RESEARCH ARTICLE

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Global diversity and molecular systematics of *Wrightoporia* s.l. (*Russulales*, *Basidiomycota*)

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Key words

ITS
nLSU
polypore
wood-inhabiting fungi

Abstract *Wrightoporia* accommodates polypores producing finely asperulate and amyloid basidiospores, and causing white rot. Thirty-nine species have been described or transferred to this genus; however, only a few species have been referred to molecular phylogeny. In this study, about 140 worldwide specimens of *Wrightoporia* s.l. were studied morphologically, and ITS and/or nLSU regions from 37 samples, representing 19 species, were sequenced for phylogenetic analysis. Six clades of *Wrightoporia* s.l. were recognized. The *Wrightoporia* s.str. clade includes *W. avellanea*, *W. lenta* (the generic type) and *W. subavellanea*. Three clades segregating from *Wrightoporia* s.str. were proposed separately as three new genera, namely *Larssoniporia* gen. nov., *Pseudowrightoporia* gen. nov. and *Wrightoporiopsis* gen. nov. Two other clades were named after *Amylonotus* and *Amylosporus*. According to phylogenetic and morphological evidence, species previously treated in *Wrightoporia* were transferred to *Amylonotus*, *Amylosporus* and the new genera, or were retained as members of *Wrightoporia* s.l. because no good solution for these species could be found so far. In addition, one new species in *Larssoniporia*, three new species in *Pseudowrightoporia* and two new species in *Wrightoporiopsis* were described. Identification keys to the six genera and species in *Amylonotus*, *Amylosporus*, *Larssoniporia*, *Pseudowrightoporia*, *Wrightoporia* and *Wrightoporiopsis* are provided, respectively.

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INTRODUCTION

Wrightoporia was described and typified with *W. lenta* (Pouzar 1966). The principal characteristics of the genus include a combination of resupinate to pileate poroid basidiocarps, an annual to perennial growth habit, a monomitic to subtrimitic hyphal structure, and amyloid asperulate basidiospores (Ryvarden 1982, David & Rajchenberg 1985, 1987, Cui & Dai 2006). Presence or absence of gloeoplerous hyphae and/or gloeocystidia is the important character for identification species in *Wrightoporia* (David & Rajchenberg 1985, 1987, Hattori 2003, 2008). *Wrightoporia* has a worldwide distribution, and 39 species in the genus have been accepted (Corner 1989, Stalpers 1996, Lindblad & Ryvarden 1999, Hattori 2003, 2008, Chen & Cui 2014), of which 17 have been recorded in China (Cui & Dai 2006, Dai & Cui 2006, Dai et al. 2011, Chen & Cui 2012, 2014, Chen & Yu 2012, Dai 2012).

Wrightoporia species produce a white-rot, belonging to the *Russulales* (Larsson & Larsson 2003) have usually been described based on morphological characters only (Hattori 2003, 2008, Cui & Dai 2006, Dai & Cui 2006, Dai et al. 2011, Chen & Cui 2012, Chen & Yu 2012). Recently, Jang et al. (2013) determined that *W. luteola* (described from China) is a taxonomic synonym of *W. japonica* (described from Japan) based on phylogenetic analysis of ITS and nLSU sequences. Chen & Cui (2014) conducted a molecular study of *Wrightoporia* and described *W. subavellanea* with morphological evidence. However, the phylogenetic relationships among most species in *Wrightoporia* sensu lato (s.l.) are ambiguous, as phylogenetic studies have shown that species are scattered in at least two families (Larsson & Larsson 2003, Miller et al. 2006, Chen & Cui 2014).

In this study about 140 specimens representing 39 *Wrightoporia* s.l. species and five species in *Amylosporus* are studied for morphological features, and their taxonomic affinities and phylogenetic relationships are analysed based on ITS and nLSU rDNA sequences data. Combining morphological and molecular evidence, *Amylonotus* and *Amylosporus* are redefined, and *Wrightoporia* sensu stricto (s.str.) is defined. Moreover, three new genera (*Larssoniporia*, *Pseudowrightoporia* and *Wrightoporiopsis*) and six new species are described, and 17 new combinations are proposed. Identification keys to the accepted species of the six genera are provided.

MATERIAL AND METHODS

Morphological studies

The studied specimens are deposited at the herbaria of the Institute of Microbiology, Beijing Forestry University (BJFC) and the Institute of Applied Ecology, Chinese Academy of Sciences (IFP). The microscopic routines followed Han et al. (2014). Sections were studied at magnification up to ×1000 using a Nikon E80i microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Microscopic features, measurements and drawings were made from slide preparations stained with Cotton Blue and Melzer's reagent. Spores were measured from sections cut from the tubes. For presenting the variation in the size of the spores, 5 % of measurements were excluded from each end of the range, and were given in parentheses. Basidiospore spine lengths were not included in the measurements. In the text the following abbreviations were used: IKI = Melzer's reagent, IKI+ = amyloid, IKI– = non-dextrinoid and non-amyloid, KOH = 5 % potassium hydroxide, CB = Cotton Blue, CB+ = cyanophilous, CB– = acyanophilous, L = mean spore length (arithmetic average of all spores), W = mean spore width (arithmetic average of all

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Table 1 Species and their GenBank accession numbers of ITS and nLSU sequences used in this study.

Species	Sample no.	Specimen no.	Host	Locality	GenBank accession numbers	
					ITS	nLSU
Albatrellus ovinus	PV 22-89	–	–	–	AF506396	AF506396
A. subrubescens	PV 154-95	–	–	–	AF506395	AF506395
Aleurocystidiellum disciforme	NH 13003	FCUG 2690	–	Russia	AF506402	AF506402
A. subcruentatum	NH 12874	FCUG 2615	–	Germany	AF506403	AF506403
Aleurodiscus amorphus	KHL 4240	–	–	Sweden	AF506397	AF506397
Amylonotus africanus	Ipulet F1883	O 18567	–	Uganda	KJ807070	KJ807083
A. labyrinthinus	Yuan 1475	IFP 12742	Angiosperm	China	KM107860[a]	KM107878[a]
	F-20724 (holotype)	–	–	Japan	KJ807069	KJ807080
Amylosporus bracei	1008/77	–	Angiosperm	USA	KM267724	KJ807076
A. campbellii	0806/20a	–	Angiosperm	Jamaica	JF692200	KJ807077
	Gilbertson 14806	–	–	USA	KM107861[a]	KM107879[a]
A. casuarinicola	Dai 6914 (holotype)	BJFC 2760	*Casuarina*	China	KJ807068	–
	Yuan 1614	IFP 12866	*Casuarina*	China	KM107862[a]	–
A. rubellus	Dai 9233	IFP 12318	*Koelreuteria*	China	KJ807071	KJ807084
A. succulentus	Dai 7802 (holotype)	BJFC 15731	Lawn	China	KM213669	KM213671
A. succulentus	Dai 7803 (paratype)	BJFC 15732	Lawn	China	KM213668	KM213670
Amylostereum areolatum	NH 8041	FCUG 1080	–	Romania	AF506405	AF506405
A. laevigatum	NH 2863	FCUG 2590	–	Sweden	AF506407	AF506407
Auricularia mesenterica	EL 66-97	–	–	USA	AF506492	AF506492
Auriscalpium vulgare	EL 33-95	–	–	Sweden	AF506375	AF506375
Basidioradulum radula	NH 9453	–	–	Finland	AF347105	AF347105
Boidinia aculeata	Wu 890714-52	FCUG 2647	–	China	AF506433	AF506433
B. granulata	Wu 9209-34	FCUG 2649	–	China	AY048880	AY048880
B. propinqua	KHL 10931	–	–	Jamaica	AF506379	AF506379
Bondarzewia montana	–	DAOM F-415	*Picea*	Canada	DQ200923	DQ234539
B. podocarpi	Dai 9261	BJFC 334	*Podocarpus*	China	KJ583207	KJ583221
Byssoporia terrestris	Hjm 18172	–	–	Sweden	DQ389664	DQ389664
Dentipellicula leptodon	GB 011123	–	–	Uganda	EU118625	EU118625
D. taiwaniana	Dai 10867	IFP 15854	Angiosperm	China	JQ349115	JQ349101
	Cui 8346	BJFC 6835	–	China	JQ349114	JQ349100
Dentipellis coniferarum	Cui 10063	BJFC 10965	*Abies*	China	JQ349106	JQ349092
	Yuan 5623	IFP 15823	Gymnosperm	China	JQ349107	JQ349093
D. fragilis	Dai 12550	IFP 15847	*Populus*	China	JQ349110	JQ349096
	Dai 9009	IFP 1519	Angiosperm	China	JQ349108	JQ349094
D. microspora	Cui 10035	BJFC 10928	*Abies*	China	JQ349112	JQ349098
D. parmastoi	Cui 8513	IFP 15850	Angiosperm	China	JQ349113	JQ349099
Dentipellopsis dacrydicola	Dai 12004	BJFC 9072	*Dacrydium*	China	JQ349104	JQ349089
	Dai 12010	BJFC 9077	*Dacrydium*	China	–	JQ349090
Dentipratulum bialoviesense	GG 1645	–	–	France	AF506389	AF506389
Echinodontium ryvardenii	Ryvarden 43370	–	–	Italy	AF506431	AF506431
E. sulcata	KHL 8267	–	–	Russia	AF506414	AF506414
E. tinctorium	NH 6695	FCUG 500	–	Canada	AF506430	AF506430
Exidia glandulosa	EL 3-97	–	–	Sweden	AF506493	AF506493
E. recisa	EL 15-98	–	–	Sweden	AF347112	AF347112
Gloeocystidiellum bisporum	KHL 11135	–	–	Norway	AY048877	AY048877
G. clavuligerum	NH 11185	FCUG 2159	–	Spain	AF310088	AF310088
G. compactum	Wu 880615-21	FCUG 2648	–	China	AF506434	AF506434
G. formosanum	Wu 9404-16	FCUG 2651	–	China	AF506439	AF506439
G. porosum	NH 10434	FCUG 1933	–	Denmark	AF310094	AF310094
Gloeocystidiopsis cryptacanthus	KHL 10334	–	–	Puerto Rico	AF506442	AF506442
Gloeodontia columbiensis	NH 11118	FCUG 2133	–	Spain	AF506444	AF506444
G. discolor	KHL 10099	–	–	Puerto Rico	AF506445	AF506445
G. pyramidata	Ryvarden 15502	–	–	Colombia	AF506446	AF506446
G. subasperispora	KHL 8695	–	–	Norway	AF506404	AF506404
Gloeopeniophorella convolvens	KHL 10103	–	–	Puerto Rico	AF506435	AF506435
Gloiodon nigrescens	Desjardin 7287	–	–	Bali	AF506450	AF506450
G. strigosus	JS 26147	–	–	Norway	AF506449	AF506449
Gloiothele lactescens	EL 8-98	–	–	Sweden	AF506453	AF506453
Hericium abietis	NH 6990	FCUG 663	–	Canada	AF506456	AF506456
H. alpestre	NH 13240	FCUG 2754	–	Russia	AF506457	AF506457
H. americanum	–	DAOM F-21467	–	Canada	AF506458	AF506458
H. cirrhatum	Tübingen F794	–	–	Germany	AF506385	AF506385
H. coralloides	NH 282	FCUG 1229	–	Sweden	AF506459	AF506459
H. erinaceus	NH 12163	FCUG 2468	–	Russia	AF506460	AF506460
Heterobasidion annosum	Korhonen 06129/6	–	*Pinus*	Russia	KJ583211	KJ583225
H. parviporum	Korhonen 04121/3	–	*Picea*	Finland	KJ583212	KJ583226
Lactarius leonis	SJ 91016	–	–	Sweden	AF506411	AF506411
Larssoniporia incrustatocystidiata	Dai 13607 (paratype)	BJFC 15069	Angiosperm	China	KM107863[a]	KM107880[a]
	Dai 13608 (holotype)	BJFC 15070	Angiosperm	China	KM107864[a]	KM107881[a]
L. tropicalis	F-16446	–	–	Japan	KJ807072	KJ807088
	Ryvarden 45363	O 18245	–	Belize	KJ513294	KJ807089
Laxitextum bicolor	NH 5166	FCUG 1350	–	Sweden	AF310102	AF310102
Lentinellus auricula	KGN 280994	–	–	Sweden	AF506415	AF506415
L. cochleatus	KGN 96-09-28	–	–	Sweden	AF506417	AF506417
L. omphalodes	JJ 2077	–	–	Sweden	AF506418	AF506418
L. ursinus	EL 73-97	–	–	USA	AF506419	AF506419
L. vulpinus	KGN 98-08-25	–	–	Sweden	AF347097	AF347097

Table 1 (cont.)

Species	Sample no.	Specimen no.	Host	Locality	GenBank accession numbers	
					ITS	nLSU
Megalocystidium luridum	KHL 8635	–	–	Norway	AF506422	AF506422
Peniophora pini	Hjm 18143	–	–	Sweden	EU118651	EU118651
Polyporoletus sublividus	JA 030918	–	–	–	DQ389663	DQ389663
Pseudowrightoporia crassihypha	Cui 9073 (paratype)	BJFC 8011	Angiosperm	China	KM107871[a]	KM107890[a]
	Yuan 5884 (paratype)	BJFC 17179	Angiosperm	China	KM107872[a]	KM107891[a]
	Yuan 6247 (holotype)	IFP 13395	Angiosperm	China	KM107873[a]	KM107892[a]
P. cylindrospora	0810/1a	PRM 915962	*Fagus*	USA	GU594161	KJ807078
	Ryvarden 46609	O 18963	*Quercus*	USA	KJ513290	KJ807079
P. hamata	Dai 8132 (paratype)	BJFC 7475	Angiosperm	China	KM107868[a]	KM107887[a]
	Dai 8152 (holotype)	BJFC 2799	Angiosperm	China	KM107869[a]	KM107888[a]
	Dai 10007 (paratype)	BJFC 8191	Angiosperm	China	KM107870[a]	KM107889[a]
P. japonica	Dai 7221 (paratype)	BJFC 2773	Angiosperm	China	FJ644289	KM107882[a]
	Dai 12086	BJFC 9123	Angiosperm	China	KJ513293[a]	KM107883[a]
	KUC 20110908	–	–	Korea	KC166692	KC166692
P. oblongispora	Cui 3344 (paratype)	BJFC 2805	Angiosperm	China	KM107865[a]	KM107884[a]
	Yuan 6101 (holotype)	BJFC 13397	Angiosperm	China	KM107866[a]	KM107885[a]
	Yuan 6106 (paratype)	BJFC 13404	Angiosperm	China	KM107867[a]	KM107886[a]
Pseudoxenasma verrucisporum	EL 34-95	–	–	Sweden	AF506426	AF506426
Russula violacea	SJ 93009	–	–	Sweden	AF506465	AF506465
Scytinostroma ochroleucum	TAA 159869	–	–	Australia	AF506468	AF506468
S. odoratum	KHL 8546	–	–	Sweden	AF506469	AF506469
S. nannfeldtii	NH 7476	FCUG 1742	–	Norway	AF506472	AF506472
Sistotrema brinkmannii	NH 11412	–	–	Turkey	AF506473	AF506473
S. coronilla	NH 7598	–	–	Canada	AF506475	AF506475
S. muscicola	KHL 8791	–	–	Sweden	AF506474	AF506474
S. sernanderi	KHL 8576	–	–	Sweden	AF506476	AF506476
Stereum hirsutum	NH 7960	FCUG 1022	–	Romania	AF506479	AF506479
Trichaptum abietinum	NH 12842	FCUG 2581	–	Finland	AF347104	AF347104
Vararia ochroleuca	JS 24400	–	–	Norway	AF506485	AF506485
Wrightoporia avellanea	LR 41710	–	–	Jamaica	AF506488	AF506488
W. lenta	Dai 10462	BJFC 4711	*Cunninghamia*	China	KJ513291	KJ807082
	Dai 12850	BJFC 13139	*Picea*	China	KM107874[a]	KM107893[a]
W. subavellanea	Dai 11484 (holotype)	BJFC 7352	*Pinus*	China	KJ513295	KJ807085
	Dai 11488 (paratype)	BJFC 7356	*Pinus*	China	KJ513296	KJ807086
	Dai 11492 (paratype)	BJFC 7360	*Pinus*	China	KJ513297	KJ807087
Wrightoporiopsis amylohypha	Yuan 3460 (paratype)	IFP 13736	Angiosperm	China	KM107875[a]	KM107894[a]
	Yuan 3467 (paratype)	IFP 13743	Angiosperm	China	KM107876[a]	KM107895[a]
	Yuan 3579 (holotype)	BJFC 13829	Angiosperm	China	KM107877[a]	KM107896[a]
W. biennis	Cui 8457 (paratype)	BJFC 6946	Angiosperm	China	KJ807066	KJ807074
	Cui 8506 (holotype)	BJFC 6995	Angiosperm	China	KJ807067	KJ807075

[a] Newly generated sequences for this study.

spores), Q = variation in the L/W ratios between the specimens studied, n = number of spores measured from given number of specimens. Special colour terms followed Petersen (1996).

DNA extraction, PCR amplification and sequencing

A CTAB rapid plant genome extraction kit (China) was used to obtain PCR products from dried specimens, according to the manufacturer's instructions with some modifications (Han et al. 2014). The DNA was amplified with the primers: ITS4 and ITS5 or ITS1 for ITS (White et al. 1990), and LR0R and LR7 or LR5 for nLSU (http://www.biology.duke.edu/fungi/mycolab/primers.htm). The PCR protocols for ITS and nLSU followed Chen & Cui (2014). The PCR products were purified and sequenced in Beijing Genomics Institute, China, with the same primers.

Phylogenetic analysis

Thirty-nine new sequences were generated for this study, and other reference sequences were downloaded from GenBank (Table 1). Sequences were aligned with BioEdit (Hall 1999) and ClustalX (Thompson et al. 1997). Prior to phylogenetic analysis, ambiguous sequences at the start and the end were deleted and gaps were manually adjusted to optimize the alignment. Sequence alignment was deposited at TreeBase (http://purl.org/phylo/treebase; submission ID 16109).

The sequences of *Sistotrema brinkmannii*, *S. coronilla*, *S. muscicola* and *S. sernanderi* were used as outgroups (Larsson & Larsson 2003). Maximum Likelihood (ML) analysis and Bayesian inference (BI) methods were also used to analyse the combined ITS and nLSU dataset. Substitution models suitable for each partition in the dataset were determined using Akaike Information Criterion implemented in MrMODELTEST2.3 (Nylander 2004). RAxML v. 7.2.6 (Stamatakis 2006) was used for ML analysis. All parameters in the ML analysis used the default setting, and statistical support values were obtained using nonparametric bootstrapping with 1 000 replicates. BI was calculated with MrBayes v. 3.1.2 (Ronquist & Huelsenbeck 2003), with a general time reversible model of DNA substitution and an invgamma distribution rate variation across sites. Eight Markov chains were run from the random starting tree for 3 million generations of the combined ITS and nLSU dataset, and sampled every 100 generations. The burn-in was set to discard the first 25 % of the trees. A majority rule consensus tree of all remaining trees was calculated. Branches that received bootstrap values for ML and Bayesian Posterior Probabilities (BPP) greater than or equal to 75 % (ML) and 0.95 (BPP) were considered as significantly supported.

RESULTS

The combined ITS and nLSU dataset included 116 sequences of ITS and 114 sequences of nLSU regions from 117 samples representing 92 species. The best model for the combined ITS and nLSU sequences dataset estimated and applied in the

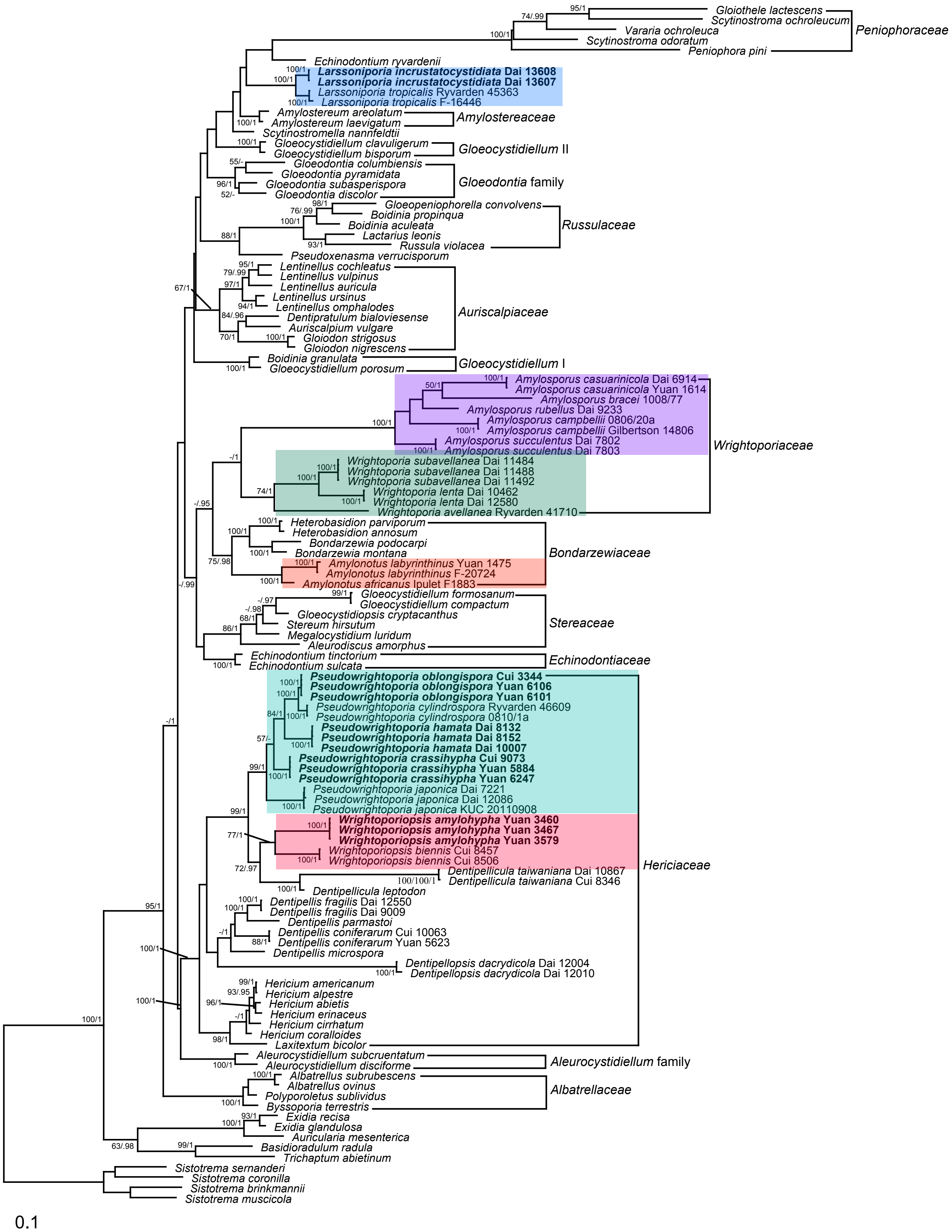

Fig. 1 Strict consensus tree illustrating the phylogeny of *Russulales* with an emphasis on poroid taxa generated by maximum likelihood based on ITS+nLSU sequence data. Branches are labelled with bootstrap proportions (before the slash markers) higher than 50 % and Bayesian Posterior Probabilities (after the slash markers) more than 0.95.

Bayesian analysis was 'GTR+I+G', lset nst=6, rates=invgamma; prset statefreqpr=dirichlet (1,1,1,1). ML and BI analyses yielded similar tree topologies with an average standard deviation of split frequencies = 0.008653, and only the ML tree was provided. Both bootstrap values (≥ 50 %) and BPPs (≥ 0.95) were showed at the nodes (Fig. 1).

The resulting phylogenetic tree resolved a strongly supported *Russulales* clade. All main (family-level) clades within *Russulales* are identified as in previous studies (Larsson & Larsson 2003, Miller et al. 2006, Larsson 2007). Meanwhile, the newly sequenced taxa are polyphyletic and scattered in the lineages of *Russulales*.

Judging from the molecular phylogenies, *Wrightoporia* presents a heterogeneous assemblage, and the type species, *W. lenta*, shows no affinity to the other genera in *Russulales* (Fig. 1). Most *Wrightoporia* s.l. species were embedded in three clades: the *Wrightoporiaceae* clade (including the type species, *W. lenta*), the *Hericiaceae* clade and the *Bondarzewiaceae* clade. Nevertheless, *W. tropicalis* and the related new species (*Larssoniporia incrustatocystidiata*) occurred on a single branch and are distant from the type species, *W. lenta*.

TAXONOMY

Combined with phylogenetic and morphological evidence, *Wrightoporia* s.str. and three new genera are set up, six new species are described and 17 new combinations are proposed. In addition, *Amylonotus* and *Amylosporus* are redefined.

Amylonotus Ryvarden, Norweg. J. Bot. 22: 26. 1975

Amylonotus was proposed by Ryvarden (1975) based on *A. africanus*, and the species in the genus were later treated in *Wrightoporia* by David & Rajchenberg (1987). In our phylogeny, *A. labyrinthinus* (= *Wrightoporia labyrinthina*) in Fig. 1 and *A. africanus* (=*Wrightoporia pouzarii*) formed a well-supported lineage within the *Bondarzewiaceae* clade (100 % ML; 1.00 BPPs), distant from *W. lenta*, and closely related to species of *Bondarzewia* and *Heterobasidion*. Morphologically the latter two genera differ from *Amylonotus* by simple septate generative hyphae (Ryvarden & Melo 2014), for which reason *Amylonotus* is considered as a well morphologically-defined genus as below.

Basidiocarps annual, sessile, pileate, effused-reflexed or resupinate, soft coriaceous when fresh, coriaceous to brittle when dry. Pileal surface cinnamon to dark brown, first finely tomentose, becoming smooth with age. Pore surface pale orange, isabelline, pale cinnamon to brown; pores large, labyrinthine to daedaleoid. Context pale cinnamon to brownish orange, membranous to fibrous. Tubes leathery to fibrous when dry. Hyphal system dimitic, generative hyphae with clamp connections, skeletal hyphae dextrinoid. Gloeoplerous hyphae present or absent. Gloeocystidia occasionally present or absent. Cystidia absent. Basidiospores ellipsoid to subglobose, hyaline, thin- to slightly thick-walled, finely asperulate, IKI+, CB+. Causing white rot.

In addition, *Wrightoporia gyropora*, *W. labyrinthina*, *W. ramosa* produce big pores (1–3 per mm), leathery to fibrous tubes, dextrinoid skeletal hyphae, and similar basidiospores, similar to *Amylonotus africanus*, and are different from species in other genera by their coriaceous basidiocarps and labyrinthine to daedaleoid pores when dry. Although the sequences of *W. gyropora* and *W. ramosa* were not obtained, according to their morphological characters, the two species and *W. labyrinthina* are transferred to *Amylonotus.* The following combinations are proposed.

Amylonotus gyroporus (Corner) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812216

Basionym. *Steccherícium gyroporum* Corner, Beih. Nova Hedwigia 96: 121. 1989.
= *Wrightoporia gyropora* (Corner) Stalpers, Stud. Mycol. 40: 37. 1996.

Descriptions in Corner (1989).

Specimen examined. Brunei, Andulai Forest, 22 Feb. 1959, *No. 185945* (holotype E).

Amylonotus labyrinthinus (T. Hatt.) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812217

Basionym. *Wrightoporia labyrinthina* T. Hatt., Mycoscience 49: 59. 2008.

Descriptions in Hattori (2008).

Specimens examined. China, Yunnan Province, Xi-Shuang-Banna, Mangao Nature Reserve, on fallen angiosperm branch, 11 Aug. 2005, *H.S. Yuan, Yuan 1475* (IFP 12752). – Japan, Ibaraki Prefecture, Kitaibaraki, Ogawa, on angiosperm twig, 30 Sept. 2003, *F-20724* (holotype TFM).

Amylonotus ramosus (A. David & Rajchenb.) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812219

Basionym. *Wrightoporia ramosa* A. David & Rajchenb., Canad. J. Bot. 65: 204. 1987.

Descriptions in David & Rajchenberg (1987).

Specimen examined. Singapore, Bukit Timah, on a very rotten trunk in a very humid place among ferns, July 1974, *LYAD 1758* (holotype LY).

Amylosporus Ryvarden, Norweg. J. Bot.. 20: 1. 1973

Amylosporus (1973), typified by *A. campbellii*, was introduced to include species having both simple septate and multi-clamped generative hyphae, and finely asperulate and amyloid basidiospores. David & Rajchenberg (1985) proposed that *A. wrightii* is a taxonomic synonym of *A. bracei*. Five species have been so far recorded in *Amylosporus*, namely *A. bracei*, *A. campbellii*, *A. iobapha*, *A. ryvardenii* and *A. succulentus*. Phylogenetically, *A. bracei*, *A. campbellii*, *Wrightoporia casuarinicola*, *W. rubella* and *A. succulentus* formed a well-supported lineage (100 % ML; 1.00 BPPs) and are related to species of *Wrightoporia* s.str. without a strong support. Species in this clade are characterized by hymenial structures without clamp connections, and *Amylosporus* is redefined as following.

Basidiocarps annual to perennial, stipitate or sessile, pileate, effused-reflexed or resupinate, soft to corky. Pileal surface buff to ochraceous, usually glabrous. Pore surface whitish, pale ochraceous, pinkish, lilac to vinaceous; pores large to small, round to angular; margin usually with rhizomorphs in the resupinate species. Context white to pale brown, cottony, soft corky to tough. Tubes soft corky. Hyphal system dimitic, generative hyphae with simple septa or with both simple septa and multiple clamp connections, skeletal hyphae dextrinoid or IKI–. Clamp connections absent in hymenium. Gloeoplerous hyphae present or absent. Gloeocystidia absent. Cystidia absent. Basidiospores broadly ellipsoid to subglobose, thin- to slightly thick-walled, finely asperulate, IKI+, CB+ or CB–. Causing white rot.

Morphologically, *Wrightoporia casuarinicola*, *W. efibulata* and *W. rubella* are characterized by their generative hyphae lacking clamp connections totally, which fits the newly defined *Amylosporus* (clamp connections are absent in hymenium). In addition, phylogenetic evidence supported that *W. casuarinicola* and *W. rubella* belong to *Amylosporus*, and the following combinations are proposed.

Amylosporus casuarinicola (Y.C. Dai & B.K. Cui) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812220; Fig. 2a

Basionym. *Wrightoporia casuarinicola* Y.C. Dai & B.K. Cui, Mycotaxon 96: 200. 2006.

Descriptions in Dai & Cui (2006).

Specimens examined. CHINA, Guangxi Autonomous Region, Beihai, on living tree of *Casuarina equisetifolia*, 12 Aug. 2005, *Y.C. Dai*, *Dai 6914* (holotype, BJFC 2760); Yunnan Province, Xi-Shuang-Banna, on fallen angiosperm trunk, 14 Aug. 2006, *H.S. Yuan*, *Yuan 1614* (IFP 12866); 12 Sept. 2006, *H.S. Yuan*, *Yuan 2340* (IFP 13293) & *Yuan 2348* (IFP13301); 11 Sept. 2007, *H.S. Yuan*, *Yuan 3447* (IFP 13723); on fallen trunk of bamboo, 14 Sept. 2007, *H.S. Yuan*, *Yuan 3566* (IFP 13817).

Amylosporus efibulatus (I. Lindblad & Ryvarden) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812221

Basionym. *Wrightoporia efibulata* I. Lindblad & Ryvarden, Mycotaxon 71: 355. 1999.

Descriptions in Lindblad & Ryvarden (1999).

Specimen examined. COSTA RICA, Alajuela, 12 July 2001, *Ryvarden 43719* (O).

Amylosporus rubellus (Y.C. Dai) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812222; Fig. 2b

Basionym. *Wrightoporia rubella* Y.C. Dai, Karstenia 35, 2: 86. 1995.

Descriptions in Dai (1995).

Specimens examined. CHINA, Beijing, Xiangshan, on rotten angiosperm wood, 26 Sept. 1993, *Y.C. Dai*, *Dai 1339* (holotype, IFP 15811); on rotten wood of *Koelreuteria*, 27 Sept. 2007, *Y.C. Dai*, *Dai 9233* (IFP 15555); Shandong Province, Mengyin County, on fallen trunk of *Robina*, 27 July 2007, *B.K. Cui*, *Cui 5009* (BJFC 3050); *Cui 5011* (BJFC 3052) & *Cui 5020* (BJFC 3061).

Larssoniporia Y.C. Dai, Jia J. Chen & B.K. Cui, *gen. nov*. — MycoBank MB812223

Etymology. *Larssoniporia* (Lat.): in honour of the Swedish mycologist Dr. Karl-Henrik Larsson.

Type species. *Larssoniporia tropicalis* (Cooke) Y.C. Dai, Jia J. Chen & B.K. Cui.

Basidiocarps annual to perennial, sessile, pileate, effused-reflexed or resupinate, woody hard when dry. Pileal surface ochraceous beige to dark brown, usually glabrous. Pore sur-

Fig. 2 Representatives of *Amylosporus*, *Larssoniporia*, *Pseudowrightoporia*, *Wrightoporia* and *Wrightoporiopsis* in China. a. *Amylosporus casuarinicola* (Dai 6914); b. *Amylosporus rubellus* (Dai 9233); c. *Larssoniporia incrustatocystidiata* (Dai 13607); d. *Pseudowrightoporia crassihypha* (Cui 9073); e. *Pseudowrightoporia hamata* (Dai 8132); f. *Pseudowrightoporia japonica* (Dai 7221); g. *Pseudowrightoporia oblongispora* (Yuan 6101); h. *Wrightoporia austrosinensis* (Dai 11579); i. *Wrightoporia borealis* (Dai 7075); j. *Wrightoporia lenta* (Dai 12850); k. *Wrightoporia subavellanea* (Dai 10302); l. *Wrightoporiopsis amylohypha* (Yuan 3460). — Scale bars: a, e = 2 cm; b–d, f = 1 cm.

face cream, grey, alutaceous to brown; pores large to small, elongated, round to angular. Context clay-buff, rusty to brown, hard corky. Tubes tough. Hyphal system dimitic, generative hyphae mainly with clamp connections and simple septa in some specimens of *Wrightoporia tropicalis*, skeletal hyphae dextrinoid. Gloeoplerous hyphae absent. Gloeocystidia present. Cystidia bearing apical crystals present. Basidiospores broadly ellipsoid to subglobose, hyaline, thin- to slightly thick-walled, finely asperulate, IKI+, CB– or CB+. Causing white rot.

Notes — *Larssoniporia* is characterized by its woody hard basidiocarps when dry, tough tubes, dextrinoid skeletal hyphae, presence of cystidia with crystals at tips and gloeocystidia, finely asperulate and amyloid basidiospores, and by presenting a distribution in the tropics. In our phylogeny, *Wrightoporia tropicalis* was present as a single lineage distant from the *Wrightoporiaceae* clade which was also shown by Larsson & Larsson (2003). *Wrightoporia tropicalis* and *L. incrustatocystidiata* showed no affinity to the other genera in *Russulales* (Fig. 1). Therefore, *Larssoniporia* gen. nov. is proposed to accommodate *W. tropicalis* and *L. incrustatocystidiata.* Moreover, we found that all specimens of *W. tropicalis* have clamped generative hyphae, and simple septa sometimes occur in some specimens of the species. *Wrightoporia gloeocystidiata* with clamped generative hyphae is a taxonomic synonym of *L. tropicalis* (Ryvarden 1983).

Larssoniporia incrustatocystidiata Y.C. Dai, Jia J. Chen & B.K. Cui, *sp. nov.* — MycoBank MB812224; Fig. 2c, 3a, 4

Etymology. incrustatocystidiata (Lat.): referring to the apical encrusted cystidia.

Holotype. China, Yunnan Province, Xi-Shuang-Banna, Jinghong Virgin Forest Park, on fallen angiosperm trunk, 22 Oct. 2013, *Y.C. Dai*, *Dai 13608* (BJFC 15070).

Basidiocarps annual, resupinate. Hyphal system dimitic; generative hyphae with clamp connections; skeletal hyphae dextrinoid, CB+; gloeocystidia and encrusted cystidia abundant. Basidiospores broadly ellipsoid to subglobose, hyaline, thin-walled, finely asperulate, IKI+, CB–.

Basidiome annual, resupinate, inseparable, woody hard upon drying, without odour or taste, up to 14 cm long, 7 cm wide, 7 mm thick at centre. Pore surface brownish, curry-yellow to clay-buff when dry; pores elongated to angular, 3–5(–6) per mm; dissepiments thin, entire. Sterile margin absent. Subiculum clay-buff to brown, hard corky, up to 1 mm thick. Tubes concolorous with pore surface, tough, up to 6 mm long. *Hyphal system* dimitic; generative hyphae with clamp connections; skeletal hyphae dextrinoid, CB+; tissues becoming dark brown in KOH. Generative hyphae in subiculum infrequent, hyaline, thin-walled, rarely branched, 1.5–2 µm diam; skeletal hyphae dominant, yellowish to slightly orange, thick-walled with a narrow lumen, unbranched, flexuous, loosely interwoven, 2–5 µm diam. Generative hyphae in trama infrequent, thin-walled, infrequently branched, 1–2 µm diam; skeletal hyphae dominant, hyaline to yellow, thick-walled with a narrow lumen, unbranched, flexuous, loosely interwoven, 1.5–3 µm diam. *Gloeocystidia* abundant, ventricose, thin-walled with granular to oily con-

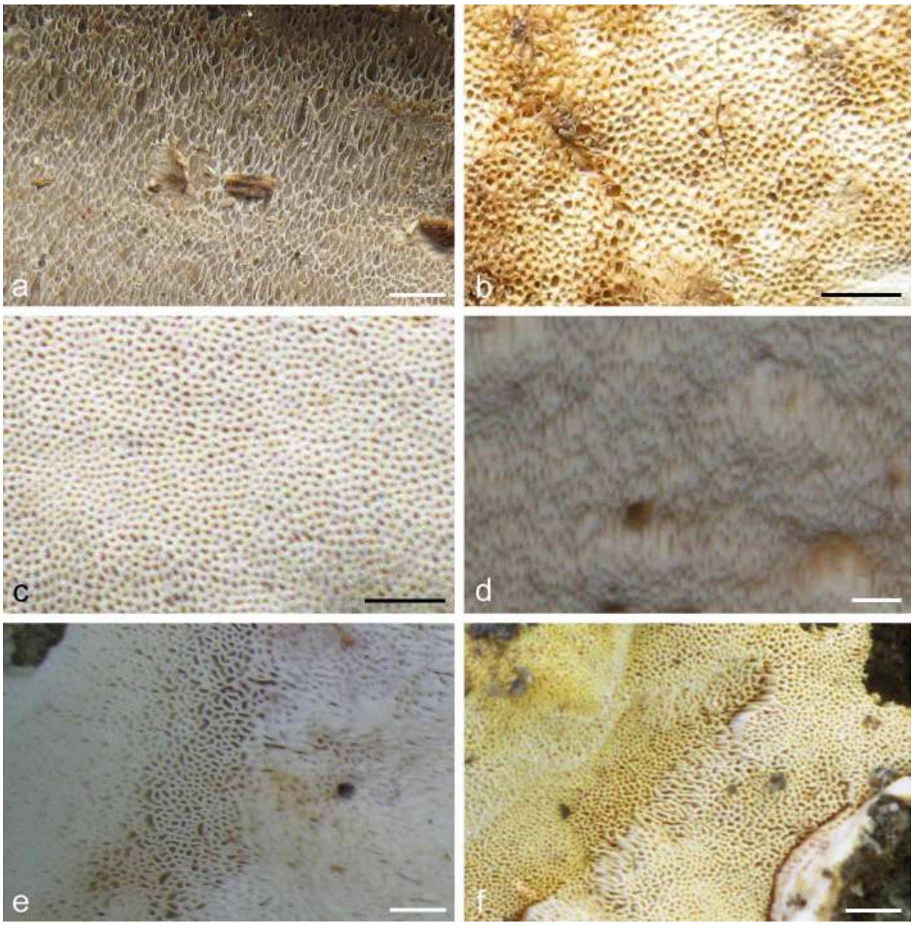

Fig. 3 These images show the pore surface of five new species and *Wrightoporia lenta* in China. a. *Larssoniporia incrustatocystidiata*; b. *Pseudowrightoporia crassihypha*; c. *Pseudowrightoporia hamata*; d. *Pseudowrightoporia oblongispora*; e. *Wrightoporia lenta*; f. *Wrightoporiopsis amylohypha*. — Scale bars: a–d, f, j–l = 1 mm; e, g–i = 2 mm.

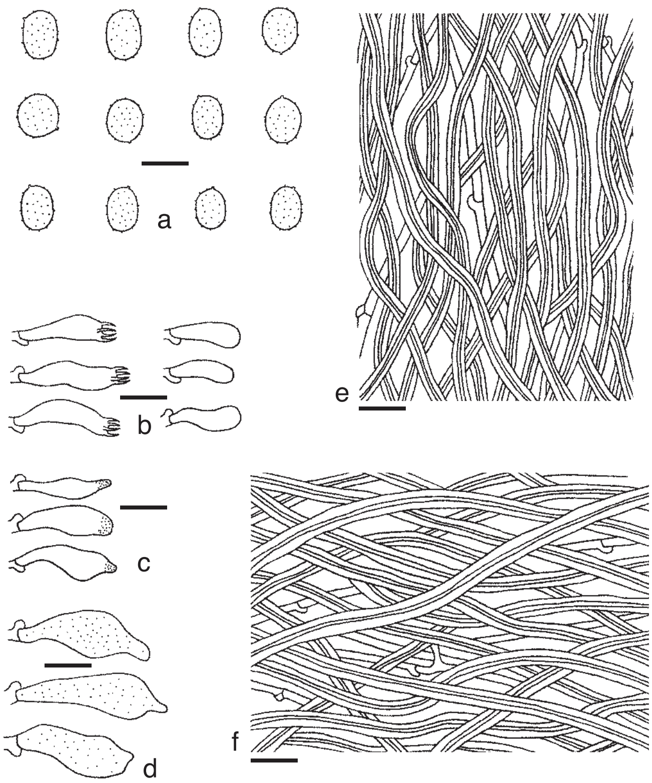

Fig. 4 Microscopic structures of *Larssoniporia incrustatocystidiata*. a. Basidiospores; b. basidia and basidioles; c. encrusted cystidia; d. gloeocystidia; e. hyphae from trama; f. hyphae from subiculum (all: holotype). — Scale bars: a = 5 µm; b–f = 10 µm.

tents,16–40 × 8–11 µm, embedded in hymenium. *Leptocystidia* fusoid to ventricose, hyaline, apically encrusted, 20–24 × 4–8 µm; *cystidioles* absent. *Basidia* clavate, bearing four sterigmata and a basal clamp connection, 17–20 × 4–6 µm; basidioles similar in shape to basidia but slightly smaller. *Basidiospores* broadly ellipsoid to subglobose, hyaline, thin-walled, finely asperulate, IKI+, CB–, 4–5.2(–5.3) × 3–4(–4.1) µm, L = 4.47 µm, W = 3.48 µm, Q = 1.25–1.32 (n = 60/2). Causing white rot.

Additional specimen (paratype) examined. China, Yunnan Province, Xi-Shuang-Banna, Jinghong Virgin Forest Park, on fallen angiosperm trunk, 22 Oct. 2013, *Y.C. Dai*, *Dai 13607* (BJFC 15069).

Notes — *Larssoniporia incrustatocystidiata* is characterized by an annual growth habit, tough resupinate basidiocarps, relatively large pores (3–5 per mm), presence of gloeocystidia and encrusted leptocystidia and relatively large basidiospores (4–5.2 × 3–4 µm); while *L. tropicalis* has a perennial growth habit, tiny pores (6–8 per mm), and smaller basidiospores (2.7–4 × 2–3 µm).

Larssoniporia tropicalis (Cooke) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812225

Basionym. *Fomes tropicalis* Cooke, Grevillea 15: 22. 1886.

= *Wrightoporia tropicalis* (Cooke) Ryvarden, Prelim. Polyp. Fl. E. Afr.: 619. 1980.
= *Wrightoporia gloeocystidiata* I. Johans. & Ryvarden, Trans. Brit. Mycol. Soc. 72: 197. 1979.

Descriptions in Ryvarden & Johansen (1980).

Specimens examined. Belize, Orange Walk district, La Milpa Field Station, 24 Oct. 2002, *Ryvarden 45184* (O); Cayo District, Guacamayo Bridge, Mecal River, 1 Nov. 2002, *Ryvarden 45363* (O). – Guyana, 1884, *Demarara* (O). – Japan, *F 16446* (TFM). – Kenya, Eastern Province, Meru District, 1 Nov. 1972, *Taylor* (O, the typical specimen of *W. gloeocystidiata*).

Pseudowrightoporia Y.C. Dai, Jia J. Chen & B.K. Cui, *gen. nov.* — MycoBank MB812226

Etymology. *Pseudowrightoporia* (Lat.): referring to resembling *Wrightoporia.*

Type species. *Pseudowrightoporia cylindrospora* (Ryvarden) Y.C. Dai & Jia J. Chen.

Basidiocarps annual, sessile, pileate, effused-reflexed or resupinate, soft corky to corky when fresh, corky when dry. Pileal surface beige, pale brown to ochraceous. Pore surface cream, buff-yellow, yellowish brown, orange to ochraceous, usually shining; pores large to tiny, round to angular. Context cream, buff, pale orange, ochraceous to brown, corky to cottony. Tubes corky to fibrous-corky. Hyphal system dimitic, generative hyphae with clamp connections, skeletal hyphae dextrinoid or IKI–. Gloeoplerous hyphae present or absent. Gloeocystidia present or absent. Cystidia present or absent. Basidiospores oblong, broadly ellipsoid, ellipsoid to subglobose, hyaline, thin- to thick-walled, finely asperulate, IKI+, CB+ or CB–. Causing white rot.

Notes — *Pseudowrightoporia* is characterized by soft corky to corky basidiocarps when fresh, corky basidiocarps when dry, usually with shining pores, corky to fibrous-corky tubes, a dimitic hyphal structure, oblong, broadly ellipsoid, ellipsoid to subglobose, finely asperulate and amyloid basidiospores, and a subtropical to tropical distribution. Based on phylogenetic analyses, both *W. cylindrospora* and *W. japonica* were clustered in the *Hericiaceae* clade that is distant from *W. lenta*, the type species of *Wrightoporia*. Both species plus three new other ones formed a well-supported lineage (Fig. 1; 99 % ML; 1.00 BPPs). Moreover, these five species differ from *Wrightoporia* s.str. and other russuloid polypores by poroid basidiocarps, more or less yellowish to pale brown pore surface, shining pores, corky to fibrous-corky tubes, and a dimitic hyphal structure with clamped generative hyphae. Therefore, *Pseudowrightoporia* gen. nov. is proposed to accommodate these five species. Although the phylogenetic statuses of *W. africana*, *W. aurantipora*, *W. gillesii*, *W. solomonensis* and *W. straminea* were not shown in Fig. 1 due to absence or incompletion of their sequences, these species fit *Pseudowrightoporia* in morphology by more or less yellowish to pale brown pore surface, shining pores and corky basidiocarps when dry and corky to fibrous-corky tubes. Therefore, these species are transferred to *Pseudowrightoporia.* The new species are described and seven new combinations are proposed as following.

Pseudowrightoporia crassihypha Y.C. Dai, Jia J. Chen & B.K. Cui, *sp. nov.* — MycoBank MB812227; Fig. 2d, 3b, 5

Etymology. *crassihypha* (Lat.): referring to the wide thick-walled skeletal hyphae in trama.

Holotype. China, Guangxi Autonomous Region, Shangsi County, Shiwandashan Nature Reserve, on fallen angiosperm branch, 24 July 2012, *H.S. Yuan*, *Yuan 6247* (IFP 13395).

Basidiocarps annual, resupinate. Hyphal system dimitic; generative hyphae with clamp connections, skeletal hyphae CB+, dextrinoid near the tube mouths, otherwise IKI–; contextual tissues becoming dark brown in KOH, otherwise unchanged in KOH. Clavate cystidia and fusoid cystidioles present. Basidiospores subglobose to broadly ellipsoid, hyaline, thick-walled, finely asperulate, IKI+, CB–.

Basidiome annual, resupinate, inseparable, corky upon drying, without odour or taste, up to 7 cm long, 2.5 cm wide, 2 mm thick at centre. Pore surface buff to fawn when dry, shining; pores round to angular, 7–9(–10) per mm; dissepiments thin, entire. Sterile margin present, buff to buff-yellow, corky, up to

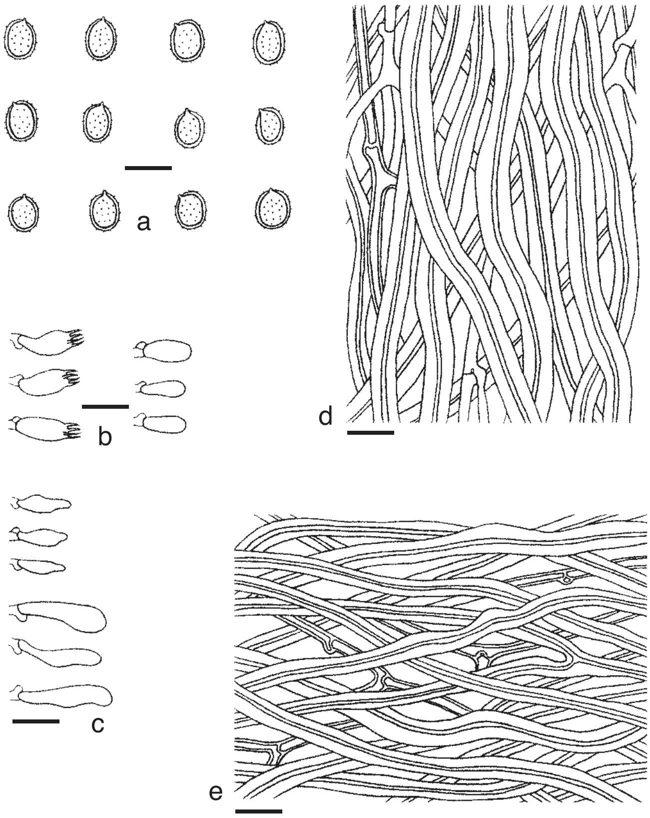

Fig. 5 Microscopic structures of *Pseudowrightoporia crassihypha*. a. Basidiospores; b. basidia and basidioles; c. cystidia and cystidioles; d. hyphae from trama; e. hyphae from subiculum (all: holotype). — Scale bars: a = 5 μm; b–e = 10 μm.

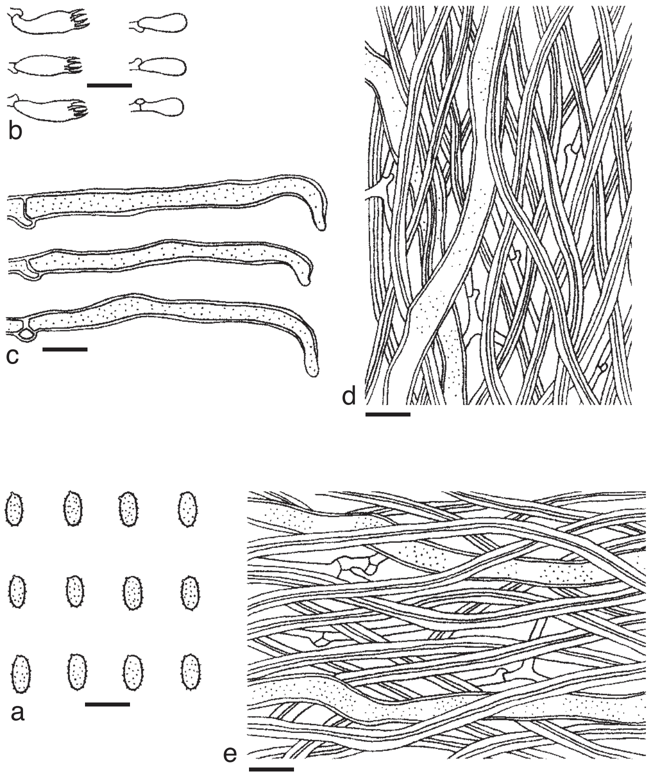

Fig. 6 Microscopic structures of *Pseudowrightoporia hamata*. a. Basidiospores; b. basidia and basidioles; c. gloeocystidia; d. hyphae from trama; e. hyphae from subiculum (all: holotype). — Scale bars: a = 5 μm; b–e = 10 μm.

1 mm wide. Subiculum buff to buff-yellow, corky, up to 0.5 mm thick. Tubes concolorous with pore surface, corky, up to 1.5 mm long. *Hyphal system* dimitic; generative hyphae bearing clamp connections; skeletal hyphae CB+, dextrinoid near the tube mouths, IKI– in other parts; contextual tissues becoming dark brown in KOH, otherwise unchanged in KOH. Generative hyphae in subiculum frequent, hyaline, fairly thick-walled with a wide lumen, frequently branched, 2–3 μm diam; skeletal hyphae dominant, hyaline to yellowish, thick-walled with a narrow lumen, unbranched, flexuous, interwoven, partly encrusted with hyaline to yellowish, irregular crystals, 3–6 μm diam. Generative hyphae in trama infrequent, thin- to slightly thick-walled, frequently branched, 1–2 μm diam; skeletal hyphae dominant, hyaline, thick-walled with a narrow lumen, unbranched, flexuous, interwoven, partly encrusted with hyaline to yellowish, irregular crystals, (2–)5–7 μm diam. *Leptocystidia* clavate, hyaline, 18–24 × 4–6 μm; *cystidioles* fusoid, hyaline, thin-walled, 10–12 × 3–4 μm. *Basidia* subclavate to barrel-shaped, bearing four sterigmata and a basal clamp connection, 10–13 × 4–6 μm; basidioles in shape similar to basidia, but slightly smaller. *Basidiospores* broadly ellipsoid to subglobose, hyaline, thick-walled, finely asperulate, IKI+, CB–, (3.4–)3.5–4(–4.1) × 2.6–3.1 μm, L = 3.73 μm, W = 2.9 μm, Q = 1.29 (n = 60/2). Causing white rot.

Additional specimens (paratypes) examined. China, Guangdong Province, Fengkai County, Heishiding Nature Reserve, on fallen angiosperm branch, 2 July 2010, *B.K. Cui*, *Cui 9073* (BJFC 8011); Guangxi Autonomous Region, Jinxiu County, Dayaoshan Nature Reserve, on fallen angiosperm branch, 25 Aug. 2011, *H.S. Yuan*, Yuan 5884 (BJFC 17179).

Notes — *Pseudowrightoporia crassihypha* is characterized by its small pores (7–9 per mm), encrusted skeletal hyphae, wide tramal skeletal hyphae (mostly 5–7 μm) and presence of cystidia. *Pseudowrightoporia japonica* is similar by sharing similar corky basidiocarps and similar sized pores (6–8 per mm); however, it usually has narrower tramal skeletal hyphae (mostly 2.4–5.3 μm) and lacks cystidia (Núñez & Ryvarden 1999, Cui & Dai 2006).

Pseudowrightoporia hamata Y.C. Dai, Jia J. Chen & B.K. Cui, *sp. nov.* — MycoBank MB812228; Fig. 2e, 3c, 6

Etymology. *hamata* (Lat.): referring to the hooked gloeocystidia.

Holotype. China, Hunan Province, Yizhang County, Mangshan Forest Park, on rotten angiosperm wood, 26 June 2007, *Y.C. Dai*, *Dai 8152* (BJFC 2799).

Basidiocarps annual, resupinate. Hyphal system dimitic; generative hyphae with clamp connections, skeletal hyphae dextrinoid, CB+; thick-walled gloeoplerous hyphae present. Gloeocystidia abundant. Basidiospores oblong, hyaline, slightly thick-walled, finely asperulate, strong IKI+, weakly CB+.

Basidiome annual, resupinate, inseparable, corky upon drying, without odour or taste, up to 12 cm long, 7 cm wide, 3 mm thick at centre. Pore surface whitish when fresh, cinnamon-buff to orange-brown when dry, shining; pores round to angular, 6–9 per mm; dissepiments thin to thick, entire to lacerate. Sterile margin distinct, clay-buff to cinnamon, corky, up to 1.1 mm wide. Subiculum clay-buff to cinnamon-brown, corky, up to 1 mm thick. Tubes concolorous with pore surface, corky, up to 2 mm long. *Hyphal system* dimitic; generative hyphae with clamp connections; skeletal hyphae dextrinoid, CB+; tissues unchanged in KOH. Generative hyphae in subiculum infrequent, hyaline, thin-walled, frequently branched, 2–2.5 μm diam; skeletal hyphae dominant, hyaline to pale orange, thick-walled with a narrow lumen, rarely branched, flexuous, interwoven, 2–5 μm diam. Generative hyphae in trama infrequent, thin-walled, frequently branched, 1–2 μm diam; skeletal hyphae dominant, hyaline, thick-walled with a narrow lumen, rarely branched, flexuous, interwoven, 2–4 μm diam; gloeoplerous hyphae present, slightly thick-walled with granular to oily contents, 4–9 µm diam, embedded in trama. *Gloeocystidia* abundant, thin-walled with granular to oily contents, embedded in hymenium, hooked at tips, 60–65 × 4–5 µm; *cystidia* and *cystidioles* absent. *Basidia* subclavate to barrel-shaped, bearing four sterigmata and a basal clamp connection, 10–13 × 4–5 µm; basidioles in shape similar to basidia, but slightly smaller. *Basidiospores* oblong, hyaline, slightly thick-walled, finely asperulate, strongly IKI+, weakly CB+, 3–3.8(–3.9) × 1.9–2.2(–2.3) µm, L = 3.28 µm, W = 2.05 µm, Q = 1.59–1.63 (n = 90/3). Causing white rot.

Additional specimens (paratypes) examined. China, Hainan Province, Ledong County, Jianfengling Nature Reserve, on fallen angiosperm trunk, 2 June 2008, *Y.C. Dai*, *Dai 9987* (BJFC 8173) & *Dai 10007* (BJFC 8191); Hunan Province, Yizhang County, Mangshan Forest park, on fallen rotten angiosperm wood, 26 June 2007, *Y.C. Dai*, *Dai 8132* (BJFC 7475), *J. Li*, *Li 1765* (BJFC 2782) & *Li 1777* (BJFC 2778).

Notes — *Pseudowrightoporia hamata* is characterized by small pores (6–9 per mm), dextrinoid skeletal hyphae, abundant gloeoplerous hyphae in trama, hooked gloeocystidia and oblong and thick-walled basidiospores. *Pseudowrightoporia oblongispora* also has small pores (6–8 per mm) and similar basidiospores (3–3.6 × 1.8–2.2 µm), but its skeletal hyphae are negative in Melzer's reagent and it lacks gloeocystidia.

Pseudowrightoporia oblongispora Y.C. Dai, Jia J. Chen & B.K. Cui, *sp. nov.* — MycoBank MB812229; Fig. 2g, 3d, 7

Etymology. *oblongispora* (Lat.): referring to the shape of basidiospores.

Holotype. China, Guangxi Autonomous Region, Tianlin County, Cenwanglaoshan Nature Reserve, on fallen angiosperm trunk, 17 July 2012, *H.S. Yuan*, *Yuan 6101* (BJFC 13397).

Basidiocarps annual, resupinate. Hyphal system dimitic; generative hyphae with clamp connections, skeletal hyphae IKI–, CB+, partly widened in trama; gloeoplerous hyphae abundant, thin- to slightly thick-walled. Basidiospores oblong, hyaline, thick-walled, finely asperulate, IKI+, CB–.

Basidiome annual, resupinate, inseparable, corky upon drying, without odour or taste, up to 8.5 cm long, 6 cm wide, 2 mm thick at centre. Pore surface pinkish buff to clay-buff when dry; pores round to angular, 6–8 per mm; dissepiments thin, entire to lacerate. Sterile margin distinct, buff to brown, corky, up to 1 mm wide. Subiculum buff to cinnamon-brown, corky, up to 1 mm thick. Tubes concolorous with pore surface, corky, up to 1 mm long. *Hyphal system* dimitic; generative hyphae with clamp connections; skeletal hyphae IKI–, CB+; contextual tissues becoming dark brown in KOH, otherwise unchanged in KOH. Abundant oily substance present among hyphae. Generative hyphae in subiculum frequent, hyaline, thin- to slightly thick-walled, frequently branched, 2–3 µm diam; skeletal hyphae dominant, hyaline to pale orange, thick-walled with a narrow lumen, rarely branched, flexuous, interwoven, partly encrusted with hyaline to yellowish, irregular crystals, 3–6 µm diam. Generative hyphae in trama infrequent, thin-walled, frequently branched, 1–2 µm diam; skeletal hyphae dominant, hyaline, thick-walled with a narrow lumen, rarely branched, flexuous, interwoven, 2–5 µm diam, some distinctly widened up to 9 µm diam; gloeoplerous hyphae abundant, thin- to slightly thick-walled with granular to oily contents, 5–9 µm diam, embedded in trama. *Cystidia* absent; *cystidioles* fusoid, hyaline, thin-walled, 9–12 × 3–4 µm. *Basidia* subclavate to barrel-shaped, bearing four sterigmata and a basal clamp connection, 10–12 × 4–5 µm; basidioles in shape similar to basidia, but slightly smaller. *Basidiospores* oblong, hyaline, thick-walled, finely asperulate, IKI+, CB–, (2.9–) 3–3.6 × (1.7–)1.8–2.2 µm, L = 3.21 µm, W = 1.95 µm, Q = 1.64–1.66 (n = 60/2). Causing white rot.

Additional specimens (paratypes) examined. China, Fujian Province, Wuyishan County, Taoyuan Valley, on rotten angiosperm wood, 24 Oct. 2005, *B.K. Cui*, *Cui 3344* (BJFC 2805); Guangxi Autonomous Region, Tianlin County, Cenwanglaoshan Nature Reserve, on fallen angiosperm trunk, 17 July 2012, *H.S. Yuan*, *Yuan 6106* (BJFC 13404); Hunan Province, Yizhang County, Mangshan Forest Park, on fallen angiosperm trunk, 26 June 2007, *Y.C. Dai*, *Dai 8148* (BJFC 2792).

Notes — *Pseudowrightoporia oblongispora* is characterized by small pores (6–8 per mm), non-dextrinoid skeletal hyphae, widened skeletal hyphae and abundant gloeoplerous hyphae in trama, presence of fusoid cystidioles and oblong and thick-walled basidiospores. *Pseudowrightoporia cylindrospora* may be confused with *P. oblongispora* by sharing widened skeletal hyphae, and similar oblong basidiospores (3–4 × 1.5–2 µm). However, *P. cylindrospora* has dextrinoid skeletal hyphae and shows an absence of gloeoplerous hyphae and cystidioles (Ryvarden 1982).

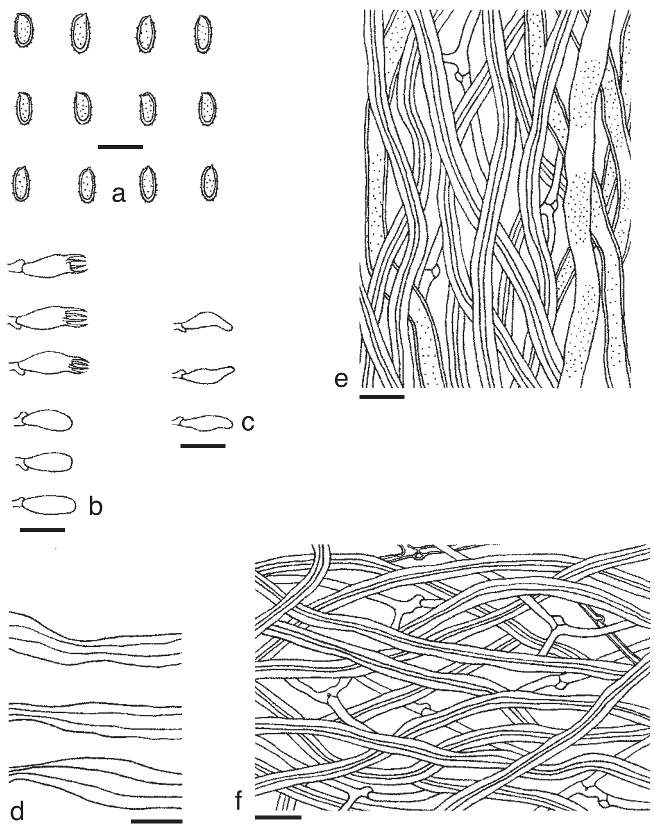

Fig. 7 Microscopic structures of *Pseudowrightoporia oblongispora*. a. Basidiospores; b. basidia and basidioles; c. cystidioles; d. inflated skeletal hyphae; e. hyphae from trama; f. hyphae from subiculum (all: holotype). — Scale bars: a = 5 µm; b–f = 10 µm.

Pseudowrightoporia africana (I. Johans. & Ryvarden) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812230

Basionym. *Wrightoporia africana* I. Johans. & Ryvarden, Trans. Brit. Mycol. Soc. 72: 196. 1979.

Descriptions in Johansen & Ryvarden (1979).

Specimens examined. Cameroon, Campo Province, Akok Lowland Rain Forest Reserve, 2 Dec. 1991, *Ryvarden 30558* (O). – Gabon, Makokou, July 1970 (LY). – Uganda, Kanungu District, Bwindi Impenetrable Forest National Park, 5 June 2003, *Ipulet F 1965* (O).

Pseudowrightoporia aurantipora (T. Hatt.) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812231

Basionym. *Wrightoporia aurantipora* T. Hatt., Mycoscience 49: 57. 2008.

Descriptions in Hattori (2008).

Specimens examined. Japan, Ibaraki Prefecture, Iwase, Tomiya-san, on angiosperm, 22 Oct. 1998, *F-19004* (holotype TFM); Okinawa Prefecture, Iriomote Island, on angiosperm, *F-16614* (paratype TFM).

Pseudowrightoporia cylindrospora (Ryvarden) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812234

Basionym. *Wrightoporia cylindrospora* Ryvarden, Nordic J. Bot. 2: 147. 1982.

Descriptions in Ryvarden (1982).

Specimens examined. USA, North Carolina State, Asheville bent Creak Experiment Forest, on *Quercus*, 18 July 2004, *Ryvarden 46609* (O); Ravine Trail, Schuylkill Canal, on *Fagus*, *0810/1a* (PRM).

Pseudowrightoporia gillesii (A. David & Rajchenb.) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812235

Basionym. *Wrightoporia gillesii* A. David & Rajchenb., Canad. J. Bot. 65: 204. 1987.

Descriptions in David & Rajchenberg (1987). Only clamped generative hyphae were recorded in the original description. However, we found some generative hyphae with simple septa in the holotype and paratype.

Specimens examined. China, Henan Province, Neixiang County, Baotianman Nature Reserve, on angiosperm stump, 28 Aug. 2005, *J. Li*, *Li 251* (BJFC 10080) & *Li 254* (IFP 15550); 30 Aug. 2005, *J. Li*, *Li 451* (BJFC 2763); 25 Aug. 2006, *J. Li*, *Li 458* (IFP 15552), *Li 1141* (IFP 15551) & *Li 1151* (BJFC 2761). – Gabon, Makokou, July 1970, *David* (holotype LY). – Ivory Coast, Banco Forest, 4 Nov. 1972, *Gilles* (paratype LY). – Uganda, Kanungu, Bwindi Forest National Park, on rotten branch, 15 Nov. 2002, *Ipulet F 1049* (O).

Pseudowrightoporia japonica (Núñez & Ryvarden) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812236; Fig. 2f

Basionym. *Wrightoporia japonica* Núñez & Ryvarden, Fung. Diversity 3: 119. 1999.
= *Wrightoporia luteola* B.K. Cui & Y.C. Dai, Nova Hedwigia 83: 159. 2006.

Descriptions in Núñez & Ryvarden (1999).

Specimens examined. China, Anhui Province, Huangshan County, Yellow Mt, on fallen angiosperm trunk, 13 Oct. 2004, *Y.C. Dai*, *Dai 6199* (holotype BJFC 2772); Qimen County, Guniujiang Nature Reserve, on dead angiosperm tree, 10 Aug. 2013, *Y.C. Dai*, *Dai 13427B* (BJFC 14891); Fujian Province, Wuyishan, on fallen angiosperm trunk, 19 Oct. 2005, *Y.C. Dai*, *Dai 7221* (BJFC 2773); Guangdong Province, Fengkai County, Heishiding Nature Reserve, on fallen angiosperm trunk, 1 July 2010, *B.K. Cui*, *Cui 9019a* (BJFC 7957); Huidong County, Gutian Nature Reserve, on fallen angiosperm branch, 22 Aug. 1986, *G.Y. Zheng*, *Zheng 11014* (paratype BJFC 2774); Guangxi Autonomous Region, Longzhou County, on fallen angiosperm branch, 3 July 2007, *X.S. Zhou*, *Zhou 28* (IFP 9491), *Zhou 41* (IFP 9503) & *Zhou 124* (IFP 9581); Laibin, Jinxiu County, 25 Aug. 2011, *H.S. Yuan*, *Yuan 5848* (IFP 17145) & *Yuan 5882* (IFP 17177); Hainan Province, Ledong County, Jianfengling Nature Reserve, on fallen angiosperm trunk, 18 Nov. 2007, *B.K. Cui*, *Cui 5200* (BJFC 3241), *Cui 5229* (BJFC 3270) & *Y.C. Dai*, *Dai 9277* (BJFC 2793); Changjiang, Bawangling Nature Reserve, on fallen angiosperm wood, 26 Nov. 2010, *Y.C. Dai*, *Dai 12086* (BJFC 9123); Henan Province, Neixiang County, Baotianman Nature Reserve, on fallen angiosperm trunk, 28 Aug. 2005, *J. Li*, *Li 267* (IFP 7468), *Li 321* (IFP 7464), *Li 329* (IFP 7462), *Li 330* (IFP 7563) & *Li 337* (IFP 7465); 29 Aug. 2005, *J. Li*, *Li 363* (IFP 7469) & *Li 405* (IFP 7461); 31 Aug. 2005, *J. Li*, *Li 460* (IFP 7466); 25 Aug. 2006, *J. Li*, *Li 1143* (IFP 7474), *Li 1144* (IFP 7467) & *Li 1150* (IFP 7473); Hunan Province, Yizhang County, on fallen angiosperm trunk, 2007, *J. Li*, *Li 1752* (IFP 7458), *Li 1763* (BJFC 2777), *Li 1766* (BJFC 2783) & *Li 1783* (IFP 7457); Zhejiang Province, Qingyun County, Baishanzu Nature Reserve, on fallen trunk of *Populus*, 8 Aug. 2013, *Y.C. Dai*, *Dai 13429* (BJFC 14893); Taishun County, Wuyanling Nature Reserve, on fallen angiosperm branch, 22 Aug. 2011, *B.K. Cui*, *Cui 10207* (BJFC 11101) & *Cui 10215* (BJFC 11109). – Japan, Ibarala Prefecture, 13 Oct. 1998, *Hattori 18988* (TFM); on fallen branch of *Carpinus*, 25 Nov. 2006, *Y.C. Dai*, *Dai 8053* (BJFC 12189); Okimawa Prefecture, 2005, *Hattori* (TFM).

Pseudowrightoporia solomonensis (Corner) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812237

Basionym. *Stecchericium solomonense* Corner, Beih. Nova Hedwigia 96: 124. 1989.
= *Wrightoporia solomonensis* (Corner) T. Hatt., Mycoscience 44: 461. 2003.

Descriptions in Corner (1989).

Specimen examined. Solomon Island, Guadalcanal, Gallego Mts, 6 July 1965, *Corner* (holotype E).

Pseudowrightoporia straminea (T. Hatt.) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812238

Basionym. *Wrightoporia straminea* T. Hatt., Mycoscience 49: 22. 2008.

Descriptions in Hattori (2008).

Specimen examined. Japan, Shiga Prefecture, Kutsuki, Asou, on angiosperm, 3 Nov. 1991, *F-16387* (holotype TFM).

***Wrightoporia* s.str.** Pouzar, Česká Mykol. 20: 173. 1966

Basidiocarps annual, resupinate, soft and cottony when fresh, membranous to cottony when dry. Pore surface white, cream to pale brown; margin usually with rhizomorphs; pores large, elongated, round to angular, 1–4 per mm. Subiculum white to cream, cottony. Tubes cream, membranous to cottony. Hyphal system dimitic, generative hyphae with clamp connections, skeletal hyphae strongly dextrinoid or IKI–. Gloeoplerous hyphae usually present. Gloeocystidia present or absent. Cystidia present or absent. Basidiospores ellipsoid, broadly ellipsoid to subglobose, hyaline, thin- to slightly thick-walled, finely asperulate, IKI+, CB+ or CB–. Causing white rot.

Notes — *Wrightoporia* s.str. is characterized by an annual growth habit, soft and cottony basidiocarps when fresh, membranous to cottony basidiocarps when dry, margins usually with rhizomorphs, big pores (1–4 per mm), membranous to cottony tubes, distinct narrow tramal skeletal hyphae (0.8–2.5 μm), finely asperulate and amyloid basidiospores, and a distribution from temperate to tropics. *Wrightoporia lenta*, the type species, *W. austrosinensis*, *W. avellanea* and *W. subavellanea* clustered together and nested within the *Wrightoporiaceae* clade. These four species and *W. borealis* share similar morphological characters. Based on both phylogenetic and morphological characters, *Wrightoporia* s.str. is defined as above.

Wrightoporiopsis Y.C. Dai, Jia J. Chen & B.K. Cui, *gen. nov.* — MycoBank MB812239

Etymology. *Wrightoporiopsis* (Lat.): having the appearance of *Wrightoporia.*

Type species. *Wrightoporiopsis neotropica* (Ryvarden) Y.C. Dai, Jia J. Chen & B.K. Cui.

Basidiocarps annual or perennial, sessile, pileate, effused-reflexed or resupinate, soft to corky when fresh, corky to tough or brittle when dry. Pileal surface orange-yellow to yellowish brown. Pore surface buff-yellow, ochraceous to olivaceous brown; pores small to tiny, round to angular. Context buff to cream, or pink to cinnamon-brown, cottony to hard corky. Tubes corky to tough, usually fragile. Hyphal system dimitic, generative hyphae with clamp connections, skeletal hyphae dextrinoid or IKI–. Gloeoplerous hyphae present or absent. Gloeocystidia present or absent. Cystidia present or absent. Basidiospores ellipsoid to subglobose, hyaline, thin- to thick-walled, finely asperulate, IKI+, CB– or CB+. Causing white rot.

Notes — *Wrightoporiopsis* is characterized by soft to corky basidiocarps when fresh, becoming tough and brittle upon drying, small to tiny pores (5–10 per mm), corky to tough and usually fragile tubes, finely asperulate and amyloid basidiospores, and a tropical distribution. *Wrightoporia biennis* and the new species *W. amylohypha* formed a well-supported lineage (77 % ML; 1.00 BPPs), and were embedded in the *Hericiaceae* clade, outside the *Wrightoporiaceae* clade. The resulting phylogenetic tree did not resolve the phylogenetic statuses of *W. micropora*, *W. neotropica* and *W. roseocontexta* because of absence or incompletion of their sequences. However, *W. biennis*, *W. micropora*, *W. neotropica*, *W. roseocontexta* and the new taxon share a similar morphology and can be readily distinguished from *Wrightoporia* s.str. and other russuloid polypores by their poroid basidiocarps, tough to brittle upon drying, and corky to tough, usually fragile tubes and a dimitic hyphal structure with clamped generative hyphae. Thus, these species are transferred to *Wrightoporiopsis*, and *W. neotropica* is designated as the generic type. The description of two new species and the proposal of three new combinations are below.

Wrightoporiopsis amylohypha Y.C. Dai, Jia J. Chen & B.K. Cui, *sp. nov.* — MycoBank MB812240; Fig. 2l, 8

Etymology. amylohypha (Lat.): referring to the amyloid contextual generative hyphae.

Holotype. China, Yunnan Province, Mengla County, Wangtianshu Park, on fallen angiosperm branch, 16 Sept. 2007, *H.S. Yuan*, *Yuan 3579* (BJFC 13829).

Basidiocarps perennial, pileate, sometimes effused-reflexed. Hyphal system dimitic; generative hyphae with clamp connections, weakly IKI+ in context, IKI– in trama; skeletal hyphae dextrinoid near the tube mouths, otherwise IKI–, CB+; thick-walled gloeoplerous hyphae present. Fusoid cystidioles present. Basidiospores subglobose to broadly ellipsoid, hyaline, thick-walled, finely asperulate, strong IKI+, CB+.

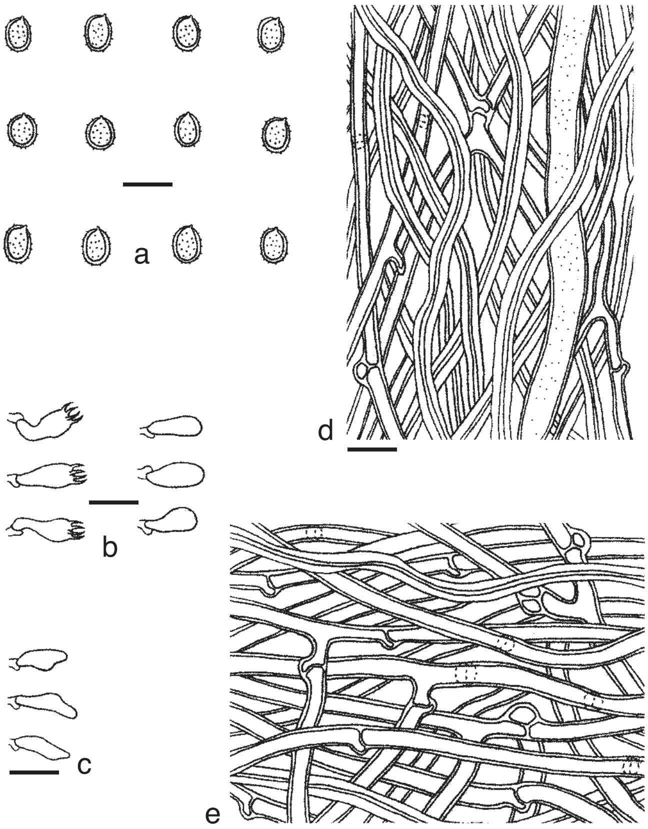

Fig. 8 Microscopic structures of *Wrightoporiopsis amylohypha*. a. Basidiospores; b. basidia and basidioles; c. cystidioles; d. hyphae from trama; e. hyphae from context (all: holotype). — Scale bars: a = 5 μm; b–e = 10 μm.

Basidiome perennial, pileate, soft corky when dry, without odour or taste. Pilei semicircular to fan-shaped, projecting up to 4 cm, 7 cm wide and 2.5 cm thick at base. Pileal surface orange-yellow to yellowish brown, crustose, azonate; margin pale orange, dull. Pore surface yellow to orange-yellow, slightly shining when dry; pores round to angular, (4–)5–6 per mm; dissepiments thin, entire to lacerate. Context yellow to cinnamon-buff, cottony, up to 1.5 cm thick. Tubes concolorous with pore surface, soft corky, up to 1 cm long. *Hyphal system* dimitic; generative hyphae with clamp connections, contextual hyphae weakly IKI+ in tissue, tramal hyphae IKI–; skeletal hyphae dextrinoid near the tube mouths, otherwise IKI–, CB+; contextual tissues becoming dark brown in KOH, tramal tissues becoming red brown in KOH. Generative hyphae in context dominant, hyaline, thick-walled with a wide lumen, frequently branched and encrusted with yellowish to pale orange, irregular crystals (these crystals may be responsible of the dark brown coloration in KOH), 3–6 μm diam; skeletal hyphae infrequent, hyaline, thick-walled with a narrow lumen, unbranched, flexuous, interwoven, 3–5 μm diam. Generative hyphae in trama frequent, thick-walled with a wide lumen, frequently branched and encrusted with yellowish to yellow, irregular crystals (these crystals may be responsible of the red brown coloration in KOH), 1.5–4 μm diam; skeletal hyphae dominant, yellow to pale orange, thick-walled with a narrow lumen, rarely branched, flexuous, interwoven, frequently encrusted with yellowish to pale orange, irregular crystals, 3–5 μm diam; gloeoplerous hyphae rare, thick-walled, with granular to oily contents, 5–8 μm diam, embedded in trama. *Cystidia* absent; *cystidioles* fusoid, hyaline, thin-walled, 7–13 × 3.5–4 μm. *Basidia* subclavate to barrel-shaped, bearing four sterigmata and a basal clamp connection, 10–12 × 4–5 μm; basidioles in shape similar to basidia, but slightly smaller. *Basidiospores* subglobose to broadly ellipsoid, hyaline, thick-walled, finely asperulate, strongly IKI+, CB+, (2.5–)2.7–3.6(–3.8) × 2–3 μm, L = 3.11 μm, W = 2.5 μm, Q = 1.21–1.29 (n = 90/3). Causing white rot.

Additional specimens (paratypes) examined. China, Hainan Province, Lingshui County, Diaoluoshan Forest Park, on fallen angiosperm trunk, 22 Nov. 2007, *B.K. Cui*, *Cui 5349* (BJFC 3390); Wuzhishan, Wuzhishan Mt, 23 July 2007, *S.H. He*, *He 1067* (BJFC 2784); Yunnan Province, Mengla County, Wangtianshu park, on fallen angiosperm branch, 16 Sept. 2007, *H.S. Yuan*, *Yuan 3603* (BJFC 13844); 2 Nov. 2009, *B.K. Cui*, *Cui 8561* (BJFC 7050); on angiosperm wood, 16 Sept. 2007, *H.S. Yuan*, *Yuan 3607* (IFP 13844) & *Yuan 3625* (IFP 13861); Xi-Shuang-Banna, Jinghong Virgin Forest Park, on fallen angiosperm branch, 16 Sept. 2012, *H.S. Yuan*, *Yuan 1591* (IFP 12845); on angiosperm wood, 11 Sept. 2007, *H.S. Yuan*, *Yuan 3460* (IFP 13736) & *Yuan 3467* (IFP 13743).

Notes — *Wrightoporiopsis amylohypha* is characterized by its perennial growth habit, pileate and soft corky basidiocarps, weakly amyloid contextual generative hyphae, infrequent contextual skeletal hyphae, scattered gloeoplerous hyphae, and presence of fusoid cystidioles.

Wrightoporiopsis fuscocinerea Y.C. Dai, Jia J. Chen & B.K. Cui, *sp. nov.* — MycoBank MB812266; Fig. 9

Etymology. fuscocinerea (Lat.): referring to the tube colour of the species.

= *Wrightoporia micropora* Aime & Ryvarden, Syn. Fungorum 23: 28. 2007, illegitimate.

Holotype. Guyana, Akaraima Mts, Upper Potaro River, 20 km east of Mt Ayanganna, near confluence of Potaro River and Alukyadongbaru Creek, Paluway plot 3 in *Dicymbe corymbosa*-dominated forest, on underside of angiosperm log, 18 May 2001, *Aime 1521* (holotype O).

Basidiocarps perennial, resupinate; new tubes grey, old tubes brown. Hyphal system dimitic; generative hyphae with clamp connections; skeletal hyphae dextrinoid, CB–; gloeocystidia, thick-walled cystidia and cystidioles abundant. Basidiospores subglobose, hyaline, thin-walled, finely asperulate, IKI+, CB–.

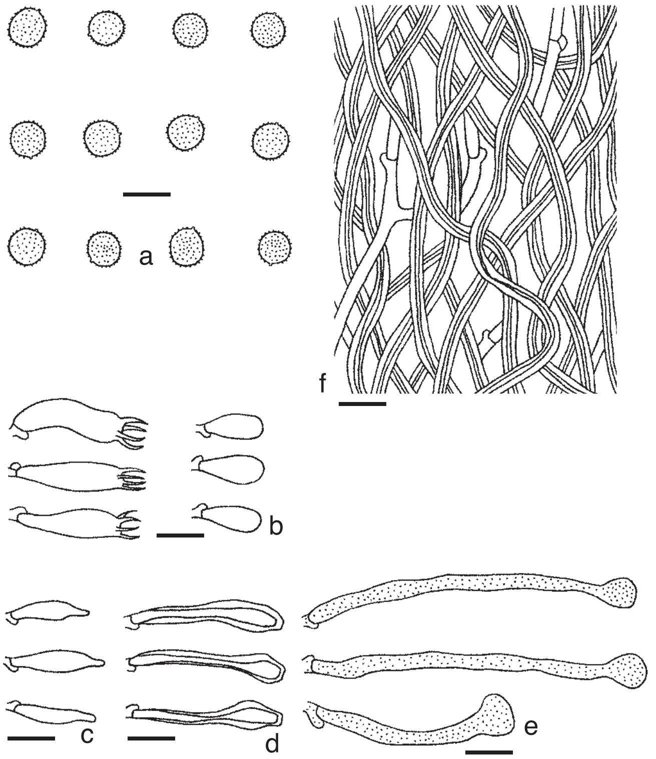

Fig. 9 Microscopic structures of *Wrightoporiopsis fuscocinerea*. a. Basidiospores; b. basidia and basidioles; c. cystidioles; d. cystidia; e. gloeocystidia; f. hyphae from trama (all: holotype). — Scale bars: a = 5 µm; b–d, f = 10 µm; e = 20 µm.

Basidiome perennial, resupinate, woody hard upon drying, without odour or taste, up to 18 cm long, 8 cm wide, 3 mm thick at centre. Pore surface grey or pale brown when dry; pores angular, 8–10(–11) per mm; dissepiments thin, entire. Sterile margin absent. Subiculum very thin to almost lacking. Tubes multi-stratified, new tubes grey, old tubes brown, tough, up to 3 mm long. *Hyphal system* dimitic; generative hyphae with clamp connections; skeletal hyphae dextrinoid, CB–; tissues becoming red brown in KOH. Abundant oily substance present in trama. Generative hyphae in trama infrequent, thin-walled, infrequently branched, 1.5–3 µm diam; skeletal hyphae dominant, yellowish to orange, thick-walled with a narrow lumen, unbranched, flexuous, interwoven, irregular crystals, 2.5–5 µm diam. *Gloeocystidia* abundant, clavate with capitate tips, thin-walled with granular to oily contents, 86–141 × 14–18 µm, embedded in hymenium; thick-walled *cystidia* present mostly in old tubes, generally ventricose, hyaline, 30–35 × 6–8 µm; *cystidioles* present, thin-walled, fusoid, tapering, 17–21 × 3–5 µm. *Basidia* clavate, bearing four sterigmata and a basal clamp connection, 20–25 × 5–7 µm; basidioles in shape similar to basidia, but slightly smaller. *Basidiospores* subglobose, hyaline, thin-walled, finely asperulate, IKI+, CB–, 3–4(–4.3) × 2.5–3.5(–3.8) µm, L = 3.65 µm, W = 3.01 µm, Q = 1.21 (n = 30/1). Causing white rot.

Notes — *Wrightoporia micropora* Aime & Ryvarden is nomenclaturally illegitimate because of *W. micropora* P.K. Buchanan & Ryvarden (Buchanan & Ryvarden 2000). We re-describe the species as *Wrightoporiopsis fuscocinerea.* It is characterized by a perennial growth habit, tough resupinate basidiocarps, tiny pores (8–10 per mm), distinct multi-stratified tubes, nearly invisible subiculum, and presence of gloeocystidia, thick-walled cystidia, and cystidioles. *Wrightoporiopsis biennis* also has tough basidiocarps, presence of cystidia and similar sized basidiospores (3.3–4 × 2.6–3.5 µm), but it shows a biennial growth habit, a presence of leptocystidia and an absence of gloeocystidia (Chen & Cui 2012).

Wrightoporiopsis biennis (Jia J. Chen & B.K. Cui) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812242

Basionym. *Wrightoporia biennis* Jia J. Chen & B.K. Cui, Mycotaxon 120: 334. 2012.

Descriptions in Chen & Yu (2012).

Specimens examined. China, Yunnan Province, Xi-Shuang-Banna, Mengla County, Wangtianshu Park, on fallen angiosperm trunk, 2 Nov. 2009, *B.K. Cui*, *Cui 8506* (holotype BJFC 6995); Mengla County, Lvshilin Park, on fallen angiosperm trunk, 1 Nov. 2009, *B.K. Cui*, *Cui 8457* (paratype BJFC 6946).

Wrightoporiopsis neotropica (Ryvarden) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812243

Basionym. *Wrightoporia neotropica* Ryvarden, Karstenia 40: 156. 2000.

Descriptions in Ryvarden (2000).

Specimen examined. Dominican Republic, La Vega Province, Casabito, El Arroyazo, 29 May 1997, *Ryvarden 40228* (O).

Wrightoporiopsis roseocontexta (Ryvarden & Iturr.) Y.C. Dai, Jia J. Chen & B.K. Cui, *comb. nov.* — MycoBank MB812244

Basionym. *Wrightoporia roseocontexta* Ryvarden & Iturr., Mycologia 95: 1076. 2003.

Descriptions in Ryvarden & Iturriaga (2003).

Specimen examined. Venezuela, Aragua State, Maracay, on angiosperm log, 24 Nov. 1994, *Ryvarden 35504* (holotype O).

OTHER SPECIMENS EXAMINED

Amylonotus africanus. Uganda, Kabale District, Bwindi Forest National Park, Ruhija, in mixed forest, 2 June 2003, *Ipulet 1883* (O). – Zambia, Chowo Forest, Nyika Plateau, 27 Jan. 1983, *J. Selander 736/7* (O).

Amylosporus bracei. Belize, Orange Walk District, 2002, *BZ-2709* (CFMR). – Brazil, Sao Paulo State, Fazenda Campinas, 29 Jan. 1987, *Ryvarden 24739* (O). – France, Martinque, 9 Oct. 1976, *LYAD 2236* (LY). – USA, Florida State, Monroe County, on angiosperm, 29 Aug. 2010, *1008/77* (PRM).

Amylosporus campbellii. Costa Rica, Guanacaste Province, Santa Rosa National Park, on dead angiosperm wood, 1 June 1997, *Lindblad 3281* (O); Tempisque, 8 June 2000, *Oses* (O). – Gango, 1984 (LY). – Jamaica, Ocho Rios, 27 July 1983, *0806/20a* (PRM). – USA, Arizona State, 27 July 1983, *Gilbertson 14806* (CFMR).

Amylosporus iobaphus. Japan, Okinawa Prefecture, Shiiva River, Iriomote Island, 19 June 1994, *Núñez 381* (O).

Amylosporus ryvardenii. Ghana, Ashanti Region, Pranum Forest Reserve, 27 April 1974, *Ryvarden 12994* (O).

Pseudowrightoporia sp. Jamaica, Saint Andrew Parish, 1999, *Nakasone* (FP-150311, CFMR).

Wrightoporia austrosinensis. China, Hainan Province, Changjiang County, Bawangling Nature Reserve, on rotten wood of *Pinus*, 8 Nov. 2009, *Y.C. Dai*, *Dai 11579* (holotype IFP 15804).

Wrightoporia avellanea. Brazil, Sao Paulo State, 16 Jan. 1987, *Ryvarden 24619* (O); Estado Amazonas, on dead angiosperm wood, 12 June 1997, *Ryvarden 40378* (O). – Congo, Dec. 1983, *LYAD 2486* (LY). – Ecuador, Sucumbios Province, 28 June 1993, *Núñez 264* (O). – Jamaica, Saint Andrew's Parish, 1999 (FP-150279, CFMR).

Wrightoporia borealis. China, Jilin Province, Antu County, Changbaishan Nature Reserve, on rotten wood of *Abies*, 28 Aug. 2005, *Y.C. Dai*, *Dai 7075* (holotype BJFC 550).

Wrightoporia cinnamomea. China, Yunnan Province, Lijiang, Yunshanping, on fallen trunk of *Abies*, 4 Sept. 2006, *H.S. Yuan*, *Yuan 2201* (IFP 7470). – Japan, Chiba Prefecture, Tokyo University Forest, Kiyosumi Forest Station, 24 Aug. 1983, *Ryvarden 21033* (O).

Wrightoporia cremea. Brazil, Estado Amazonas, 25 Nov. 1984, *Iturriaga 287* (O). – Ecuador, Sucumbios Province, 28 June 1993, *Núñez 280* (O).

Wrightoporia dimidiata. Singapore, Mac Ritchie Reservoir, at the base of a rotten stump, July 1974, *LYAD 1840* (holotype LY); Bukit Timah, 10 Mar. 1994, *Legon* (O).

Wrightoporia flava. Gabon, Ogooué-Ivindo Province, Makokou, Ipassa, Dec. 1974, *LYAD 1733* (LY). – Malawi, Southern province, Makwawa, 16 Dec. 1981, *BM 342* (O). – Tanzania, Tanga Province, Usambara Mts, Amani, Tanga district, 18 Feb. 1973, *Ryvarden 10594* (O).

Wrightoporia lenta. China, Fujian Province, on stump of *Cunninghamia*, 19 Oct. 2005, *Y.C. Dai*, *Dai 7209* (BJFC 2768) & *Dai 7234* (BJFC 2771); 23 Oct. 2005, *B.K. Cui*, *Cui 3290* (BJFC 2769) & *Cui 3292* (BJFC 2770); Heilongjiang Province, on stump of *Picea*, 5 Aug. 2012, *Y.C. Dai*, *Dai 12850* (BJFC 13139); Jilin Province, on stump of *Abies*, 11 Oct. 1993, *Y.C. Dai*, *Dai 1506* (BJFC 2766); 17 Oct. 1993, *Y.C. Dai*, *Dai 1675* (IFP 15549); on stump of *Pinus*, 27 Aug. 2005, *Y.C. Dai*, *Dai 7053* (BJFC 10081); Jiangxi Province, Fenyi County, on rotten wood of *Cunninghamia*, 18 Sept. 2008, *Y.C. Dai*, *Dai 10462* (BJFC 4711) & *Dai 10473* (BJFC 4722); on stump of *Cunninghamia*, 22 Sept. 2009, *B.K. Cui*, *Cui 7804* (BJFC 6293); 23 Sept. 2009, *B.K. Cui*, *Cui 7922* (BJFC 6411). – Japan, Fujiyama, on *Abies*, 26 Nov. 2007, *Y.C. Dai*, *Dai 9394* (IFP 15553). – USA, Warrensburg, on *Tsuga*, 1940, *Lowe 1767* (holotype H); Tennessee, Great Smoky National Park, on *Tsuga*, 13 July 2004, *Ryvarden 46577* (O).

Wrightoporia micropora. New Zealand, Westland, Lake Kaniere, on dead angiosperm wood, 26 May 1996, *Ryvarden 38712* (holotype PDD).

Wrightoporia nigrolimitata. China, Hunan Province, Yizhang County, Mangshan Forest Park, on angiosperm stump, 25 June 2007, *J. Li*, *Li 1697* (holotype BJFC 2780).

Wrightoporia novae-zelandiae. New Zealand, Auckland, Waitakere Ranges, Kitekite Track, on *Leptospermum*, 19 April 1989, *Buchanan 89/114* (paratype PDD 55206).

Wrightoporia ochrocrocea. China, Guangdong Province, Heyuan, Daguishan Forest Park, on fallen angiosperm branch, 18 Aug. 2011, *B.K. Cui*, *Cui 10129* (BJFC 11023). – New Guinea, Morobe District, Bulolo, 5 Dec. 1967, *Wright* (O). – Thailand, Issan District, Khao Yai National Park, near the fall, along the river, 11 Aug. 1997, *Núñez 1997* (O).

Wrightoporia porilacerata. Brazil, Parana State, Parangua, Guaraguacu, Fazenda Sambaqui, on decayed angiosperm trunk, 22 June 1993, *Meijer 2805* (O).

Wrightoporia subavellanea. China, Guangxi Autonomous Region, Nanning, Qingxiushan Park, on rotten wood of *Pinus*, 9 Nov. 2009, *Y.C. Dai*, *Dai 11484* (holotype BJFC 7352), *Dai 11488* (paratype BJFC 7356) & *Dai 11492* (paratype BJFC 7360); Hainan Province, Ledong County, Jianfengling Nature Reserve, 4 Sept. 2008, *Y.C. Dai*, *Dai 10302* (IFP 8450); Changjiang County, Bawangling Nature Reserve, on rotten trunk of *Pinus*, 10 May 2009, *Y.C. Dai*, *Dai 10826* (paratype BJFC 5068).

Wrightoporia trametoides. Malaysia, Johore, Sedili River, 22 May 1940, *Corner* (holotype E).

Wrightoporia unguliformis. China, Hainan Province, Ledong County, Jianfengling Nature Reserve, on fallen angiosperm trunk, 4 Jan. 1960, *Dai* (holotype HMAS 29718).

DISCUSSION

In this study, about 140 specimens of *Wrightoporia* s.l. worldwide were morphologically examined. We studied type materials and other authentic specimens of most species in the genus except *W. brunneo-ocharacea*, *W. isabellina*, *W. subrutilans* and *W. trimitica*. Along with all the available sequences of *Wrightoporia* s.l., 19 species of *Wrightoporia* s.l., including 12 from China, were sequenced here and referred in the present phylogeny.

Previous studies suggested that *Wrightoporia* s.l. was polyphyletic based on ITS and nLSU sequences, and species of *Wrightoporia* s.l. were mainly placed in the *Bondarzewiaceae* clade and the *Wrightoporiaceae* clade (Larsson & Larsson 2003, Chen & Cui 2014). Our phylogenetic results are consistent with previous observations, and further information on phylogeny and taxonomy of *Wrightoporia* s.l. are supplied (Fig. 1).

For species without sequence data, we studied their morphological characters of authentic specimens, and 17 *Wrightoporia* s.l. species are transferred to *Amylonotus*, *Amylosporus*, *Larssoniporia*, *Pseudowrightoporia* and *Wrightoporiopsis*. Without authentic specimens available for morphological verification, the species with ambiguous position (*W. brunneo-ocharacea*, *W. isabellina*, *W. subrutilans* and *W. trimitica*) are retained in *Wrightoporia*.

Initial analysis included ITS rDNA sequences of *Pseudowrightoporia gillesii* (KM107898) and *Wrightoporiopsis fuscocinerea* (KM107897), which in preliminary ITS dataset showed affinity to *Pseudowrightoporia* and *Wrightoporiopsis*, respectively. These taxa consistently generated long branches with species without nLSU sequences because of sequence deviations in regions. Due to failing to acquire their nLSU sequences, the problem cannot be easily addressed. We excluded the above-mentioned taxa from the present study. However, they should be given renewed consideration in future analyses with an expanded sampling of the russuloid clade.

We also examined the specimen of '*Wrightoporia lenta*' from Jamaica mentioned by Larsson & Larsson (2003). However, molecular and morphological data suggested that the Jamaica collection is not a representative of *W. lenta*. The ITS and nLSU rDNA sequences (AF506489) of '*W. lenta*' shows a high similarity with those of *P. cylindrospora*, and '*W. lenta*' was embedded in *Pseudowrightoporia* lineage. The ITS region of *P. cylindrospora* and '*W. lenta*' showed 31 different sites from a total of 548 aligned ones (5.7 %), which is enough to delimit the two species in a genetic perspective (Tedersoo et al. 2003, Izzo et al. 2005). '*Wrightoporia lenta*' can be readily distinguished from *P. cylindrospora* by its subglobose basidiospores. For the time being, we refer '*W. lenta*' as *Pseudowrightoporia* sp.

Amylonotus belongs to *Bondarzewiaceae*; *Pseudowrightoporia* and *Wrightoporiopsis* belong to *Hericiaceae*; and *Amylosporus* and *Wrightoporia* belong to *Wrightoporiaceae*. The above-mentioned genera have morphologically variable features as resupinate to effused-reflexed or pileate basidiocarps, an annual to perennial growth habit, a monomitic or dimitic hyphal structure with clamp connections and/or simple septa on generative hyphae, and presence or absence of gloeoplerous hyphae, and presence or absence of gloeocystidia and/or cystidia. So the morphology does not run together with the molecular phylogeny and morphological characters are overlapped in these families.

In summary, we performed an in-depth study of *Wrightoporia* s.l. On the basis of morphological and phylogenetic evidence, three new genera, *Larssoniporia*, *Pseudowrightoporia* and *Wrightoporiopsis*, six new species, *Larssoniporia incrustatocystidiata*, *Pseudowrightoporia crassihypha*, *P. oblongispora*, *P. hamata*, *Wrightoporiopsis amylohypha* and *W. fuscocinerea* are described, and 17 new combinations are proposed. A fully resolved phylogeny for *Wrightoporia* s.l. and its related genera requires evolutionary information from wider taxa samplings (fresh collections) and more conserved gene markers.

Key to Amylonotus, Amylosporus, Larssoniporia, Pseudowrightoporia, Wrightoporia s.str. and Wrightoporiopsis

1. Clamp connections absent in hymenium . . . *Amylosporus*
1. Clamp connections present in hymenium 2
2. Pore labyrinthine to daedaleoid . . . . *Amylonotus*
2. Pore elongated, round to angular 3
3. Basidiocarp tough to woody hard 4
3. Basidiocarp membranous, cottony to corky 5
4. Cystidia bearing crystals . . . . *Larssoniporia*
4. Cystidia smooth . . . . *Wrightoporiopsis*
5. Basidiocarp membranous to cottony, margin usually with rhizomorphs . . . . *Wrightoporia* s.str.
5. Basidiocarp corky, margin without rhizomorphs . . . . *Pseudowrightoporia*

Key to species of Amylonotus

1. Basidiocarps pileate . . . . *A. africanus*
1. Basidiocarps resupinate to effused-reflexed 2
2. Basidiocarps with rhizomorphs . . . . *A. ramosus*
2. Basidiocarps without rhizomorphs 3
3. Gloeoplerous hyphae present . . . . *A. labyrinthinus*
3. Gloeoplerous hyphae absent . . . . *A. gyroporus*

Key to species of Amylosporus

1. Basidiocarps pileate and stipitate 2
1. Basidiocarps resupinate to effused-reflexed 3
2. Skeletal hyphae non-dextrinoid . . . . *A. campbellii*
2. Skeletal hyphae dextrinoid. . . . . *A. succulentus*
3. Pores 2–4 per mm 4
3. Pores 4–8 per mm 6
4. Basidiocarps perennial . . . . *A. casuarinicola*
4. Basidiocarps annual 5
5. Basidiospores > 4 µm long . . . . *A. rubellus*
5. Basidiospores < 4 µm long . . . . *A. iobapha*
6. Generative hyphae bearing both simple septa and multiple clamp connections . . . . *A. bracei*
6. Generative hyphae bearing simple septa only 7
7. Basidiospores > 4 µm long . . . . *A. ryvardenii*
7. Basidiospores < 4 µm long . . . . *A. efibulatus*

Key to species of Larssoniporia

1. Basidiocarps annual; basidiospores > 4 µm long . . . . *L. incrustatocystidiata*
1. Basidiocarps perennial; basidiospores < 4 µm long . . . . *L. tropicalis*

Key to species of Pseudowrightoporia

1. Basidiospores oblong 2
1. Basidiospores ellipsoid, broadly ellipsoid or subglobose . 4
2. Skeletal hyphae non-dextrinoid . . . . *P. oblongispora*
2. Skeletal hyphae dextrinoid 3
3. Gloeocystidia present, hooked . . . . *P. hamata*
3. Gloeocystidia absent . . . . *P. cylindrospora*
4. Gloeocystidia present . . . . *P. solomonensis*
4. Gloeocystidia absent 5
5. Cystidia present 6
5. Cystidia absent 7
6. Basidiospores > 3.5 µm long . . . . *P. crassihypha*
6. Basidiospores < 3.5 µm long . . . . *P. straminea*
7. Generative hyphae bearing both clamp connections and simple septa . . . . *P. gillesii*
7. Generative hyphae bearing clamp connections only 8
8. Tramal skeletal hyphae < 2 µm diam . . . . *P. africana*
8. Tramal skeletal hyphae > 2 µm diam 9
9. Pores 4–6 per mm . . . . *P. aurantipora*
9. Pores 6–8 per mm . . . . *P. japonica*

Key to species of Wrightoporia s.str.

1. Basidiospores > 5.3 µm long . . . . *W. lenta*
1. Basidiospores < 5.3 µm long 2
2. Skeletal hyphae non-dextrinoid . . . . *W. austrosinensis*
2. Skeletal hyphae dextrinoid 3
3. Tramal skeletal hyphae < 1.5 µm diam . . *W. subavellanea*
3. Tramal skeletal hyphae > 1.5 µm diam 4
4. Basidiospores > 4 µm long . . . . *W. borealis*
4. Basidiospores < 4 µm long . . . . *W. avellanea*

Key to species of Wrightoporiopsis

1. Skeletal hyphae non-dextrinoid . . . . *W. roseocontexta*
1. Skeletal hyphae dextrinoid 2
2. Basidiocarps pileate . . . . *W. amylohypha*
2. Basidiocarps resupinate to effused-reflexed 3
3. Cystidia absent . . . . *W. neotropica*
3. Cystidia present 4
4. Gloeocystidia present . . . . *W. fuscocinerea*
4. Gloeocystidia absent . . . . *W. biennis*

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