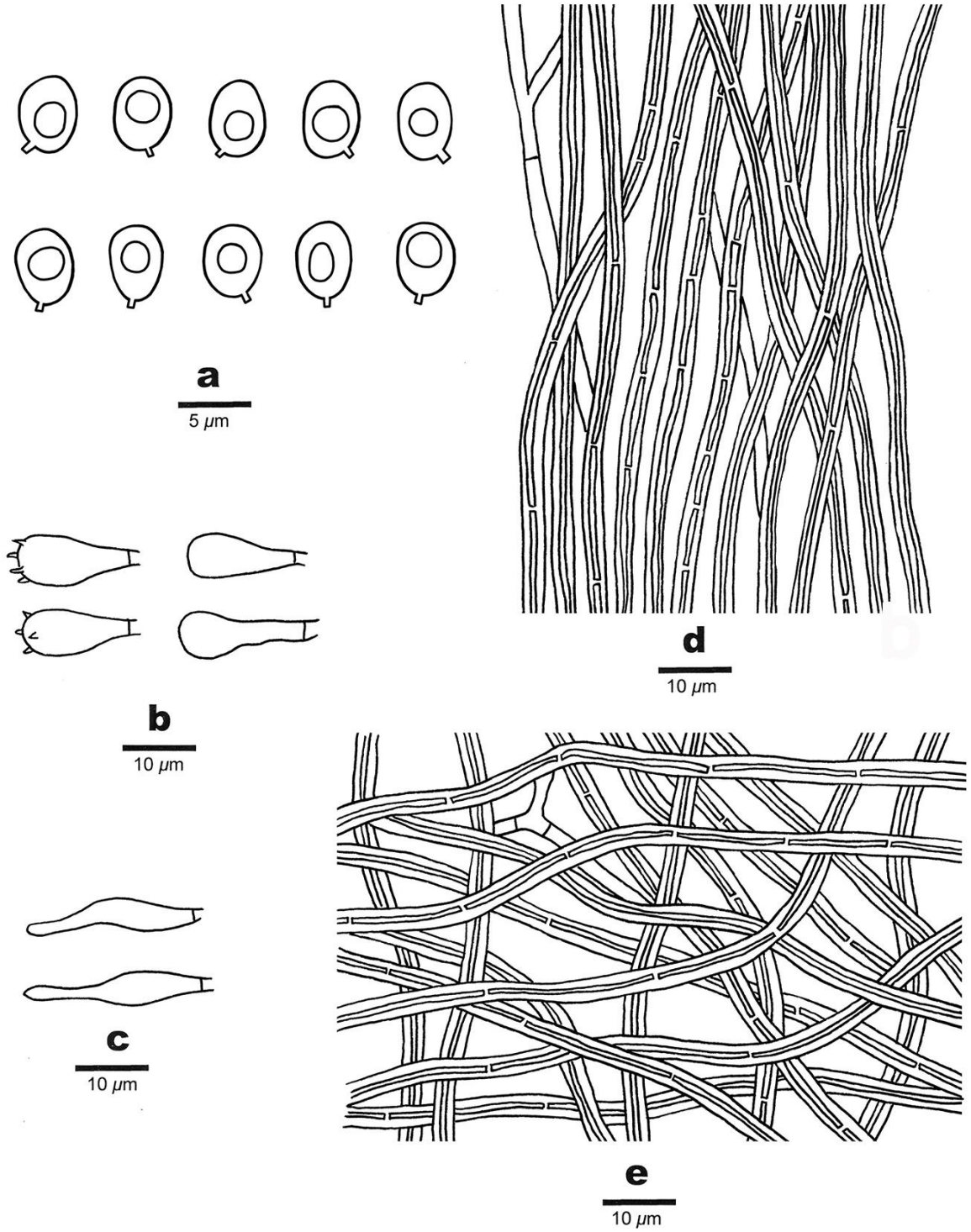

Figure 12 – Microscopic structures of *Fuscoporia shoreae* (holotype, Dai 17818). a. Basidiospores. b. Basidia and basidioles. c. Cystidioles. d. Hyphae from trama. e. Hyphae from context.

Spores – Basidiospores broadly ellipsoid, hyaline, thin-walled, smooth, bearing a medium guttule, IKI–, CB–, (3.5–)3.8–4.8(–5) × (2.6–)3–3.8 (–4) μm, L = 4.18 μm, W = 3.34 μm, Q = 1.24–1.30 (n = 60/2).

Other materials examined (paratypes) – Singapore, Bukit Timah Nature Reserve, on fallen angiosperm trunk, 18 Jul 2017, Y.C. Dai 17800 (BJFC 025332), Y.C. Dai 17806 (BJFC 025338).

Note – Three specimens of *Fuscoporia shoreae* from Singapore are clustered into a lineage with high support (100/100 in Fig. 2). The species is phylogenetically nested in *Fuscoporia*, although morphologically it doesn't present hymenial setae and encrustations on generative hyphae. In fact, *F. longisetulosa* (Bondartseva & S. Herrera) Bondartseva & S. Herrera and *F. discipes* (Berk.) Y.C. Dai & Ghob.-Nejh. neither present hymenial setae, *F. discipes* differs from *F. shoreae* by its larger pores (6–8 per mm, Ryvarden & Johansen 1980, Dai 2010) and usually laterally stipitate; *F. longisetulosa* differs from *F. shoreae* by presence of mycelial setae (Ryvarden 2004). It seems that the hymenial setae are not an important character for diagnosis of *Fuscoporia* although most species in the genus have hymenial setae, and the hyaline, thin-walled basidiospores are the basic character for definition of the genus.

Fuscoporia subchrysea Q. Chen, F. Wu & Y.C. Dai, sp. nov. Figs 10e, 13

MycoBank number: MB 833961; Facesoffungi number: FoF 07992.

Etymology – *Subchrysea* (Lat.): referring to the species similar to *Fuscoporia chrysea*.

Holotype – China, Hainan Province, Wuzhishan County, Wuzhishan Nature Reserve, on dead bamboo, 15 Nov 2015, Y.C. Dai 16201 (BJFC 020287).

Basidiocarps – Annual, resupinate, inseparable, soft corky and without odor or taste when fresh, becoming corky and light-weight upon drying, up to 18 cm long, 4 cm wide and 1 mm thick at centre. Pore surface fuscous to honey-yellow or fawn, occasionally cracked when dry; sterile margin cinnamon-buff, distinctly paler than pore surface, usually with abundant mycelial setae, up to 1 mm wide; pores more or less circular, 8–9 per mm; dissepiments thin, entire, abundant hymenial setae seen in tube cavities (under anatomical lens). Subiculum reddish brown, corky, very thin, up to 0.2 mm thick. Tubes grayish brown, paler than subiculum, hard corky, up to 0.8 mm long.

Hyphal structure – Hyphal system dimitic; generative hyphae simple septate; tissue darkening but otherwise unchanged in KOH.

Subiculum – Generative hyphae rare, hyaline, thin-walled, occasionally branched, frequently simple septate, 2–3.5 μm in diam.; skeletal hyphae dominant, rust-brown, thick-walled with a wide lumen, unbranched, occasionally septate, flexuous, interwoven, 3.5–4 μm in diam.; mycelial setae frequent, dark reddish brown, thick-walled, tapering to apex, present in the subiculum and in the rotten wood cavities, sometimes locally abundant, often in bundles, up to 130 μm long and 6–9 μm in the widest part.

Tubes – Generative hyphae frequent, mostly present at dissepiment edges and subhymenium, hyaline, thin-walled, occasionally branched and frequently simple septate, 1.5–3 μm in diam, some of them encrusted at dissepiment edges and in hymenium; skeletal hyphae dominant, yellowish brown, thick-walled with a medium or wide lumen, unbranched, aseptate, more or less straight, subparallel along the tubes, 3–4 μm in diam. Hymenial setae frequent, narrowly subulate, mostly originating from tramal hyphae, dark brown, thick-walled, 40–68 × 5–8 μm; basidia barrel-shaped, with four sterigmata and a simple septum at the base, 11–13 × 5–7.5 μm; basidioles dominating in hymenium, capitate, but shorter than basidia.

Spores – Basidiospores ellipsoid, hyaline, thin-walled, smooth, usually glued in tetrads, sometimes bearing a small guttule, IKI–, CB–, 3.8–4.4(–4.7) × 2.6–3.2(–3.4) μm, L = 4.07 μm, W = 3 μm, Q = 1.31–1.42 (n = 60/2).

Other material examined (paratype) – China, Hainan Province, Baoting County, Qixianling Forest Park, on fallen angiosperm trunk, 8 Jun 2017, Y.C. Dai 17656 (BJFC 025188).

Note – *Fuscoporia subchrysea* is characterized by small pores (8–9 per mm), septate skeletal hyphae, long hymenial setae (> 40 μm), presence of mycelial setae and absence of cystidioles. The species may be confused with *F. chrysea* (Lév.) Baltazar & Gibertoni by the similar resupinate basidiocarps, small pores (9–10 per mm in *F. chrysea*) and broadly ellipsoid basidiospores. However, *F. chrysea* has perennial basidiocarps with bright golden yellow pore surface and absence

of mycelial setae (Ryvarden & Johansen 1980, Ryvarden 2004, Dai 2010). In addition, *F. subchrysea* and *F. chrysea* are genetically very distant species (Fig. 2). *Fuscoporia bambusae* and *F. subchrysea* are found in tropical Asia, and both species can grow on bamboo. However, pores are bigger in *F. bambusae* than in *F. subchrysea* (5–7 per mm vs. 8–9 per mm), and spores are longer in *F. bambusae* than in *F. subchrysea* (4.3–5.3 μm vs. 3.8–4.4 μm).

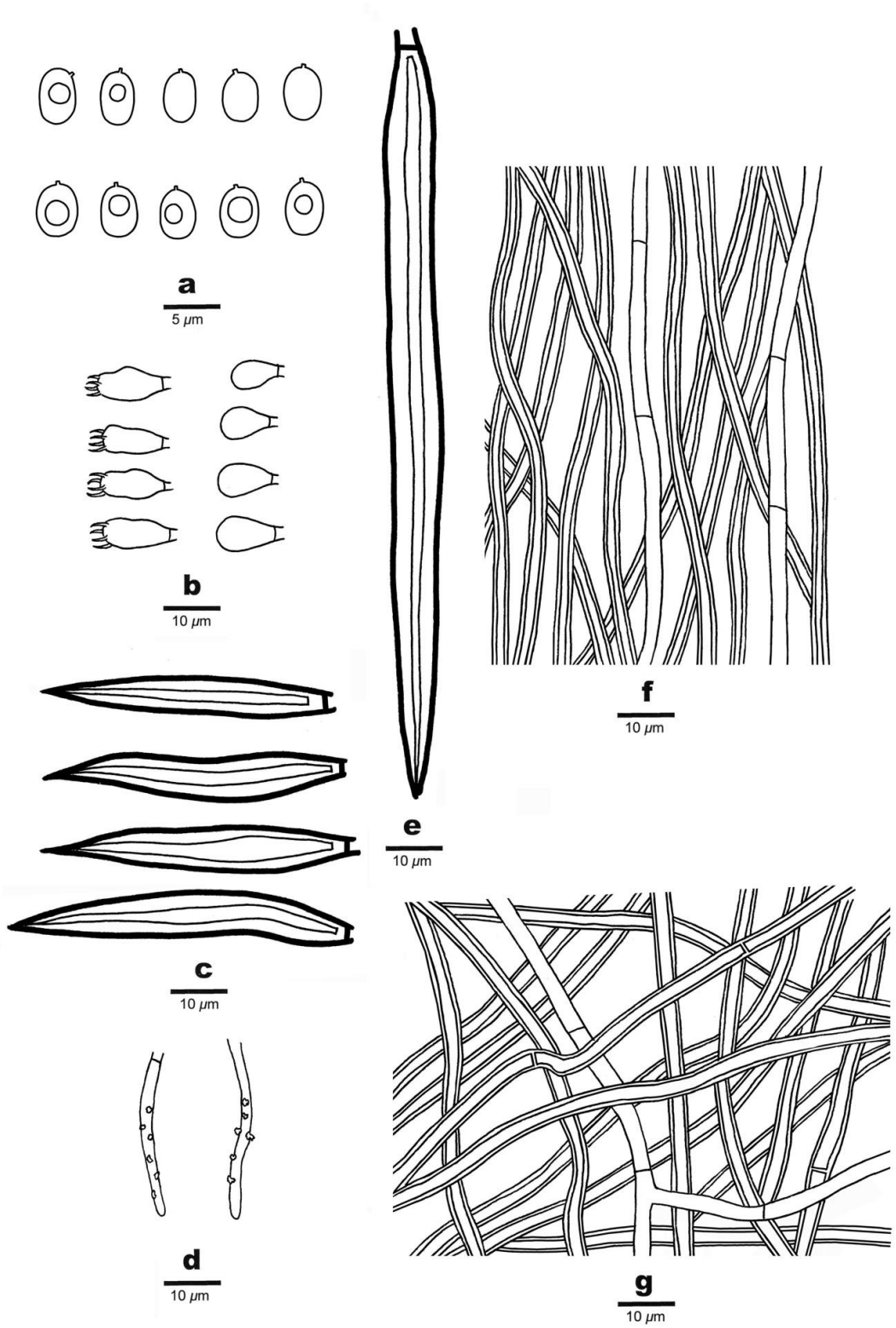

Figure 13 – Microscopic structures of *Fuscoporia subchrysea* (holotype, Dai 16201). a Basidiospores. b Basidia and basidioles. c Hymenial setae. d Generative hyphae at dissepiment edge. e Mycelial setae. f Hyphae from trama. g Hyphae from subiculum.

Fuscoporia bambusicola (L.W. Zhou & B.S. Jia) Q. Chen, F. Wu & Y.C. Dai, comb. nov. Figs 10f, 14

MycoBank number: MB 833968; Facesoffungi number: FoF 07993.

Basionym: *Phellinus bambusicola* L.W. Zhou & B.S. Jia, Mycotaxon 114: 212 (2010).

Material examined – China, Hainan Province, Changjiang County, Bawangling Nature Resever, on dead bamboo, 8 Jul 2009, B.K. Cui 8692 (BJFC 007632, holotype).

Note – *Fuscoporia bambusicola* was originally described as *Phellius bambusicola* from southern China based on morphology (Zhou & Jia 2010). Its holotype was studied and DNA was extracted. Our phylogenetic analysis indicated that *F. bambusicola* nested in *Fuscoporia*. It is therefore the above combinaton is proposed. *Fuscoporia bambusicola* is closely related to *F. latispora* Y.C. Dai, Q. Chen & J. Vlasák (Figs 1–2), but *F. latispora* has mycelial setae often in sterile margin which lead the sterile margin darker than pores surface, longer hymenial setae (55–72 μm), and a distribution in Central America (Chen et al. 2019); while *F. bambusicola* has mycelial setae in subiculum rather than at sterile margin, shorter hymenial setae (32–54 μm), and occurs in tropical China (Zhou & Jia 2010). *Fuscoporia monticola* also occurs in southern China, it resembles *F. bambusicola* by similar basidiocarps and presence of mycelial setae, but it has larger pores (2–3 per mm vs. 3–5 per mm in *F. bambusicola*) and oblong ellipsoid basidiospores (4.4–6.3 × 2.4–3.2 μm vs. 4.2–5 × 3.1–4 μm in *F. bambusicola*, Chen et al. 2019, Zhou & Jia 2010). *Fuscoporia bambusae* grows also on bamboo, but it differs from *F. bambusicola* by smaller pores (5–7 per mm, 3–5 per mm in *F. bambusicola*), In addition, both species are phylogenetically distant (Figs 1–2).

Fuscoporia roseocinerea (Murrill) Q. Chen, F. Wu & Y.C. Dai, comb. nov. Figs 10g, 15

MycoBank number: MB 833970; Facesoffungi number: FoF 07994.

Basionym: *Pyropolyporus roseocinereus* Murrill, N. Amer. Fl. (New York) 9: 104 (1908).

≡*Phellinus roseocinereus* (Murrill) D.A. Reid, Mem. N. Y. bot. Gdn 28: 194 (1976).

Materials examined – Costa Rica, Guanacaste Province, Lomas de Barbudal Biological Reserve, on hardwood, Jul 2014, J. Vlasák, JV 1407/84 (duplicate in BJFC 020687), JV 1407/85 (duplicate in BJFC 020686); Parque Nacional Santa Rosa, on hardwood, Aug 2014, J. Vlasák, JV 1408/31 (duplicate in BJFC 020688). USA, Texas, Brownswille, Resaca de la Palma State Park, on *Acacia farnesiana*, Sep 2011, J. Vlasák, JV 1109/78-J (duplicate in BJFC 020653).

Note – *Fuscoporia roseocinerea* was originally described as *Pyropolyporus roseocinereus* from Costa Rica and Cuba (Murrill 1908) and combined as *Phellinus roseocinereus* for a long time (Reid 1976). Three specimens from USA and Costa Rica were studied, which presented a dimitic hyphal system with encrustations on generative hyphae and broadly ellipsoid, hyaline, thin-walled basidiospores (4–5 × 3–3.6 μm, Q = 1.30–1.35). These data are more or less close to the descriptions by Murrill (1908) and Reid (1976). In addition, these three samples nested in *Fuscoporia* and clustered into a lineage with high support (100/100 in Fig. 2), so *Fuscoporia roseocinerea* is proposed.

Following Murrill (1908), *Fuscoporia roseocinerea* is characterized by perennial, effused-reflexed basidiocarps, encrusted pilear surface with concentrically sulcate, acute margin, round pores, 5–6 per mm, entire dissepiments, globose to ovoid, smooth, hyaline basidiospores, 5–6 × 3–4 μm. However, Lowe (1957) mentioned the species has pores as 6–10 per mm, and spores as broadly oval, 3.5–4 × 2–3 μm (Larsen & Cobb-Poulle 1990). So, there are very different morphologies on this species. We did not study its type, and further study in needed to confirm its morphology.

Fuscoporia roseocinerea is similar to *F. callimorpha* (Lév.) Groposo, Log.-Leite & Góes-Neto but the latter has smaller pores (7–10 per mm) and oblong ellipsoid basidiospores (3.5–4.5 × 2–3 μm, Lowe 1957, Ryvarden & Johansen 1980, Raymundo et al. 2013a). *Fuscoporia chrysea* (type locality in Colombia) is closely related to *F. roseocinerea* (Figs 1–2), but the former species has smaller basidiospores (3–4 × 2–2.5 μm, Ryvarden 2004).

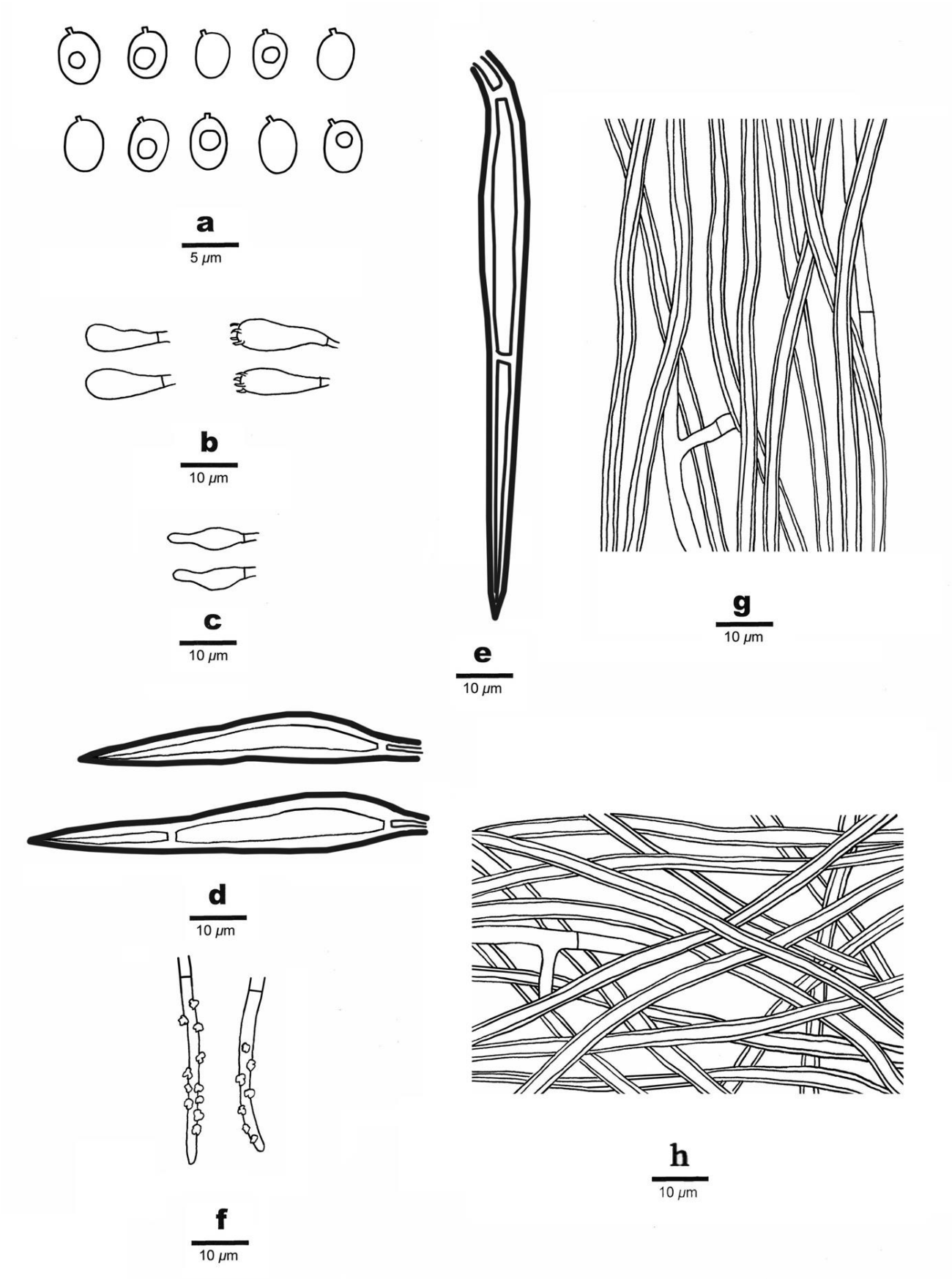

Figure 14 – Microscopic structures of *Fuscoporia bambusicola* (holotype, Cui 8692). a Basidiospores. b Basidia and basidioles. c Cystidioles. d Hymenial setae. e Mycelial setae. f Generative hyphae at dissepiment edge. g Hyphae from trama. h Hyphae from subiculum.

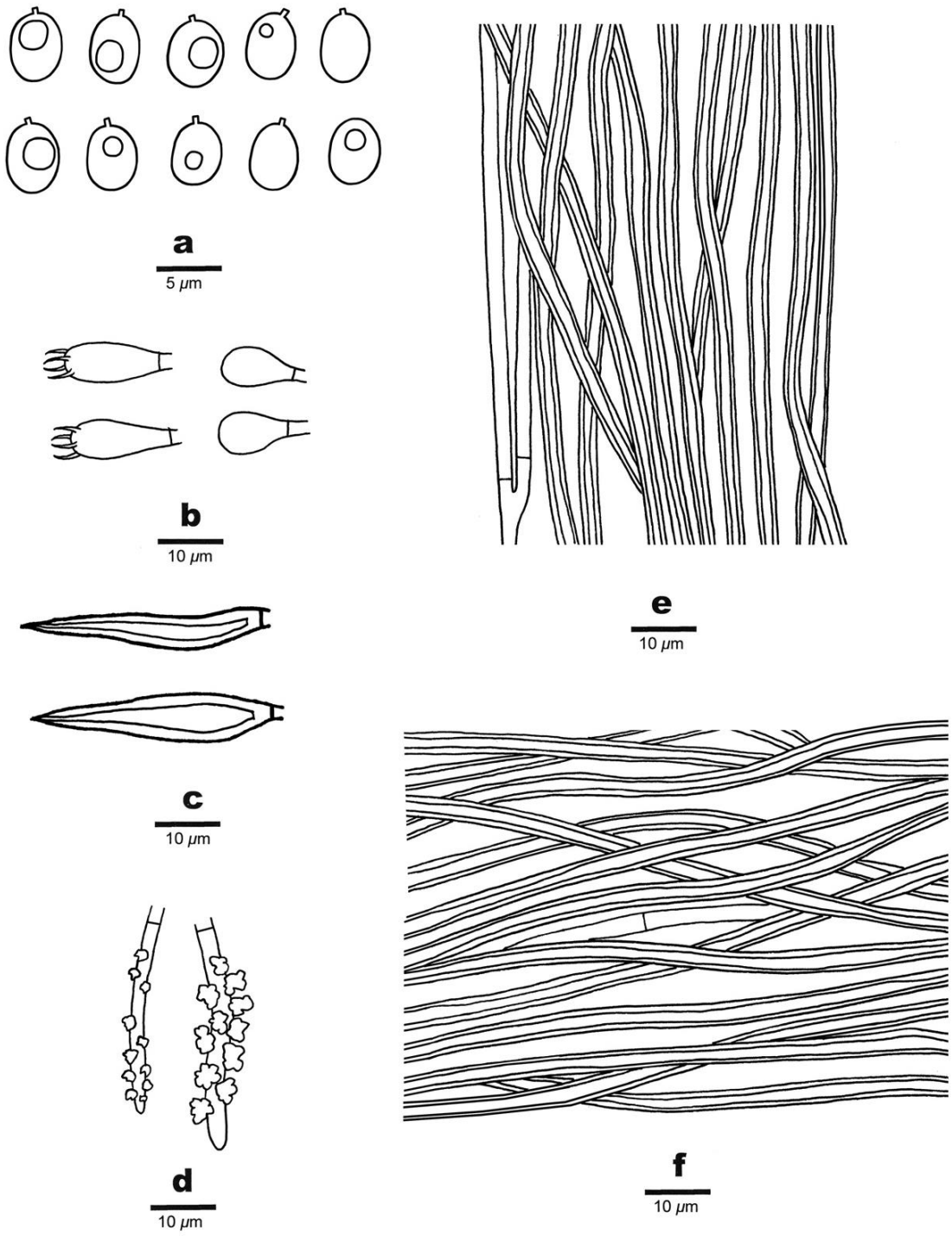

Figure 15 – Microscopic structures of *Fuscoporia roseocinerea* (JV 1407/84). a Basidiospores. b Basidia and basidioles. c Hymenial setae. d Generative hyphae at dissepiment edge. e Hyphae from trama. f Hyphae from context.

A key to species of *Fuscoporia* in worldwide

1. Basidiocarps resupinate.....2
1. Basidiocarps effused-reflexed to pileate.....27
2. Pores 2–5 per mm.....3
2. Pores > 5 per mm.....12

3. Basidiocarps perennial 4
3. Basidiocarps annual 5
4. Cystidioles present, basidiospores broadly ellipsoid, 4.2–5 × 3.1–4 µm. Type locality probably France ..... *F. contigua* (Pers.) G. Cunn
4. Cystidioles absent, basidiospores subglobose, 5.1–5.5 × 4–4.5 µm. Type locality Mexico ..... *F. xerophila* Raymundo et al.
5. Margin paler than pore surface 6
5. Margin darker than pore surface 9
6. Mycelial setae absent 7
6. Mycelial setae present 8
7. Basidiospores 6–8.3 × 2.4–3 µm. Type locality China ..... *F. yunnanensis* Y.C. Dai
7. Basidiospores 7–8 × 1.6–2 µm. Type locality in Russia.. *F. contiguiformis* (Pilát) Raymundo et al.
8. Basidiospores broadly ellipsoid, 4.2–5 × 3.1–4 µm, Q = 1.31. Type locality China ..... *F. bambusicola* (L.W. Zhou & B.S. Jia) Q. Chen et al.
8. Basidiospores cylindric, 6–7 × 2–3 µm, Q = 2.33–2.57. Type locality USA ..... *F. septiseta* Y.C. Dai et al.
9. Mycelial setae swollen and bent near the base. Type locality USA ..... *F. americana* Y.C. Dai et al.
9. Mycelial setae straight 10
10. Mycelial setae septate. Type locality China ..... *F. monticola* Y.C. Dai et al.
10. Mycelial setae aseptate 11
11. Basidiospores cylindric, 5.8–7 × 2.4–3 µm, Q = 2.32–2.38. Type locality China. ..... *F. sinica* Y.C. Dai et al.
11. Basidiospores broadly ellipsoid, 4–5 × 2.8–3.5 µm, Q = 1.47–1.57. Type locality Mexico ..... *F. latispora* Y.C. Dai et al.
12. Pores 5–7 per mm 13
12. Pores > 7 per mm 23
13. Basidiocarps annual 14
13. Basidiocarps perennial 17
14. Basidiospores cylindric 15
14. Basidiospores ellipsoid to broadly ellipsoid 16
15. Cystidioles absent, basidiospores 4.8–6 × 2.8–3.2 µm, Q = 1.82–1.87. Type locality Costa Rica. ..... *F. centroamericana* Y.C. Dai et al.
15. Cystidioles present, basidiospores 5.8–7 × 2–2.5 µm, Q = 2.57–2.88. Type locality China ..... *F. ramulicola* Y.C. Dai & Q. Chen
16. Basidiospores broadly ellipsoid to drop-shaped, 3–4 × 2–2.5 µm, Q = 1.37. Type locality Colombia ..... *F. chrysea* (Lév.) Baltazar & Gibertoni
16. Basidiospores ellipsoid, 4.3–5.3 × 2.8–3.6 µm, Q = 1.47– 1.54. Type locality Thailand ..... *F. bambusae* Q. Chen et al.
17. Hymenial setae absent. Type locality Cuba ..... *F. longisetulosa* (Bondartseva & S. Herrera) Bondartseva & S. Herrera
17. Hymenial setae present 18
18. Cystidioles present and basidiospores cylindric to subcylindrical 19
18. Cystidioles absent and basidiospores ellipsoid to oblong-ellipsoid 21
19. Skeletal hyphae septate. Type locality Russia ..... *F. insolita* Spirin et al.
19. Skeletal hyphae aseptate 20
20. Basidiospores cylindric, 6–7.8 × 2–2.5 µm, Q = 2.84–3.38. Type locality France. ..... *F. ferrea* (Pers.) G. Cunn
20. Basidiospores cylindric to subcylindrical, 4.2–5.2 × 2.8–3.5 µm. Type locality USA. ..... *F. punctatiformis* (Murrill) Zmitr. et al.
21. Basidiospores oblong-ellipsoid. Type locality Costa Rica ..... *F. costaricana* Y.C. Dai et al.
21. Basidiospores ellipsoid 22

22. Cystidioles absent; basidiospores 4.5–5.6× 3–3.8 μm, Q = 1.50–1.65. Type locality China. ....*F. karsteniana* Q. Chen et al.
22. Cystidioles present; basidiospores 4.1–5.2 × 2.8–3.2 μm, Q = 1.55–1.61. Type locality Germany .....*F. ferruginosa* (Schrad.) Murrill
23. Mycelial setae absent 24
23. Mycelial setae present 25
24. Basidiospores cylindric, 4.2–6.2 × 2–2.6 μm. Type locality China. ....*F. subferrea* Q. Chen & Y. Yuan
24. Basidiospores globose, 4–4.5 × 3–4 μm. Type locality Cuba. .... *F. altocedronensis* (Murrill) Bondartseva & S. Herrera
25. Basidiospores globose and cystidioles present. Type locality Nicaragua..... .....*F. nicaraguensis* Murrill
25. Basidiospores ellipsoid and cystidioles absent.....26
26. Cystidioles absent.Type locality China.....*F. subchrysea* Q. Chen et al.
26. Cystidioles present. Type locality Cuba.....*F. rufitincta* (Berk. & M.A. Curtis ex Cooke) Murrill
27. Basidiocarps effused-reflexed 28
27. Basidiocarps strictly pileate.....44
28. Pores 1–4 per mm 29
28. Pores > 4 per mm 30
29. Basidiospores 5.5–7 × 1.8–2.5 μm, Q = 2.92. Type locality Japan. ....*F. setifera* (T. Hatt.) Y.C. Dai
29. Basidiospores 8–10 × 2.7–3.5 μm, Q = 2.43. Type locality USA ....*F. palomari* Vlasák & Ryvarden
30. Basidiocarps annual 31
30. Basidiocarps perennial 36
31. Hymenial setae bifurcate or spiny. Type locality Brazil.....*F. bifurcata* Baltazar et al.
31. Hymenial setae simple 32
32. Hymenial setae mostly hooked. Type locality Brazil .....*F. atlantica* Motato-Vásq. et al.
32. Hymenial setae straight.....33
33. Basidiospres cylindric, 7.5–9 μm long. Type locality China ....*F. acutimarginata* Y.C. Dai & Q. Chen
33. Basidiospres ellipsoid, 3–4 μm long.....34
34. Dissepiments lacerate; cystidioles present. Type locality China..... .....*F. chinensis* Q. Chen et al.
34. Dissepiments entire; cystidioles absent.....35
35. Pores 7–10 per mm .....*F. rhabarbarina* (Berk.) Groposo et al.
35. Pores 6 per mm ..... *F. chrysea* (Lév.) Baltazar & Gibertoni
36. Darker line present between the stratified tubes 37
36. Darker line absent between the stratified tubes 38
37. Basidiocarps subungulate, with finely tomentose and hispid pilear surface, basidiospores 4–5 × 3–3.8 μm, Q = 1.26–1.39. Type locality France ..... *F. torulosa* (Pers.) T. Wagner & M. Fisch.
37. Basidiocarps applanate, with fuscous to black and lacking finely tomentose or hispid pilear surface, basidiospores 3.8–4.8 × 2.6–3.2 μm, Q = 1.40–1.60. Type locality Chile ....*F. senex* (Nees & Mont.) Ghob.-Nejh.
38. Hymenial setae hooked 39
38. Hymenial setae straight.....40
39. Basidiospores 4–5.2 × 3.2–4.2 μm, Q = 1.25–1.36. Type locality South Africa ....*F. wahlbergii* (Fr.) T. Wagner & M. Fisch.
39. Basidiospores 4.3–5.5 × 4–4.5 μm, Q = 1.16–1.22. Type locality Australia. ....*F. eucalypti* Q. Chen et al.
40. Basidiospores cylindrical. Type locality USA .....*F. viticola* (Schwein.) Murrill
40. Basidiospores ellipsoid to broadly ellipsoid 41

41. Cystidioles present, basidiospores ellipsoid, 4–5 × 3–3.5 μm, Q = 1.42–1.50. Type locality USA ..... *F. gilva* (Schwein.) T. Wagner & M. Fisch.
41. Cystidioles absent 42
42. Skeletal hyphae aseptate. Type locality Cuba ..... *F. roseocinerea* (Murrill) Q. Chen et al.
42. Skeletal hyphae septate 43
43. Basidiospores ellipsoid, 3.2–4.3 × 2.5–3.2 μm. Type locality Cuba ..... *F. flavomarginata* (Murrill) Groposo et al.
43. Basidiospores subglobose, ovoid to broadly elipsoid, 4–4.8 × 3.2–4 μm. Type locality Mexico ..... *F. mesophila* Raymundo et al.
44. Pores 2–5 per mm. Type locality China ..... *F. formosana* (T.T. Chang & W.N. Chou) T. Wagner & M. Fisch.
44. Pores > 5 per mm 45
45. Basidiocarps perennial 46
45. Basidiocarps annual 47
46. Hymenial setae present, hooked, basidiospores broadly ellipsoid to subglobose, 4–5 × 3.2–4 μm, Q = 1.12–1.15. Type locality China. ..... *F. australasica* Q. Chen et al.
46. Hymenial setae absent, basidiospores cylindric, 4.5–5.5 × 2–3 μm, Q = 1.63. Type locality Sri Lanka ..... *F. discipes* (Berk.) Y.C. Dai & Ghob.-Nejh.
47. Hymenial setae absent. Type locality Singapore ..... *F. shoreae* Q. Chen et al.
47. Hymenial setae present 48
48. Skeletal hyphae aseptate. Type locality Australia ..... *F. australiana* Q. Chen et al.
48. Skeletal hyphae septate 49
49. Pilear surface nodulose, basidiospores ellipsoid, 3–3.8 × 2.2–2.8 μm, Q = 1.31–1.40. Type locality Australia ..... *F. plumeriae* Q. Chen et al.
49. Pilear surface glabrous, basidiospores oblong ellipsoid to almost sub-cylindrical, 3.5–4.5 ×2–3 μm, Q = 1.43–1.53. Type locality Madagascar ..... *F. callimorpha* (Lév.) Groposo et al.

Discussion

In this study 315 sequences of ITS, nLSU, RPB2 and TEF1 were analyzed, of them 181 sequences, *viz.* 46 ITS, 49 nLSU, 34 RPB2 and 52 TEF1 are newly generated. Phylogenetic analyses from 105 specimens including 41 species of *Fuscoporia* were studied; 226 specimens were morphologically examined. Based on laboratory examinations and phylogenetic analyses, nine new species are described and two new combinations are proposed. To date, 49 *Fuscoporia* species are accepted, but eight species, *Fuscoporia altocedronensis* (Murrill) Bondartseva & S. Herrera, *F. bifurcata* Baltaza et al., *F. contiguiformis* (Pilát) Raymundo et al., *F. flavomarginata* (Murrill) Groposso et al., *F. longisetulosa*, *F. mesophila* Raymundo et al., *F. nicaraguensis* Murrill and *F. xerophila* Raymundo et al., were studied only by literature due to lack of voucher specimens and DNA sequences data. So, their phylogenetic relationships with other species remain uncertain. Our newly described species can be distinghuished from these eight species in morphology. An identification key to 49 accepted species in the genus is provided.

Previously *Fuscoporia* was defined by a dimitic hyphal system, generative hyphae encrusted with crystals in the dissepiment edge and tube trama, the hymenial setae mostly originating from tramal hyphae and hyaline, thin-walled, smooth basidiospores (Fiasson & Niemelä 1984, Dai 2010, Chen et al. 2019). However, there are some exceptions like *F. shoreae*, *F. longisetulosa* and *F. discipes* without hymenial setae. Hence, we re-define the genus as basidiocarps annual to perennial, resupinate to pileate, hyphal system dimitic, generative hyphae encrusted (at least at dissepiments) in most species, hymenial setae usually present, mycelial setae present in some species, and basidiospores hyaline, thin-walled, smooth.

Six groups, *Fuscoporia contigua* group, *F. ferrea* group, *F. ferruginosa* group, *F. gilva* group, *F. torulosa* group, and *F. viticola* group are recognized with strong support in our phylogenies (Figs 1–2). The *Fuscoporia ferrea* group includes *F. ferrea*, *F. punctatiformis* (Murrill) Zmitr. et al., *F. ramulicola*, *F. subferrea* and *F. yunnanensis*. These species are characterized by resupinate

basidiocarps, aseptate skeletal hyphae, absence of mycelial setae, presence of hymenial setae and cystidioles, and cylindric basidiospores (Dai 2010, Chen & Dai 2019).

The *Fuscoporia contigua* group includes *F. americana*, *F. bambusicola*, *F. centroamericana* Y.C. Dai, Q. Chen & J. Vlasák, *F. contigua*, *F. costaricana* Y.C. Dai, Q. Chen & J. Vlasák, *F. latispora*, *F. monticola*, *F. rufitincta* (Berk. & M.A. Curtis ex A.L. Sm.) Murrill, *F. septiseta* and *F. sinica*. Species in this group are characterized by resupinate basidiocarps, moderately large pores, presence of long mycelial setae and large hymenial setae (Niemelä 2005, Ryvarden & Melo 2017, Chen et al. 2019).

The *Fuscoporia ferruginosa* group includes *F. ferruginosa*, *F. karsteniana*, *F. bambusae* and *F. subchrysea*. These species are characterized by resupinate basidiocarps, relatively small pores, entire dissepiments, straight hymenial setae, presence of mycelial setae and ellipsoid basidiospores. In our phylogeny (Fig. 2), samples of *F. ferruginosa* nested in two independent lineages, one lineage represented by American and Chinese samples, another by European samples. Because the type locality of *F. ferruginosa* is Germany, it means that the European samples represent the real *F. ferruginosa*, and the American and Chinese samples may be new species. The European specimens can be segregated from American and Chinese ones by perennial basidiocarps (annual in the latter) and smaller pores (6–8 per mm in the former and 5–6 per mm in the latter). Because some synonyms of *F. ferruginosa* were described from North America, for the time being we treat all these samples as *F. ferruginosa*.

The *Fuscoporia gilva* group including *F. atlantica*, *F. australiana*, *F. chinensis*, *F. formosana*, *F. gilva*, *F. plumeriae*, and *F. setifera*. These species are characterized by effused-reflexed to pileate basidiocarps, indistinctly concentrically sulcate with zones, hispid to rugose or nodulose pileal surface, lacerate dissepiments, presence of cystidioles and ellipsoid to cylindric basidiospores. *Fuscoporia gilva* was originally described as *Boletus gilvus* Schwein. from USA (Schweinitz 1822), and it is a common fungus on hardwoods in southwest America (Gilbertson 1979). Abundant specimens of *F. gilva sensu lato* were collected from China, but most of them are in fact *F. chinensis*, which differ from *F. gilva* by the aseptate skeletal hyphae and smaller basidiospores (3–4 × 2–2.5 μm vs. 4–5 × 3–3.5 μm, Gilbertson 1979). Several synonyms of *F. gilva* were described from Argentina, France, North America and New Zealand. We have studied these taxa following the literature (*Polyporus balansae* Speg., Spegazzini 1884, *Placodes fucatus* Quél., Quélet 1887, *Polyporus calvescens* Berk., Berkeley 1839, *Polyporus gilvorigidus* Lloyd, Lloyd 1925) and our newly described species *F. chinensis* is different from these taxa.

The *Fuscoporia torulosa* group includes *F. callimorpha*, *F. torulosa* (Pers.) T. Wagner & M. Fisch., *F. rhabarbarina* (Berk.) Groposo et al. and *F. senex* (Nees & Mont.) Ghob.-Nejh., *F. wahlbergii*, *F. australasica*, *F. eucalypti*, *F. roseocinerea*, *F. chrysea* and *F. shoreae*. Species in this group are characterized by the resupinate, effused-reflexed to pileate basidiocarps, small pores (5–10 per mm), entire dissepiments, septate skeletal hyphae, straight or hooked hymenial setae, lacking mycelial setae, presence of cystidioles, broadly ellipsoid to subglobose basidiospores. *Fuscoporia senex* is very close to *F. rhabarbarina* in phylogeny (Fig. 2), but *F. rhabarbarina* has a distinctive black crust at upper surface, smaller basidiospores and skeletal hyphae swelling in KOH (Singer 1959, Bakshi et al. 1970, Ryvarden & Johansen 1980, Corner 1991, Groposo et al. 2007). Specimens from type locality of these two species should be compared and phylogenetically analyzed in the future. *Fuscoporia callimorpha* present a pantropical distribution (Ryvarden & Johansen 1980, Lowe 1957, Loguercio-Leite & Wright 1995, Groposo et al. 2007, Raymundo et al. 2013a), and it is easily separated from other species in the group by smaller basidiospores (3.5–4.5 × 2.4–3 μm, Ryvarden & Johansen 1980). *Fuscoporia wahlbergii* was reported to have a wide distribution among pantropical zones (Ryvarden & Johansen 1980, Ryvarden & Gilbertson 1994, Loguercio-Leite & Wright 1995, Wagner & Fischer 2001), despite the species was originally described from South Africa. No sequences of *F. wahlbergii* from the type locality are avialble and we presume that the species has a wide distribution in Europe, USA, Australia and Asia, so specimens from these areas are treated as *F. wahlbergii* in our study. The Chinese samples previously treated as *F. wahlbergii* in Dai (2010) are in fact different from the type description of *F.*

wahlbergii, because the spores from the type of *F. wahlbergii* are globose, 3.5–4 μm in diam. (Reid 1975), and now Chinese specimens were described as *F. australasica*. *Fuscoporia atlantica* from Brazil also has hooked hymenial setae and ellipsoid basidiospores, but the species clustered into *F. gilva* group (Pires et al. 2015).

The *Fuscoporia viticola* group includes *F. palomari* Vlasák & Ryvarden and *F. viticola* (Schwein.) Murrill. The two species are characterized by resupinate to effused-reflexed basidiocarps, moderately large pores (< 7 per mm), absence of mycelial setae, narrowly subulate and long hymenial setae (> 40 μm long), cylindric and long basidiospores (> 7 μm long). This small group is distinguished from other groups by the longer hymenial setae and larger basidiospores (Vlasák et al. 2012).

Fuscoporia acutimarginata, *F. discipes*, *F. insolita* Spirin, Vlasák & Niemelä are nested in three subclades (Fig. 2), but without enough support. They certainly do not belong to a group, and are different from the above mentioned six groups. For the time being we do not treat them in any groups.

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References

Anonymous. 1969 – Flora of British fungi. Colour identification chart. London: Her Majesty's Stationery Office.

Bakshi BK, Sen M, Singh B. 1970 – Cultural diagnosis of Indian Polyporaceae. 2. Genera *Fomes* and *Trametes*. Indian Forest Records 2, 245–276.

Baltazar JM, Gibertoni TB. 2010 – New combinations in *Phellinus* s.l. and *Inonotus* s.l. Mycotaxon 111, 205–208.

Baltazar JM, Trierveiler-Pereira L, Loguercio-Leite C, Ryvarden L. 2009 – Santa Catarina Island mangroves 3: a new species of *Fuscoporia*. Mycologia 100, 859–863.

Berkeley MJ. 1839 – Descriptions of exotic fungi in the collection of Sir W.J. Hooker, from memoirs and notes of J.F. Klotzsch, with additions and corrections. Annals and Magazine of Natural History 3, 375–401.

Chang TT, Chou WN. 1998 – Two new species of *Inonotus* from Taiwan. Mycological Research 102, 788–790.

Chen JJ, Cui BK, Dai YC. 2016 – Global diversity and molecular systematics of *Wrightoporia* s. l. (Russulales, Basidiomycota). Persoonia 37, 21–36.

Chen Q, Dai YC. 2019 – Two new species of *Fuscoporia* (Hymenochaetales, Basidiomycota) from southern China based on morphological characters and molecular evidence. Mycokeys 61, 75–89.

Chen Q, Wu F, Ji XH, Si J et al. 2019 – Phylogeny of the genus *Fuscoporia* and taxonomic assessment of the *F. contigua* group. Mycologia 111, 1–22.

Chen Q, Yuan Y. 2017 – A new species of *Fuscoporia* (Hymenochaetales, Basidiomycota) from southern China. Mycosphere 8, 1238–1245.

Corner EJH. 1991 – Ad Polyporaceas 7. The xanthochroic polypores. Nova Hedwigia 101, 1–175.

Cunningham GH. 1948 – New Zealand Polyporaceae 2. The genus *Fuscoporia*. Bulletin of the New Zealand Department of Industrial Research 73, 1–14.

Dai YC. 1999 – *Phellinus* sensu lato (Aphyllophorales, Hymenochaetaceae) in East Asia. Acta Botanica Fennica 166, 1–115.

Dai YC. 2000 – A checklist of polypores from Northeast China. Karstenia 40, 23–29.

Dai YC. 2010 – Hymenochaetaceae (Basidiomycota) in China. Fungal Diversity 45, 131–343.

Dai YC, Cui BK, Yuan HS, Li BD. 2007 – Pathogenic wood-decaying fungi in China. Forest Pathology 37, 105–120.
Dai YC, Zhou LW, Cui BK, Chen YQ, Decock C. 2010 – Current advances in *Phellinus* sensu lato: medicinal species, functions, metabolites and mechanisms. Applied Microbiology and Biotechnology 87, 1587–1593.
Felsenstein J. 1985 – Confidence intervals on phylogenetics: an approach using bootstrap. Evolution 39, 783–791.
Fiasson JL, Niemelä T. 1984 – The Hymenochaetales: a revision of the European poroid taxa. Karstenia 24, 14–28.
Gilbertson RL. 1979 – The genus *Phellinus* (Aphyllophorales: Hymenochaetaceae) in western North America. Mycotaxon 9, 51–89.
Groposo C, Loguercio-Leite C, Góes-Neto A. 2007 – *Fuscoporia* (Basidiomycota, Hymenochaetales) in southern Brazil. Mycotaxon 101, 55–63.
Hall TA. 1999 – Bioedit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. Nucleic Acids Symp Ser 41, 95–98.
Index Fungorum. 2020 – http://www.indexfungorum.org/names/Names.asp (accessed: March 2020).
Jeewon R, Hyde KD. 2016 – Establishing species boundaries and new taxa among fungi: recommendations to resolve taxonomic ambiguities. Mycosphere 7, 1669–1677.
Larsen MJ, Cobb-Poulle LA. 1990 – *Phellinus* (Hymenochaetaceae). A survey of the world taxa. Synopsis Fungorum 3, 1–206.
Larsson KH, Parmasto E, Fischer M, Langer E et al. 2006 – Hymenochaetales: a molecular phylogeny for the hymenochaetoid clade. Mycologia 98, 926–936.
Lloyd CG. 1925 – Mycological Notes 74. Mycological Writings 7, 1333–1348.
Loguercio-Leite C, Wright JE. 1995 – The genus *Phellinus* (Hymenochaetaceae) on the Island of Santa Catarina, Brazil. Mycotaxon 54, 361–388.
Lowe JL. 1966 – Polyporaceae of North America. The genus *Poria*. State University College of Forestry at Syracuse University Technology Publication 90, 1–183.
Lowe JL. 1957 – Polyporaceae of North America. The genus *Fomes*. State University College of Forestry at Syracuse University, Technical publication 80, 1–97.
Nylander J. 2004 – MrModeltest v2. Program distributed by the author. Uppsala: Evolutionary Biology Centre, Uppsala University.
Matheny PB. 2005 – Improving phylogenetic inference of mushrooms with RPB1 and RPB2 nucleotide sequences (Inocybe, Agaricales). Mollecular Phylogenetics and Evolution 35, 1–20.
Murrill WA. 1907 – Polyporaceae, Part 1. North American Flora 9, 1–72.
Murrill WA. 1908 – Polyporaceae, Part 2. North American Flora 9, 73–131.
MycoBank. 2020 – www.mycobank.org/Biolomics.aspx?Table=Mycobank&Page=200&ViewMode=Basic (accessed: March 2020).
Niemelä T. 2005 – Polypores, lignicolous fungi. Norrlinia 13, 1–320.
Niemelä T, Wagner T, Fischer M, Dai YC. 2001 – *Phellopilus* gen. nov. and its affinities within *Phellinus* s. lato and *Inonotus* s. lato (Basidiomycetes). Annales Botanici Fennici 38, 51–62.
Overholts LD. 1953 – The Polyporaceae of the United States, Alaska and Canada. University Michigan Press, Ann Arbor.
Petersen JH. 1996 – Farvekort. The Danish Mycological Society's colour-chart. Greve: Foreningen til Svampekundskabens Fremme, Greve 1–6.
Pires RM, Motato-Vásquez V, Gugliotta AM. 2015 – *Fuscoporia atlantica* sp. nov., a new polypore from the Brazilian Atlantic Rainforest. Mycotaxon 130, 843–855.
Posada D, Crandall KA. 1998 – Modeltest: testing the model of DNA substitution. Bioinformatics 14, 817–818.
Quélet L. 1887 – Quelques especes critiques ou nouvelles de la Flore Mycologique de France. Comptes Rendus de l´Association Française pour l´Avancement des Sciences 15, 484–490.

Raymundo T, Valenzuela R, Bautista-Hernández S, Esqueda M et al. 2013a – The genus *Fuscoporia* (Hymenochaetales, Basidiomycota) in Mexico. Revista Mexicana de Biodiversidad 84, 50–69.
Raymundo T, Valenzuela R, Esqueda M. 2013b – Hymenochaetaceae from Mexico 6. A new *Fuscoporia* species from the Sonoran Desert. Mycotaxon 125, 37–43.
Rehner SA, Buckley E. 2005 – A *Beauveria* phylogeny inferred from nuclear ITS and EF1-a sequences: evidence for cryptic diversification and links to *Cordyceps teleomorphs*. Mycologia 97, 84–98.
Reid DA. 1975 – Type studies of the larger Basidiomycetes described from South Africa. Contributions from the Bolus Herbarium 7, 1–255.
Reid DA. 1976 – Notes on polypores. 2. Memoirs of the New York Botanical Garden 28, 179–198.
Ryvarden L. 2004 – Neotropical polypores 1. Introduction, Hymenochaetaceae and Ganodermataceae. Synopsis Fungorum 19, 1–227.
Ryvarden L. 2005 – The genus *Inonotus*, a synopsis. Synopsis Fungorum 21, 1–149.
Ryvarden L, Gilbertson RL. 1994 – European polypores 2. Synopsis Fungorum 7, 394–743.
Ryvarden L, Johansen I. 1980 – A preliminary polypore flora of East Africa. Fungiflora, Norway 1–636.
Ryvarden L, Melo I. 2017 – Poroid fungi of Europe, 2nd edition. Synopsis Fungorum 37, 1–431.
Schweinitz LD. 1822 – Synopsis fungorum Carolinae superioris. Schriften der Naturforschenden Gesellschaft zu Leipzig 1, 21–31.
Silvestro D, Michalak I. 2012 – RaxmlGUI: a graphical front-end for RAxML. Organisms Diversity and Evolution 12, 335–337.
Singer R. 1959 – Basidiomycetes from Masatierra (Juan Fernandez Islands, Chile). Ark Bot 4, 370–400.
Spegazzini C. 1884 – Fungi Guaranitici. Pugillus 1. Anales de la Sociedad Científica Argentina 17, 42–48.
Spirin V, Vlasák J, Niemelä T. 2014 – *Fuscoporia insolita* (Hymenochaetales, Basidiomycota), a new species from Russian Far East. Annales Botanici Fennici 51, 403–406.
Stamatakis A. 2006 – RAxML-VI-HPC: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. Bioinformatics 22, 2688–2690.
Swofford DL. 2002 – PAUP*: Phylogenetic analysis using parsimony (*and other methods). Version 4.0b10. Massachusetts: Sinauer Associates.
Song J, Cui BK. 2017 – Phylogeny, divergence time and historical biogeography of *Laetiporus* (Basidiomycota, Polyporales). BMC Evolutionary Biology 17, 102.
Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997 – The clustal_X windows interface: Flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Research 25, 4876–4882.
Vilgalys R, Hester M. 1990 – Rapid genetic identification and map- ping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. Journal of Bacteriology 172, 4238–4246.
Vlasák J, Vlasák J Jr, Ryvarden L. 2012 – Four new polypore species from the western United States. Mycotaxon 119, 217–231.
Wagner T, Fischer M. 2001 – Natural groups and a revised system for the European poroid Hymenochaetales (Basidiomycota) supported by nLSU rDNA sequence data. Mycological Research 105, 773–782.
Wagner T, Fischer M. 2002 – Proceedings towards a natural classification of the worldwide taxa *Phellinus* s.l. and *Inonotus* s.l., and phylogenetic relationships of allied genera. Mycologia 94, 998–1016.
White TJ, Bruns TD, Lee S, Taylor J. 1990 – Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ, eds. PCR protocols: A guide to methods and applications. New York: Academic Press 315–322.

Wu F, Zhou LW, Yang ZL, Bau T et al. 2019 – Resource diversity of Chinese macrofungi: edible, medicinal and poisonous species. Fungal Diversity 98, 1–76.
Zhou LW, Jia BS. 2010 – A new species of *Phellinus* (Hymenochaetaceae) growing on bamboo in tropical China. Mycotaxon 114, 211–216.
Zhou LW, Vlasák J, Dai YC. 2016 – Taxonomy and phylogeny of *Phellinidium* (Hymenochaetales, Basidiomycota): a redefinition and the segregation of *Coniferiporia* gen. nov. for forest pathogens. Fungal Biology 120, 988–1001.
Zhu L, Song J, Zhou JL, Si J, Cui BK. 2019 – Species diversity, phylogeny, divergence time and biogeography of the genus *Sanghuangporus* (Basidiomycota). Frontiers in Microbiology 10, 812.
Zmitrovich IV, Malysheva VF. 2014 – Studies on *Oxyporus* I. Segregation of *Emmia* and general topology of phylogenetic tree. Mycology and Phytopathology 48, 161–171.