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ARTICLE

Notes on all Genera of Omphalotaceae: Expanding the Taxonomic Spectrum in China and Revisiting Historical Type Specimens

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Abstract

Since the 1990s, *Gymnopus* sensu lato has undergone significant taxonomic revisions, which have led to elucidative taxonomic and systematic studies in Omphalotaceae. These revisions are characterized by the introduction of five novel genera and the reallocation of specific taxa to existing genera, all aimed at rectifying their polyphyletic status. However, the persistent polyphyletic nature of *Gymnopus* is underscored by the distinct lineage within the basal clade formed by the reference sequences of *G. contrarius*, which stands apart from the primary *Gymnopus* clade. The classification of this ambiguous clade remains a mystery. The species' original description was re–evaluated and refined based on the examination of the two related type specimens and further bolstered by continuous research on new samples from China. A century–old type specimen from the USA has enabled its sequence to be included in a comprehensive molecular phylogenetic analysis of Omphalotaceae. This investigation employed two markers, the internal transcribed spacer (ITS) and the nuclear large subunit (LSU), were used to explore phylogenetic relationships between genera. Through detailed morphological assessments against recognized genera, this clade was validated as a unique monotypic genus, leading to the proposal of *Peckorumyces* gen. nov. This new classification bridges existing morpho–phylogenetic gaps and addresses the longstanding polyphyletic issue of *Gymnopus*. To compare with this unusual "*Gymnopus*" species, 20 taxa within Omphalotaceae were studied, including 15 new species and five known species. Among these taxa, one genus and three species are new to China. In addition, nine new combinations were made based on phylogenetic analyses. This study is enriched with vivid colour photographs, line drawings of microscopic structures, detailed description of the new genus, and well–sampled phylogeny.

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INTRODUCTION

The family Omphalotaceae, typified by the genus *Omphalotus* Fayod (Kämmerer et al. 1985), is currently undergoing reassessment through the polyphasic method. Recent studies, which follow a more restricted morphological concept to reduce polyphyletic groups in phylogeny, have led to an increase in the number of newly identified genera within this family (Crous et al. 2004, Hughes et al. 2010, Sandoval–Leiva et al. 2016, Oliveira et al. 2019, Petersen & Hughes 2020). According to He et al. (2019), the family is diverse, encompassing fifteen genera: *Anthracophyllum* Ces., *Collybiopsis* Earle, *Connopus* R.H. Petersen, *Gymnopanella* Sand–Leiva, J.V. McDonald & Thorn, *Gymnopus* (Pers.) Gray, *Hymenoporus* Tkalčec, Mešić & Chun Y. Deng, *Lentinula* Earle, *Mycetinis* Earle, *Neonothopanus* R.H. Petersen & Krisai, *Omphalotus*, *Paragymnopus* J.S. Oliveira, *Paramycetinis* R.H. Petersen, *Pseudomarasmius* R.H. Petersen & K.W. Hughes, *Pusillomyces* J.S. Oliveira, and *Rhodocollybia* Singer. Currently, only 91 species have been reported across twelve genera in China, but most of these records lack morphological or molecular evidence. (Bi 1983, Chen 2022, Chow 1935, Deng et al. 2011, 2016, Hu et al. 2022a, 2022b, Institute of Microbiology, Chinese Academy of Sciences 2024, Li 2020, Li & Bau 2014, Li et al. 2015, 2021a, 2021b, 2022a, 2022b, Liu et al. 2024, Liu & Hu 1993, Lu et al. 2000, Mao 2000, Mao et al. 2022, Petersen & Hughes 2017, 2020, Sun et al. 2021, Tkalčec et al. 2015, Wang et al. 2015, 2024, Yan et al. 2015, Yang & Feng 2013, Yang et al. 2024, Zhang 2023, Zhang et al. 2017, 2023). Despite its significant economic value and cosmopolitan distribution, the family's diversity in China remains poorly understood. Contributing to the thorough study of Oliveira et al. (2019), the polyphyletic nature of *Gymnopus* has been more extensively clarified. However, the taxonomic placement of *G. contrarius* (Peck) Halling remains a significantly unresolved taxonomic issue that is still pending, a resolution of which can further enhance the monophyly of *Gymnopus*.

Gymnopus, a typical example of a polyphyletic group, has been central to the major revisions within the family in recent years (Moncalvo et al. 2002, Wilson & Desjardin 2005, Mata et al. 2007). Several clades were given a modified morphological concept successively. *Gymnopus acervatus* (Fr.) Murrill was defined as the component of *G.* sect. *Vestipedes* (Fr.) Antonín, Halling & Noordel. based on morphology (Antonín & Noordeloos 1997). However, a phylogenetic study showed *G. acervatus* segregated from the major clade of *G.* sect. *Vestipedes* form a supportless long branch (Mata et al. 2007). To reconcile the conflict between morphology and phylogeny, a new genus, *Connopus*, was proposed (Hughes et al. 2010). Petersen & Hughes (2017) once argued that a clade annotated as '*Marasmius pallidocephalus*' probably represented a new genus, subsequently supported by Oliveira et al. (2019). Besides, Oliveira et al. (2019) proposed two new genera, *Paragymnopus*, to integrate the *G.* sect. *Perforantia* (Singer) R.H. Petersen and *Pusillomyces* to integrate two *Gymnopus* taxa and a new manuripioid species, resulting in *Gymnopus* and *Marasmiellus* Murrill forming more restricted monophyletic groups. After that, *Pseudomarasmius* R.H. Petersen & K.W. Hughes was proposed to accommodate *Marasmius pallidocephalus* Gilliam and another two *Gymnopus* taxa (Petersen & Hughes 2020), and *Paramycetinis* was proposed by including two non–official described *Gymnopus* species that were not formerly argued as an independent generic–level taxon (Petersen & Hughes 2017, Oliveira et al. 2019, Petersen & Hughes 2020). *Collybiopsis* was resurrected to replace *Marasmiellus* based on the International Code of Nomenclature for algae, fungi, and plants (Petersen & Hughes 2021). Likewise, *G. contrarius* is one such unsolved monotypic clade and awaits a redefinition within the Omphalotaceae (Matheny et al. 2006, Petersen & Hughes 2017, Oliveira et al. 2019).

Gymnopus contrarius, a species associated with musci, *Picea*, and *Abies balsamea* in ecology, was originally described from New York State, the USA, as *M. contrarius* Peck (Peck 1911). Peck (1873) described another USA–sourced species, *M. umbonatus* Peck, morphologically

very close to *M. contrarius*. Singer (1943) combined *M. umbonatus* into the *Collybia* (Fr.) Staude by giving a new name, *C. umbonatella* Singer, because there was already a species named *C. umbonata* Peck. Gilliam (1976) excluded *M. contrarius* and treated it as a synonymy of *C. umbonatella*. Later, Halling (1983) provided a description in concord with Desjardin (1989) in all respects and both of them suggested that *M. contrarius* is conspecific to *M. umbonatus*. The epithet "*contrarius*" is the next earliest name instead of *C. umbonatella* for the same taxon legitimately according to the nomenclatural rules. Thus, *M. contrarius* was combined as *C. contraria* (Peck) Halling into *C.* subgenus *Collybia* sect. *Subfumosae* Singer ex Halling, characterized by the radially or interwoven arranged pileipellis, with repent or erected, cylindrical, diverticulate, and sometimes encrusted hyphae (Halling 1983). After that, this species was transferred to *G.* sect. *Vestipedes* as *G. contrarius* (Antonín et al. 1997, Antonín & Noordeloos 2010).

This study is devoted to improving the knowledge of Omphalotaceae and evaluating the taxonomic position of *G. contrarius* and its related lineages based on morphology and phylogeny. The open questions are whether the monophyletic clade represents a distinct new genus and whether the newly obtained samples are new or previously known species. Phylograms, morphological descriptions, colour photos of basidiomata, and line drawings of microscopic structures are provided, and discussions on close species and taxonomic placement are also given.

MATERIALS AND METHODS

Abbreviations

For Latin names: *Anthracophyllum = A.*, *Collybia = C.*, *Collybiopsis = Co.*, *Connopus = Con.*, *Crinipellis = Cr.*, *Gymnopanella = Gy.*, *Gymnopus = G.*, *Lentinula = L.*, *Marasmiellus = Ma.*, *Marasmius = M.*, *Micromphale = Mi.*, *Mycetinis = My.*, *Neonothopanus = Ne.*, *Omphalotus = O.*, *Paragymnopus = Pg.*, *Paramycetinis = Pm.*, *Peckorumyces = Pe.*, *Pseudomarasmius = Ps.*, *Pusillomyces = Pu.*, *Rhodocollybia = R. Setulipes = S.* For phylogeny: Bayesian Inference = BI, Bootstrap values = BS, maximum likelihood = ML, Posterior Probability = PP.

Specimens

Seventy–three collections were included in this study, including two of Peck's historical type specimens loaned from the New York State Museum, Albany, USA (NYS), with permission to undergo micromorphological analysis and DNA extraction sampling procedure. Specimens from China were deposited in the Fungarium of the Guangdong Institute of Microbiology, Guangdong Academy of Sciences, Guangzhou, China (GDGM), the Fungarium of Mycology, Jilin Agricultural University, Changchun, China (HMJAU) and Herbarium of Guizhou Academy of Sciences, Guiyang, China (HGAS–MF).

Morphology

Macromorphological studies of specimens from China were done based on field notes and photographs of fresh as well as dried basidiomata. Colour descriptions were alphanumerically referenced following Kornerup & Wanscher (1978). The number of full–length lamellae is represented by 'L' and 'l' refers to the number of lamellulae tiers. Tissue sections were made for the micromorphology study, mounted in 5% KOH solution. Congo Red solution was used to highlight the hyaline structures outline. Melzer's reagent to test amyloid or dextrinoid reactions. Microscopic observation was done using ZEISS Axioscope 5 and visualized by camera, quantitative characters of microstructures were measured by ZEN 3.1 (blue edition, Carl Zeiss Microscopy GmbH). Measurement values obtained with three decimal places through software are rounded to one decimal place in Excel for statistical analysis. The 'n' in square brackets refers to the number of measured structures. The quantitative character of a basidiospore (length × width) was displayed as (a)b–c(d), indicating the minimum of 90% of the measured values by "b–c", "a" and/or "d" represent the minimum and maximum of all measured values. The ratio of spore length to width is denoted as

E, while Q represents the average E value. The main body of each structure was measured (length × width), but the appendages (i.e., the apiculus of basidiospores, sterigmata of basidia, etc.) were not quantified.

DNA extractions, PCR amplification, and sequencing

Recent samples underwent Sanger sequencing, whereas the historical type specimen was subjected to genome skimming using the Illumina Novaseq 6000 platform, a method suggested by Dr. Yi Li (Yangzhou University, Jiangsu, China) (Li et al. 2021c). The DNA of samples from China was extracted using a NuClean Plant Genomic DNA Kit (Cowin Biotech Co., Ltd., Taizhou, China) following the operation manual. The primer pairs used for PCR amplification followed Li et al. (2021a, 2022b). To all DNA regions, the PCR cycle programme was: 4 min at 95 °C; 35 cycles of 45 s at 95 °C, 50 s at 55 °C, 50 s at 72 °C; 10 min at 72 °C. Amplified products were sent to Sangon Biotech (Changchun, Jilin, China) for Sanger sequencing; some samples underwent TA cloning if poly peaks were present. The genomic DNA of the type material (NYSf 859) was extracted at Biozeron's lab using an E.Z.N.A.® Fungal DNA Kit (D3390, Omega BIO–TEK, USA), and subsequently underwent quality control. A nucleotide database was set up based on the genome skimming of NYSf 859 using the BLAST+ program version 2.13.0 (Altschul et al. 1990). The local BLAST was conducted to retrieve the fragments of ITS, LSU, and TEF1-α sequences from the nucleotide database (Altschul et al. 1990), and then manually assembly if necessary. The ITS sequence was improved based on the original Illumina raw reads. The LSU sequence contains too many missing data. Thus, it was excluded from the DNA matrix. All the sequences from this study have been deposited in GenBank.

Phylogeny

Based on the phylogenetic results of Matheny et al. (2006), followed by those in Sandoval–Leiva et al. (2016) and Oliveira et al. (2019), showing *G. contrarius* along with other genera belonging to the Omphalotaceae, a combined ITS and LSU datasets were analysed in this study. A total of 387 ITS sequences and 269 LSU sequences were included in the dataset. Following Oliveira et al. (2019), Marasmiaceae taxa were selected as outgroups, including *Chaetocalathus liliputianus*, *Crinipellis* sp., *Cr. zonata*, *Marasmius oreades*, and *Moniliophthora* sp. The dataset was supplemented by additional sequences detailed in Table 1. The ITS and LSU sequences were aligned separately using MAFFT version 7 (https://mafft.cbrc.jp/alignment/software/) with default parameters but with the guide tree set to UPGMA. After manually trimming the ends of each alignment using BioEdit v7.0.9 (Hall 2011), the two aligned matrices were concatenated using the PhyloSuite v1.2.3 platform (Zhang et al. 2020). All the terminal gaps were treated as missing data. The preliminary combined ITS–LSU dataset had 2741 sites, revealing 1785 distinct patterns. Within the alignment, there were 1149 parsimony-informative sites, 232 singleton sites, and 1360 constant sites. The preliminary matrix generated a guide tree with IQ–TREE v1.6.12 using the GTR+G model and 5000 ultrafast bootstrap replicates (Nguyen et al. 2015). The unaligned ITS dataset and the newly generated guide tree were processed using PRANK v.170427 (Löytynoja 2014), with the–t and –F option enabled, to produce the final alignment. The final alignment of the LSU dataset was obtained using the same method with the additional option-prunetree. The alignment gaps were kept to augment the phylogenetic signal in fungal ITS sequences (Nagy et al. 2012). The final alignments of the ITS and LSU datasets were concatenated using the PhyloSuite v1.2.3 platform for the following analyses (Zhang et al. 2020). The final combined ITS–LSU dataset had 5345 sites, revealing 2594 distinct patterns. Within the alignment, there were 1094 parsimony-informative sites, 388 singleton sites, and 3863 constant sites. The alignment was partitioned into four charsets: 1–1765 sites for the ITS1 region, 1766–1928 sites for the 5.8S region, 1929–4399 for the ITS2 region, and 4400–5345 sites for the LSU region. The best–fit model of each partition for Bayesian Inference (BI) analyses, and Maximum Likelihood (ML) analyses was tested using Modelfinder with option edge–unlinked enabled, according to the AICc criterion (Kalyaanamoorthy 2017). The best–fit model for ML analyses of each partition was as follows:

TIM2 + F + R5 for the ITS1 region, JC for the 5.8S region, GTR + F + R5 for the ITS2 region, and TVMe + R3 for the LSU region. The best–fit model for BI analyses of each partition was as follows: GTR + F + I + G4 for the ITS1 region, JC for the 5.8S region, GTR + F + I + G4 for the ITS2 region, and SYM + I + G4 for the LSU region. The ML analyses were performed by IQ–TREE v1.6.12 in partition mode, with settings of 5000 for the –bb option and 0.9 for the –bcor option (Nguyen et al. 2015, Chernomor et al. 2016). The BI analyses were performed by the MPI version of MrBayes v3.2.7a in partition mode to run 4000000 generations for Markov chain Monte Carlo (MCMC) simulations (Ronquist et al. 2012). The analyses were run in parallel with two independent runs and four chains each. Branch lengths were saved, and a burn-in fraction of 0.25 was used. Summarized statistics were computed using the "halfcompat" option. The FigTree v1.4.2 and iTOL were used for the tree visualization, and then edited in Adobe Illustrator (Letunic & Bork 2024). The tree file and combined ITS and LSU matrix were submitted to TreeBASE under accession number 31111.

Table 1 Names, collection numbers, and corresponding ITS and LSU GenBank numbers of the taxa used in this study. Newly generated sequences are in bold, and type specimens were followed by an asterisk.

Species Name	**Collection No.**	**ITS**	**LSU**
Anthracophyllum archeri	AFTOL–ID 973	DQ404387	AY745709
A. archeri	TENN–F–050049	DQ444308	N/A
A. lateritium	TENN–F–062043	FJ596891	N/A
A. lateritium	TENN–F–062043	FJ596892	N/A
A. sinense	HFJAU 12000*	ON711250	ON711248
A. sinense	HMJAU 60457	PP664141	PP664142
Agaricomycetes sp.	Fu–BL181	LC505143	N/A
Basidiomycota sp.	TR115	HQ608126	N/A
Chaetocalathus liliputianus	MCA 485	AY916682	AY916680
Collybiopsis aff. *dichroa*	TENN–F–056721	KY026654	KY026654
Co. aff. *dichroa*	TENN–F–067859	KY026696	KY026696
Co. aff. *melanopus*	TENN–F–068085	KY026699	KY026699
Co. albicantipes	SFC20170725–35*	OL467272	OL462811
Co. albicantipes	SFC20180704–86	OL467273	OL462812
***Co. alpina* sp. nov.**	**HMJAU 60411**	**PP151537**	**N/A**
***Co. alpina* sp. nov.**	**HMJAU 60410***	**PP151538**	**PP151568**
Co. baiyunensis	GDGM 93885*	OR598795	OR598808
Co. bambusicola	BJFC 032412*	MW969675	ON697204
Co. biformis	TENN–F–068109	KJ416245	KJ189567
Co. biformis	KA16–0526	OL467228	OL462785
Co. billbowesii comb. nov.	SFSU: DED 8250*	MF100989	N/A
Co. brunneigracilis	SFSU: AWW01	AY263434	AY639412
Co. californica	TENN–F–052617	MN413338	N/A
Co. carneopallida	BRNM: 747442	OM522632	N/A
Co. cimrmanii	BRNM: 828680	MW924061	OM333231
Co. cimrmanii	BRNM: 828679*	MW924062	OM333232
Co. clavicystidiata	SFC20180705–84*	OL467252	OL462817
Co. confluens	TENN–F–067819	KP710280	KJ189582
Co. confluens	TENN–F–065131	KP710288	KJ189571
Co. confluens	SFC20190731–06	OL467237	OL462797
Co. cylindrica comb. nov.	TENN–F–058097*	AF505776	N/A
Co. diaphana comb. nov.	XAL: César 202*	MT232390	N/A
Co. diaphana comb. nov.	XAL: César 44	MT232391	N/A
Co. dichroa	TENN–F–056727	KY026655	KY026655
Co. dichroa	TENN–F–060029	KY026665	KY026665

Table 1 Continued.

Species Name	Collection No.	ITS	LSU
Co. dichroa	TENN–F–051775	MW396868	MW396868
Co. disjuncta	TENN–F–069172*	KJ416252	PP430330
Co. eneficola	TENN–F–069123*	KJ128264	KJ189586
Co. fibrosipes	TENN–F–056660	AF505763	N/A
Co. filamentipes	TENN–F–065861*	MN897832	MN897832
Co. foliiphila	CUM AM101	KP317638	KP317636
Co. foliiphila	CUH: AM090	NR_154176	NG_060320
Co. fulva	KA13–0216	OL467258	OL462794
Co. fulva	KA 15–0210*	OL467259	OL462795
Co. furtiva	SFSU: DED 4425*	DQ450031	AF042650
Co. gibbosa	SFSU: AWW112	AY263435	AY639417
Co. hasanskyensis	TENN–F–060731	MN897830	N/A
Co. hirtelloides comb. nov.	SFSU: DED 8318*	MF100975	N/A
Co. indocta	SFSU: AWW04	AY263439	N/A
Co. indocta	SFSU: AWW17	AY263440	N/A
Co. istanbulensis	KATO Fungi 3596*	KX184795	KX184796
Co. juniperina	TENN–F–059540	AY256708	AY256708
Co. juniperina	TENN–F–058988	KY026661	KY026661
Co. koreana	SFC20120821–84	KJ609161	OL546545
Co. koreana	SFC20130711–05	OL467270	OL462801
Co. luxurians	TENN–F–057910	AY256709	AY256709
Co. melanopus	SFSU: AWW54*	AY263425	AY639422
Co. mesoamericana	TENN–F–058613*	DQ450035	KY019632
Co. micromphaloides	TENN–F–068165*	KJ416243	KY019645
Co. minor	TENN–F–059993*	MN413334	MW396880
Co. mustachia comb. nov.	SFSU: BAP 670*	MF100987	N/A
Co. neotropica	TENN–F–058110	AF505769	N/A
Co. nonnulla	SFSU: AWW05	AY263445	AY639426
Co. nonnulla	TENN–F–068133	KY026701	KY026701
Co. nonnulla	RAK 372.2	MN930622	N/A
Co. nonnulla	KA13–0254	OL467242	OL462820
Co. obscuroides	GB–0150514	KX958399	KX958399
Co. ocella comb. nov.	SFSU: DED 8280*	MF100976	N/A
Co. omphalodes	TENN–F–058629	AF505761	N/A
Co. omphalodes	TENN–F–056734	AY256700	N/A
Co. omphalodes	TENN–F–058121	DQ450011	N/A
Co. orientisubnuda	NIBRFG0000500990*	OL467262	OL546546
Co. orientisubnuda	SFC20170823–39	OL467263	OL546547
Co. pakistanica	LAH 37522*	OP199106	OP209954
Co. parvula	TENN–F–058113*	DQ450060	N/A
Co. peronata	TENN–F–065120	KY026677	KY026677
Co. pleurocystidiata	SFSU: BAP 651*	MF100977	N/A
Co. polygramma	URM 90015	KY074640	KY088275
Co. polygramma	URM 90017	KY074642	N/A
Co. polygramma	MHHNU 30912	MK214392	N/A
Co. polygramma	SFC20170807–35	OL467245	OL546542
Co. pseudolodgeae comb. nov.	TENN–F–058601*	AF505747	N/A
Co. pseudoluxurians	TENN–F–068144*	KY026702	KY026702
Co. pseudomphalodes	NYBG REH 7348	AF505762	N/A
Co. quercophila	TENN–F–069267	KY026728	KY026728
Co. ramealis	TENN–F–065145*	MN413345	MN413345

Table 1 Continued.

Species Name	Collection No.	ITS	LSU
Co. ramealis	SFC20180829–20	OL467261	OL546548
Co. ramulicola	GDGM 43884*	KU057798	N/A
Co. readiae	TENN–F–053687	DQ450034	N/A
Co. readiae	PDD: 95844	HQ533036	N/A
Co. readiae	TENN–F–061061	KJ416244	N/A
Co. rodhallii	SFSU: BAP 630	MF100981	N/A
Co. rodhallii	SFSU: BAP 627*	MF100982	N/A
***Co. schizophylloides* sp. nov.**	**HMJAU 60446***	**PP133256**	**PP133257**
Co. sp.	TENN–F–054944	MW396870	MW396870
Co. sp.	TENN–F–051101	MW396874	MW396874
Co. stenophylla	TENN–F–065943	MN413331	MW396886
Co. subcyathiformis	URM 90022	KY404982	KY404982
Co. subnuda	TENN–F–065985	MW396876	MW396876
Co. subpruinosus	BRNM: 781138	MK646034	N/A
Co. subumbilicata	SFC20140701–03*	OL467232	OL462787
Co. termiticola	SFSU: AWW106	AY263451	AY639430
Co. trogioides comb. nov.	SFSU: AWW51*	AY263428	AY639431
Co. undulata	SFC20120821–04*	OL467239	OL462813
Co. vaillantii	TENN–F–065115	KY026676	KY026676
Co. vellerea	SFC20140821–29*	OL467267	OL462810
Co. villosipes	TENN–F–060951	KJ416255	FJ750264
Connopus acervatus	TENN–F–061292	GU318383	FJ750254
Con. acervatus	TENN–F–062879	GU318387	FJ750255
Con. acervatus	TENN–F–062824	GU318393	FJ750260
Con. acervatus	TENN–F–062825	GU318395	FJ750259
Crinipellis sp.	MCA 1527	AY916701	AY916699
Crinipellis zonata	VPI 3355	AY916692	AY916690
Gymnopus adventitius nom. prov.	SFSU: DED8813	KY026760	KY026760
G. aff. dryophilus	TENN–F–065157	KY026679	KY026679
G. aff. dryophilus	TENN–F–065157	KY026680	KY026680
G. aff. *moseri*	SFSU: AWW10	AY263431	AY639409
G. alliifoetidissimus	GDGM 76695*	MT023348	MT017526
G. androsaceus	TENN–F–055679	KY026648	KY026648
G. androsaceus	TENN–F–059594	KY026663	KY026663
G. androsaceus	TFB 4975	KY026745	KY026745
G. androsaceus	TFB 5021	KY026747	KY026747
G. androsaceus	TFB 5609	KY026750	KY026750
G. androsaceus	TENN–F–069268 h2	KY696772	KY696772
G. aurantiipes	SFSU: AWW118	AY263432	AY639410
***G. aurantiofuscus* sp. nov.**	**HGASMF01–7019**	**PP151498**	**PP151550**
***G. aurantiofuscus* sp. nov.**	**HGASMF01–7024***	**PP151504**	**PP151551**
***G. aurantiofuscus* sp. nov.**	**HGASMF01–7957**	**PP151505**	**PP151552**
***G. aurantiofuscus* sp. nov.**	**HGASMF01–8120**	**PP151511**	**PP151557**
***G. aurantiofuscus* sp. nov.**	**HGASMF01–7006**	**PP151512**	**PP151558**
***G. aurantiofuscus* sp. nov.**	**HGASMF01–7961**	**PP151514**	**N/A**
***G. aurantiofuscus* sp. nov.**	**HGASMF01–7009**	**PP151518**	**PP151562**
G. barbipes	TENN–F–067858*	KJ416269	KY019642
G. bicolor	SFSU: AWW116*	AY263423	AY639411
G. bisporus	BCN:SCM B–4065*	JN247551	JN247555
G. brassicolens	TENN: F–059294	DQ449991	N/A
G. brunneiniger	XAL: Cesar50	MT232388	MW187069

Table 1 Continued.

Species Name	Collection No.	ITS	LSU
G. brunneiniger	XAL: Cesar49*	MT232389	MW187070
***G. brunneostipitatus* sp. nov.**	**HMJAU 60412***	**PP151535**	**PP639544**
***G. brunneostipitatus* sp. nov.**	**HMJAU 60448**	**PP657584(–8)**	**PP639545**
G. bunerensis	LAH 35878*	MK122772	MK122770
G. catalonicus	BCN:SCM B–4057*	JN247552	JN247556
G. cervinus	SFSU: DED 8298	MF100984	N/A
G. cervinus	SFSU: BAP 623	MF100985	N/A
***G. chowii* sp. nov.**	**HMJAU 60415***	**PP151495**	**PP151548**
***G. chowii* sp. nov.**	**HMJAU 60416**	**PP151496**	**N/A**
***G. conifericola* sp. nov.**	**HMJAU 60413**	**PP151542**	**PP151571**
***G. conifericola* sp. nov.**	**HMJAU 60414***	**PP151543**	**N/A**
G. cremeostipitatus	BRNM: 747547*	KF251071	KF251091
G. densilamellatus	BRNM: 714927	KP336685	KP336694
G. dryophilus	TENN–F–057012	DQ241781	AY640619
G. dryophilus	BRNM: 732938	JX536149	N/A
G. dysodes	TENN–F–061125	KY026666	FJ750265
G. earleae	TENN–F–059457	AY256694	N/A
G. efibulatus	HGASMF01–7052*	OM970865	OM970865
G. efibulatus	HGASMF01–7052*	OM970866	OM970866
G. efibulatus	HGASMF01–11995	OM970873	OM970877
G. foetidus	TENN–F–065806	KY026682	KY026682
G. foetidus	TENN–F–069280	KY026730	KY026730
***G. fuscus* sp. nov.**	**GDGM28929***	**PP151515**	**N/A**
G. fusipes	TENN–F–059217	AY256710	AY256710
G. fusipes	TENN–F–069254	KY026727	KY026727
G. hirtellus	SFSU: DED 8299	MF100974	N/A
G. impudicus	BRNM: 714849	LT594119	LT594119
G. impudicus	JVG 1130531–2	LT594120	LT594120
G. indoctoides	SFSU: AWW125*	AY263424	AY639419
G. inflatotrama nom. prov.	TENN–F–048143	KY026619	KY026619
G. inflatotrama nom. prov.	TENN–F–051233	KY026632	KY026632
G. inflatotrama nom. prov.	TENN–F–053490	KY026640	KY026640
G. inflatotrama nom. prov.	TFB 4529	KY026744	KY026744
G. inusitatus	BCN:SCM B–4058*	JN247553	JN247557
G. inusitatus var. *cystidiatus*	BRNM: 737257*	JN247550	MK278109
G. iocephalus	TENN–F–052970	DQ449984	KY019630
G. iodes	HGASMF01–10068*	OM970869	OM970869
G. lodgeae	TENN–F–058638	AY256705	N/A
G. montagnei	JMCR 143	DQ449988	AF261327
G. neobrevipes	TENN–F–069182	KY026722	KY026722
G. neobrevipes	TFB 14594	KY026751	KY026751
G. neobrevipes	TFB 14599	KY026752	KY026752
G. neobrevipes	TENN–F–069197*	MH673477	MH673477
***G. niveus* sp. nov.**	**GDGM70487***	**PP151516**	**PP151560**
***G. niveus* sp. nov.**	**GDGM70488**	**PP151517**	**PP151561**
***G. niveus* sp. nov.**	**GDGM76400**	**PP151506**	**N/A**
G. novomundi nom. prov.	SFSU: DED5097	KY026759	KY026759
G. ocior	TENN–F–065135	KY026678	KY026678
G. omphalinoides	GDGM 78318*	MW134044	MW134730
G. otagensis	PDD:106823	MT974597	MT974601
G. otagensis	PDD:113265	MT974600	MT974602

Table 1 Continued.

Species Name	Collection No.	ITS	LSU
G. pallipes	GDGM 81513*	MW582856	OK087327
G. portoricensis	TENN–F–050999	KY026627	KY026627
G. portoricensis	TENN–F–051029*	KY026628	KY026628
G. portoricensis	TENN–F–051029*	KY026629	KY026629
G. pygmaeus	URM 90003*	KX869966	KY088273
G. schizophyllus	GDGM 77165*	MW134043	MW134729
G. semihirtipes	TENN–F–007595	OK376741	N/A
G. sepiiconicus	SFSU: AWW126	AY263449	AY639427
G. similis	BRNM: 766739*	KP336692	KP336699
G. sp.	WRW 05–1170	KY026764	KY026764
G. sp.	URM 90051	KY321568	KY321568
G. sp.	URM 90053	KY321570	KY321570
G. sp.	URM 90043	KY321573	N/A
G. sp.	URM 90042	KY321574	KY321574
G. sp.	URM 90045	KY321575	KY321575
G. sp.	URM 90054	KY404984	N/A
G. sp.	Fu–BL41	LC505135	N/A
G. sp.	FH: BHI–F523	MF161290	N/A
G. sp.	TENN–F–058602	KY026660	FJ750263
G. sp. 2	RAK370	MN930623	N/A
G. sp. 2	RAK 373.2	MN930624	N/A
G. spongiosus	TENN–F–065912	KY026686	KY026686
G. spongiosus	TENN–F–068184	KY026706	KY026706
G. stipitovirens sp. nov.	BRNM: 718669	MH589976	N/A
***G. stipitovirens* sp. nov.**	**HMJAU 60421**	**PP151527**	**N/A**
***G. stipitovirens* sp. nov.**	**HMJAU 60420***	**PP151528**	**N/A**
***G. stipitovirens* sp. nov.**	**HMJAU 60422**	**PP151529**	**N/A**
***G. stipitovirens* sp. nov.**	**HMJAU 60423**	**PP151524**	**N/A**
***G. stipitovirens* sp. nov.**	**HMJAU 60424**	**PP151526**	**PP151565**
***G. stipitovirens* sp. nov.**	**HMJAU 60425**	**PP151530**	**N/A**
***G. stipitovirens* sp. nov.**	**HMJAU 60426**	**PP151531**	**N/A**
***G. tianbaoyanensis* sp. nov.**	**HMJAU 60418**	**PP151520**	**N/A**
***G. tianbaoyanensis* sp. nov.**	**HMJAU 60419**	**PP151521**	**PP151563**
***G. tianbaoyanensis* sp. nov.**	**HMJAU 60417***	**PP151500**	**N/A**
G. ugandensis	SFSU: BAP 614	MF100986	N/A
G. utriformis nom. prov.	TENN–F–068185	KY026707	KY026707
G. utriformis nom. prov.	TENN–F–068185	KY026708	KY026708
G. variicolor	BRNM: 714959	LT594121	KP348011
***G. viridocephalus* sp. nov.**	**HGASMF01–7008**	**PP151497**	**PP151549**
***G. viridocephalus* sp. nov.**	**HGASMF01–7003***	**PP151513**	**PP151559**
G. vitellinipes	SFSU: AWW127*	AY263429	AY639432
Gymnopanella nothofagi	SGO: 163624	KT906424	KT906424
Gy. nothofagi	SGO:163625*	KT906425	KT906425
Lentinula aciculospora	PPN–ag–001	JQ247977	N/A
L. aciculospora	TENN–F–056421*	MW508917	N/A
L. aff. detonsa	IE17_R38	MW508923	AF261560
L. aff. raphanica	INPA 272282	MW508929	N/A
L. boryana	TENN–F–057787	KY026657	KY026657
L. detonsa	TENN–F–058616	MW508933	MK278256
L. edodes	CBS 226.51	MH856832	MH868347
L. guzmanii	TENN–F–055247*	MW508945	N/A

Table 1 Continued.

Species Name	Collection No.	ITS	LSU
L. ixodes	INPA 289637	OL329825	N/A
L. ixodes	RVI29	ON117629	N/A
L. lateritia	DSH92–143	U33070	AF287872
L. madagasikarensis	PC0142531*	MW810301	N/A
L. madagasikarensis	PC0142532	MW810302	MW810300
L. novaezelandiae	TMI–1172	U33081	AF261561
L. raphanica	TENN–F–056291	KY026653	KY026653
Marasmiellus sp.	TENN–F–069322	KY026738	KY026738
Marasmius oreades	PBM 2701	DQ490641	DQ156126
M. sp. 1	TENN–F–050116	KY026621	KY026621
Moniliophthora sp.	MCA 2500	AY916754	AY916752
Mycetinis alliaceus	TENN–F–055630	KY696752	KY696752
My. alliaceus	TENN–F–069243	KY696770	KY696770
My. applanatipes	SFSU: DED6628	KY696775	KY696775
***My. arbuscularis* sp. nov.**	**HMJAU 60428**	**PP151532**	**N/A**
***My. arbuscularis* sp. nov.**	**HMJAU 60427***	**PP151533**	**PP151566**
***My. arbuscularis* sp. nov.**	**HMJAU 60429**	**PP151536**	**N/A**
My. copelandii	TENN–F–055408	KY696751	KY696751
My. copelandii	TENN–F–055408	KY696750	KY696750
My. curraniae	JAC10833	KY696778	N/A
My. curraniae	JAC11095	KY696780	N/A
My. kallioneus	GB–0150513	KX958397	KX958397
My. opacus	TENN–F–060016	KY696758	KY696758
My. opacus	TENN–F–069200	KY696768	KY696768
My. opacus	TENN–F–069200	KY696769	KY696769
My. opacus	TENN–F–054871	MW396877	MW396877
My. opacus	TENN–F–070567	MW396878	MW396878
My. prasiosmus	TENN–F–055630	KY696784	KY696785
My. querceus	BRNM: 666586	KY696774	N/A
***My. rufodiscus* sp. nov.**	**HMJAU 60430**	**PP151522**	**PP639543**
***My. rufodiscus* sp. nov.**	**HMJAU 60431**	**PP151523**	**N/A**
My. salalis	DAOM: 175251	KX752265	KX752265
My. scorodonius	TENN–F–050522	KY696731	KY696731
My. scorodonius	TENN–F–050689	KY696733	KY696733
My. scorodonius	TENN–F–050696	KY696734	KY696734
My. scorodonius	TENN–F–051442	KY696739	KY696739
My. scorodonius	TENN–F–053465	KY696740	KY696740
My. scorodonius	TENN–F–053466	KY696741	KY696741
My. scorodonius	TENN–F–053467	KY696742	KY696742
My. scorodonius	TENN–F–053471	KY696746	KY696746
My. scorodonius	TENN–F–053474*	KY696748	KY696748
My. scorodonius	TENN–F–059615*	KY696757	KY696757
Neonothopanus nambi	DUKE3980	AF525074	N/A
Ne. nambi	DUKE2581	AF525075	N/A
Omphalotus guepiniiformis	TNS Kasuya B817	KJ395102	KJ395105
O. illudens	G.M. 2015–08–13.1	MN737454	MN737454
O. mexicanus	TENN–F–051283	AY313274	N/A
O. nidiformis	VilgalysE5332	AY313275	N/A
O. olearius	culture 9061b	AY313277	N/A
O. olearius	CBS 102282	DQ494681	DQ470816
O. olivascens	TENN–F–056257	AY313279	N/A

Table 1 Continued.

Species Name	Collection No.	ITS	LSU
O. subilludens	TENN–F–054230	AY313283	N/A
***Paragymnopus brunneodiscus* sp. nov.**	**HMJAU 60432***	**PP151534**	**PP151567**
***Pg. brunneodiscus* sp. nov.**	**HMJAU 60433**	**PP151539**	**PP151569**
Pg. foliiphilus	TENN–F–068183*	KY026705	KY026705
Pg. perforans	TENN–F–050318	KY026623	KY026623
Pg. perforans	TENN–F–050319	KY026624	KY026624
Pg. perforans subsp. *transatlanticus*	TENN–F–061587*	KY026671	KY026671
Pg. perforans subsp. *transatlanticus*	TENN–F–061587*	KY026672	KY026672
Pg. pinophilus	TENN–F–067846	KY026695	KY026695
Pg. pinophilus	**HMJAU 60434**	**PP151541**	**PP151570**
Pg. pinophilus	**HMJAU 60435**	**PP151544**	**N/A**
Pg. pinophilus	**HMJAU 60436**	**PP151545**	**N/A**
Pg. ponderosae	TENN–F–053488	KY026639	KY026639
Pg. sequoiae	TENN–F–069325	KY026740	KY026740
Paramycetinis austrobrevipes	TENN–F–050135*	KY026622	KY026622
Pm. austrobrevipes	TENN–F–053149	KY026637	KY026637
Pm. austrobrevipes	TENN–F–053181	KY026638	KY026638
Pm. caulocystidiatus	TENN–F–053683	KY026642	KY026642
Pm. caulocystidiatus	TENN–F–053721	KY026643	KY026643
Pm. caulocystidiatus	TENN–F–053725	KY026644	KY026644
Pm. caulocystidiatus	TENN–F–054050*	KY026645	KY026645
Peckorumyces umbonatus comb. nov.	TENN–F–062527	DQ486708	DQ457670
Pe. umbonatus comb. nov.	4725	MH930172	N/A
Pe. umbonatus comb. nov.	LAH37669	OQ302559	N/A
***Pe. umbonatus* comb. nov.**	**HMJAU 60400**	**OP894907**	**OP889545**
***Pe. umbonatus* comb. nov.**	**HMJAU 60402**	**OP894908**	**N/A**
***Pe. umbonatus* comb. nov.**	**HMJAU 60403**	**OP894915**	**N/A**
***Pe. umbonatus* comb. nov.**	**HMJAU 60391**	**OP894910**	**OP889546**
***Pe. umbonatus* comb. nov.**	**HMJAU 60389**	**OP894911**	**OP889547**
***Pe. umbonatus* comb. nov.**	**HMJAU 60396**	**OP894912**	**OP889548**
***Pe. umbonatus* comb. nov.**	**HMJAU 60399**	**OP894913**	**OP889549**
***Pe. umbonatus* comb. nov.**	**HMJAU 60394**	**OP894914**	**OP889550**
***Pe. umbonatus* comb. nov.**	**NYSf 859**	**OP894916**	**N/A**
Pseudomarasmius efibulatus	TENN–F–056187*	MK268234	N/A
Ps. glabrocystidiatus	KFRI1935	KF251072	KF251093
Ps. glabrocystidiatus	BRNM: 718676*	KF251073	KF251092
Ps. glabrocystidiatus	**HMJAU 60437**	**PP151525**	**PP151564**
Ps. glabrocystidiatus	**HMJAU 60438**	**PP151499**	**N/A**
Ps. nidus–avis	TENN–F–069310	KY026732	KY026732
Ps. nidus–avis	TENN–F–069311	KY026733	KY026733
Ps. nidus–avis	XAL: Cesar36*	MH560576	N/A
Ps. pallidocephalus	TENN–F–052401	KY026635	KY026635
Ps. pallidocephalus	TENN–F–065829	KY026684	KY026684
Ps. pallidocephalus	TENN–F–065829	KY026685	KY026685
Ps. patagonianus	TENN–F–054424*	KY352649	N/A
Ps. quercophylloides	TENN–F–049177*	MK268235	N/A
Ps. quercophylloides	**HMJAU 60439**	**PP151501**	**N/A**
Ps. quercophylloides	**HMJAU 60440**	**PP151502**	**N/A**
Ps. quercophylloides	**GDGM70244**	**PP151510**	**PP151556**
Pusillomyces asetosus	BRNM: 715010*	KF251066	KF251086

Table1 Continued.

Species Name	Collection No.	ITS	LSU
Pu. asetosus	KFRI1918	KF251070	KF251090
Pu. funalis	BRNM: 718747	KF251056	KF251077
Pu. funalis	KFRI1870	KF251062	KF251082
Pu. manuripioides	INPA 280704*	MK434210	MK434211
Pu. manuripioides	INPA 282050	MK434212	MK434213
***Pu. nodulocystidiatus* sp. nov.**	**HMJAU 60441**	**PP151519**	**N/A**
***Pu. nodulocystidiatus* sp. nov.**	**HGASMF01–10207***	**PP151507**	**PP151553**
***Pu. nodulocystidiatus* sp. nov.**	**HGASMF01–10239**	**PP151508**	**PP151554**
***Pu. nodulocystidiatus* sp. nov.**	**HGASMF01–10223**	**PP151509**	**PP151555**
***Pu.* sp.**	**HMJAU 60458**	**PP760156**	**N/A**
Pu. spinulosus	XAL: Cesar43	MT232384	N/A
Pu. spinulosus	XAL: Cesar209	MT232385	N/A
Pu. spinulosus	XAL: Cesar206*	MT232386	N/A
Rhodocollybia asema	LE–BIN1232	KY026754	KY026754
R. asema	O–F–248288	MZ156764	N/A
R. badiialba	UBC F16283	EU486446	EU486446
R. badiialba	Dai 22695	OL457981	OL457449
R. butyracea	TENN–F–069047	KY026716	KY026716
R. butyracea	O–F–75421	MZ156769	N/A
R. ciliatomarginata	CAL 1244*	MF803835	N/A
R. clavipes	SFSU: DED8151	GU369941	N/A
R. dotae	NYBG REH 7007	AF505758	N/A
R. incarnata	PDD:97091	KM975425	KM975381
R. incarnata	PDD:87538	KM975429	KM975385
R. laulaha	F:MRK55	GU369958	AY639441
R. lignitilis	TENN–F–056628*	GU369959	GU369966
R. maculata	TENN–F–065926	KY026688	KY026688
R. maculata	TENN–F–065926	KY026689	KY026689
R. maculata	TENN–F–067881	KY026698	KY026698
R. maculata	CBS:134.57	MH857674	MH869212
R. maculata	BRNM: 840489	OM200334	OM189437
R. olivaceogrisea	JLM 2175	KT205399	N/A
R. pandipes	TENN–F–058622	AF505752	N/A
R. pandipes	TENN–F–053838	AY313294	N/A
R. prolixa var. *distorta*	NYBG EFM 1403	AF505748	N/A
R. purpurata	PDD:95837	KJ461902	N/A
R. spissa	SFSU AWW129*	AY263427	AY639428
R. turpis	TENN–F–058017	AF505749	N/A
R. unakensis	TENN–F–058545	AY313298	GU369967
R. variabilicolor	BRNM: 840482	OM200322	OM189430
R. variabilicolor	**HMJAU 60442**	**PP151540**	**N/A**
R. variabilicolor	**HMJAU 60443**	**PP151503**	**N/A**
Setulipes afibulatus	SFSU: DED 8208	MF100972	N/A

RESULTS

Phylogenetic analyses

Phylogenetic analyses were conducted using a combined ITS and LSU dataset to recognize new lineages and investigate the relationships between genera in the Omphalotaceae, specifically for the ill-defined clade *G. contrarius*. The resulting phylogenetic trees, inferred by Bayesian Inference (BI) and Maximum Likelihood (ML) methods, shared high similarity in topology. The

ML tree is detailed in Fig. 1a–d, and the phylogenetic framework is shown in Fig. 1e. ML Bootstrap (BS) values ≥ 70% and BI Posterior Probability (PP) values ≥ 0.95 were considered significant for each node. The Omphalotaceae represents a well–supported monophyletic clade (100% / 1.00) and comprises four major lineages (Clade A–D). All the known genera within Omphalotaceae are monophyletic and well supported (79%–100% / 0.99–1.00), except for the genus *Hymenoporus*, which, with only LSU sequences available, was excluded from this analysis.

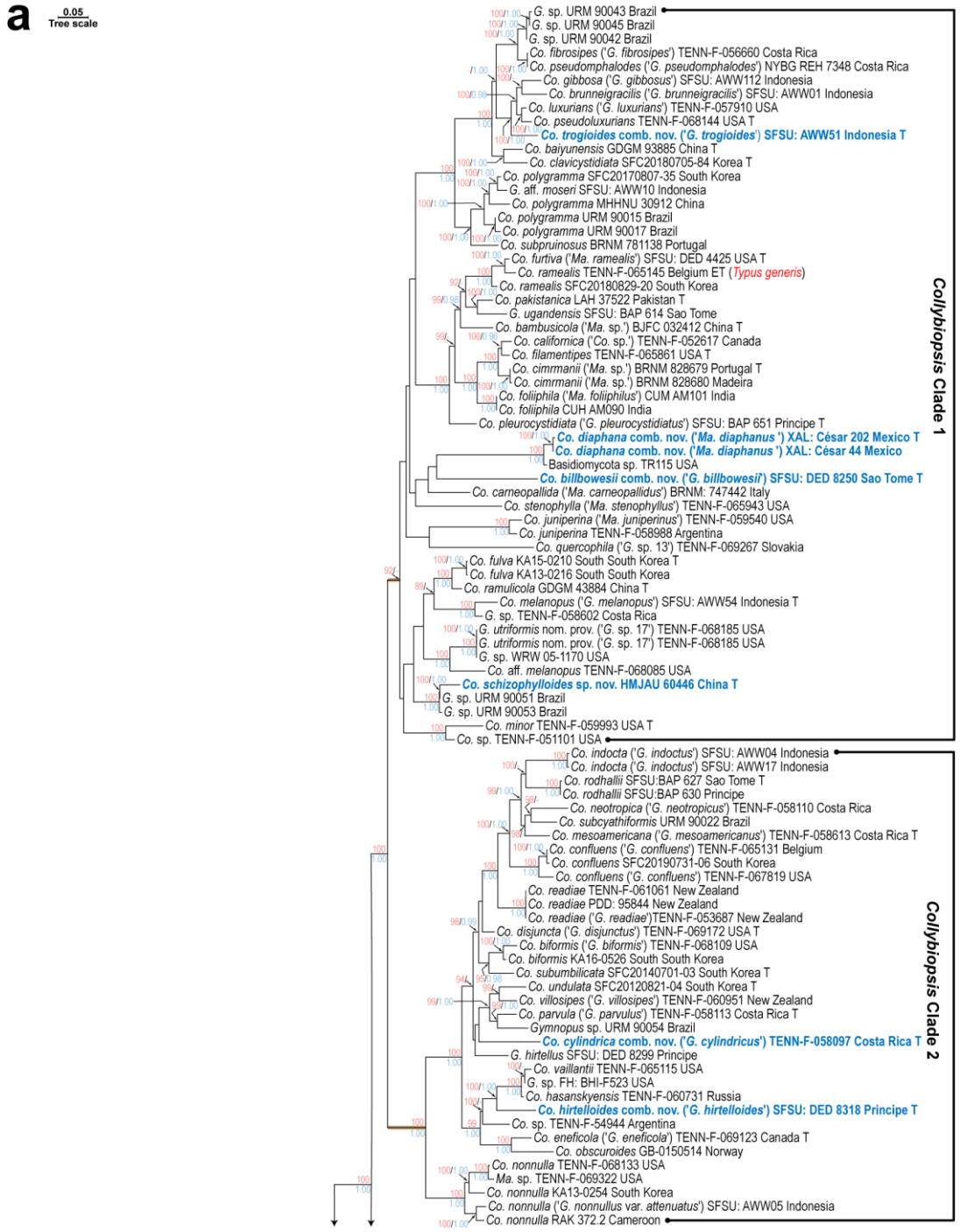

Figure 1 – Phylogenetic tree of Omphalotaceae (combined ITS and LSU dataset) based on ML method, species within Marasmiaceae are selected as outgroups. MLBS values ⩾ 70%, and BIPP values ⩾ 0.95 are shown around the nodes. Taxa involved in this study are highlighted in bold.

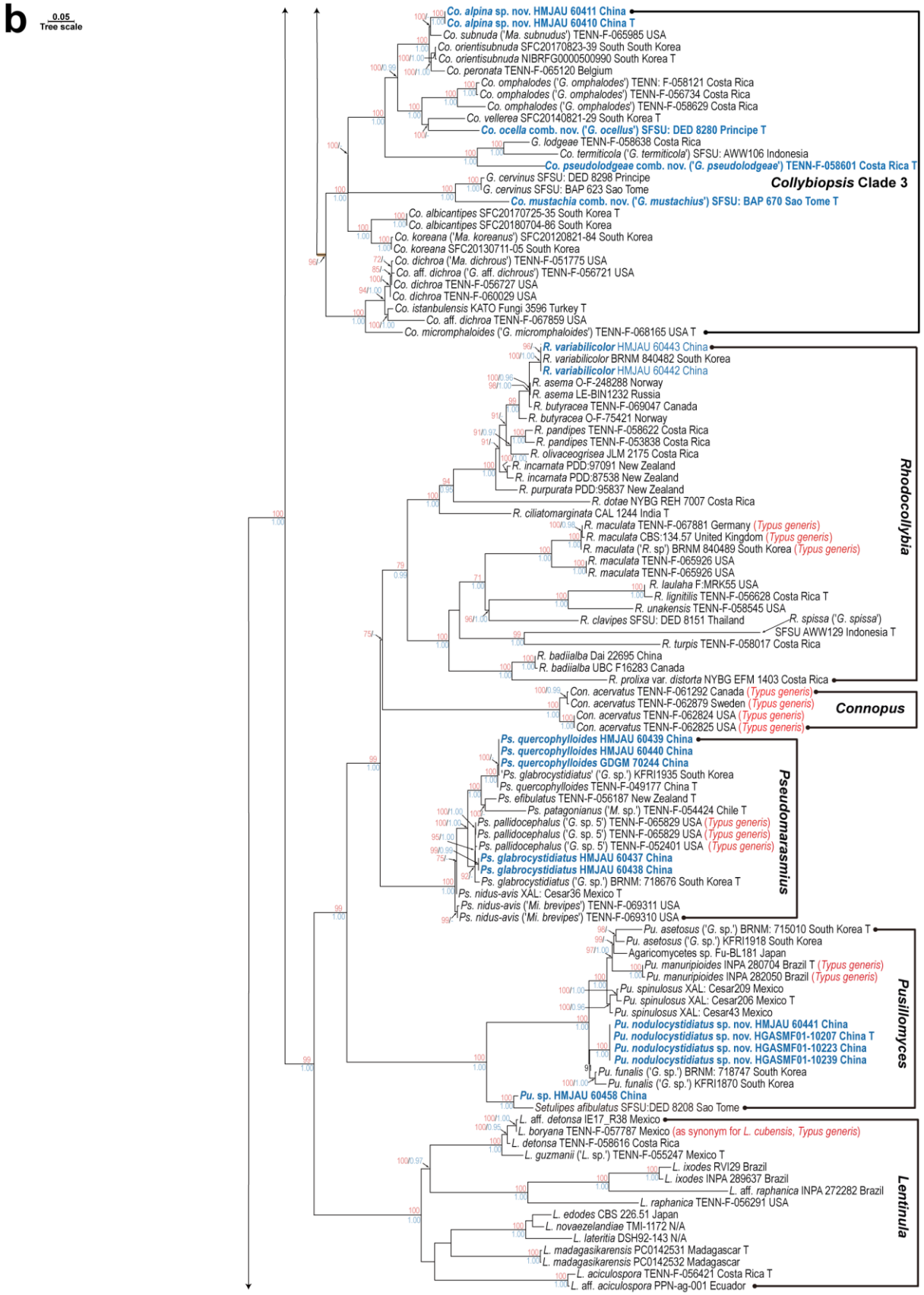

Figure 1 – Continued.

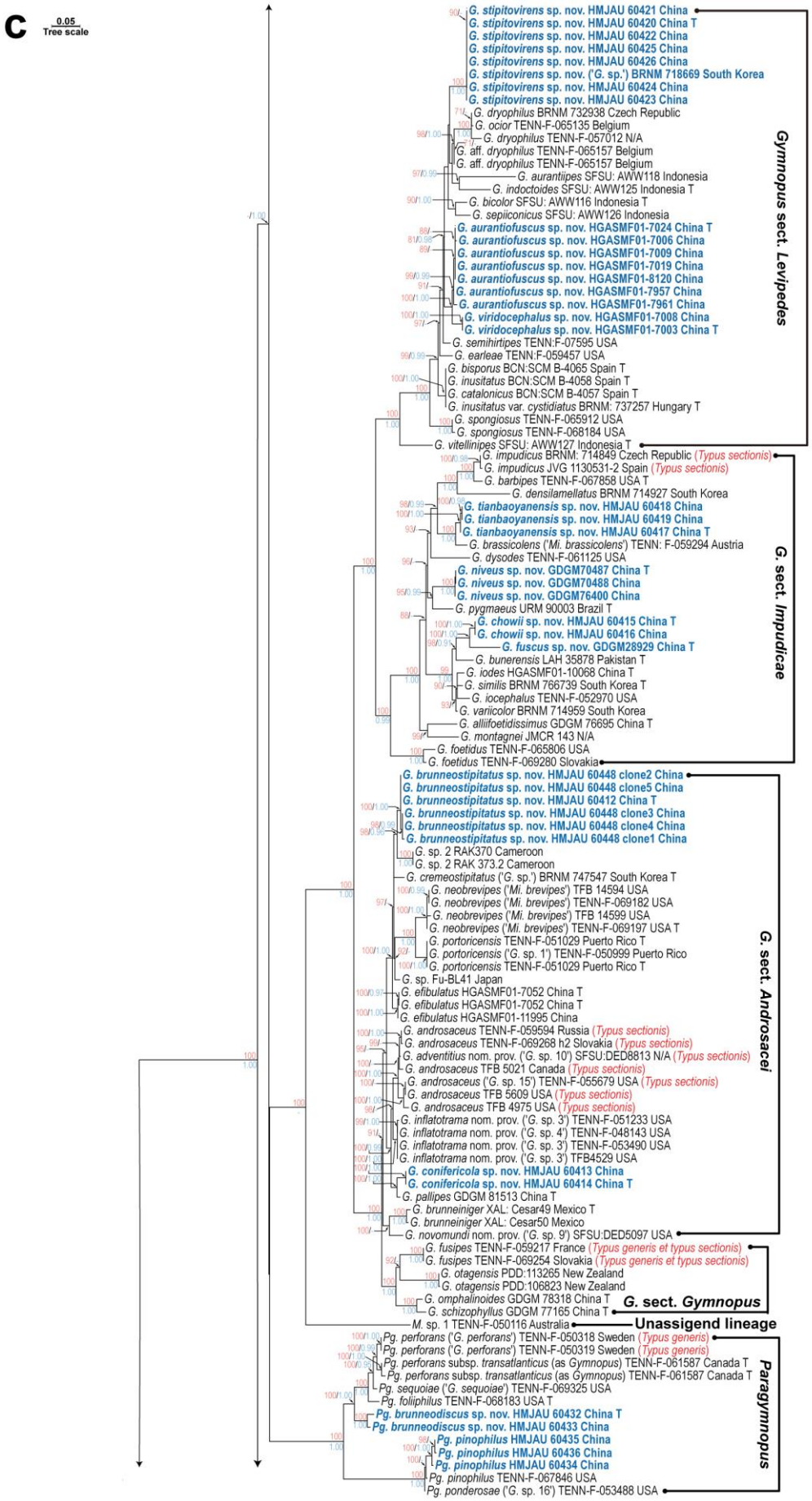

Figure 1 – Continued.

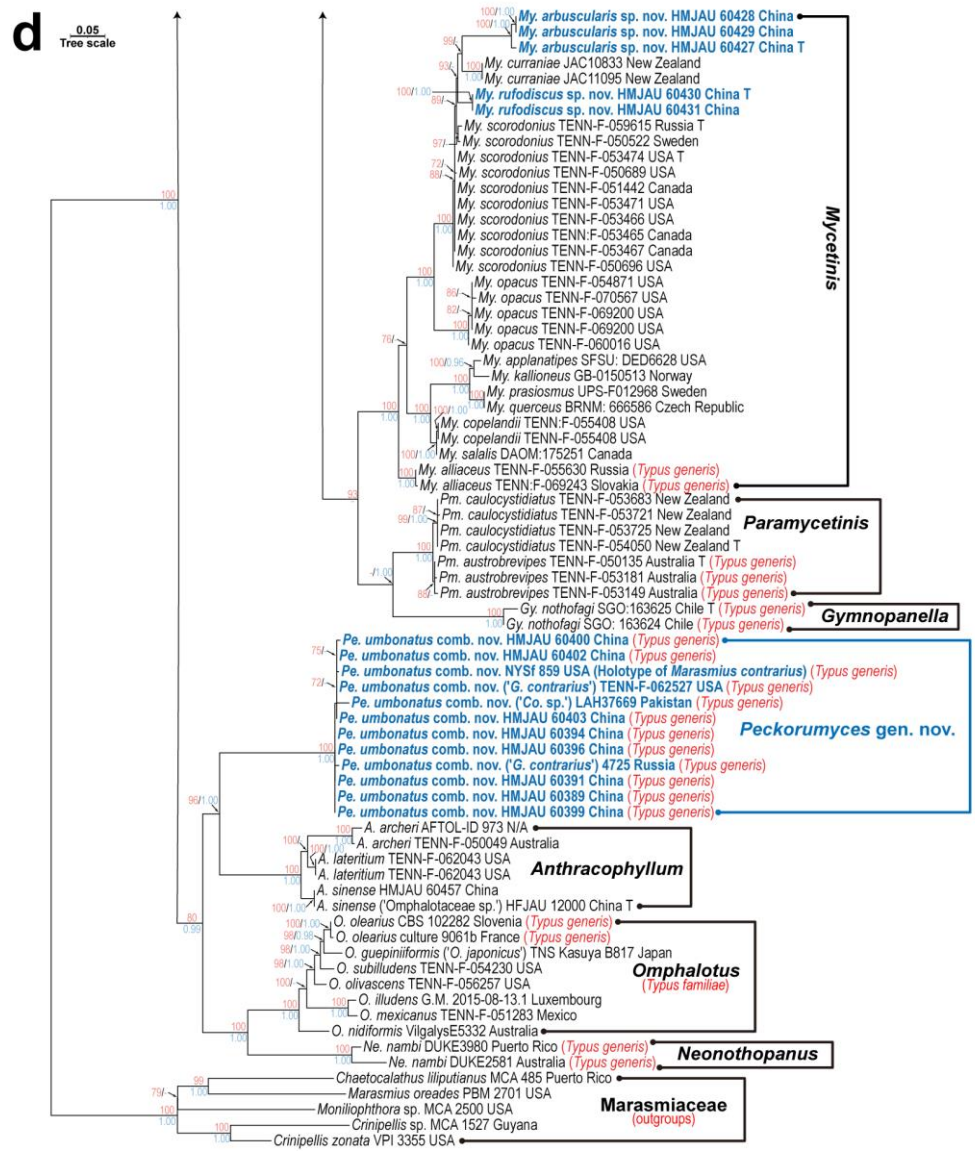

Figure 1 – Continued.

Clade A (80% / 0.99, Fig. 1d, e) is a well–supported basal clade within the family Omphalotaceae and includes four major clades. Three of these clades represent the recognized genera, including *Omphalotus*, the type genus of the family, while the fourth is an ill-defined monotypic clade of *G. contrarius*. All four major clades exhibit robust phylogeny (100% / 1.00). The type species of each accepted genus is included in the analysis, except for *A. beccarianum* Ces., whose sequence is unavailable. The monotypic clade of *G. contrarius*, comprising sequences from twelve collections, includes two samples from the USA (the historical type specimen of *M. contrarius*, NYSf 859, and TENN–F–062527), one sample each from Pakistan and Russia, and eight newly collected samples from China, and is robust in its phylogenetic standing (100% / 1.00). This clade is notably distant from the major clade of *Gymnopus*. However, it is closely related as the sister clade to *Anthracophyllum*, with significant support (96% / 1.00).

Clade B (93% / 1.00, Fig. 1d, e) includes three robust monophyletic genera, namely *Gymnopanella*, *Mycetinis*, and *Paramycetinis*. Type species of each genus are included in this clade. The genus *Gymnopanella* (Fig. 1d) is a monotypic clade (100% / 1.00). The genus *Paramycetinis* (Fig. 1d) is sister to *Gymnopanella* but lacks statistical support by ML analysis (not significant / 1.00), and is paraphyletic to *Mycetinis*. Among the *Mycetinis* clade (100% / 1.00, Fig. 1c), newly generated sequences are separated into two different lineages. Sequences of HMJAU 60427, HMJAU 60428, and HMJAU 60429 are within one new distinct lineage with high support (100% /

1.00). The well–supported lineage formed by the sequences from HMJAU 60430 and HMJAU 60431 (100% / 1.00), is paraphyletic to the reference sequence of *My. curraniae* (G. Stev.) J.A. Cooper & P. Leonard, whereas, the relationship lacks support by BI analysis (93% / not significant). All of these taxa share the most recent common ancestor with *My. scorodonius* (Fr.) A.W. Wilson & Desjardin with high statistical support (100% / 1.00).

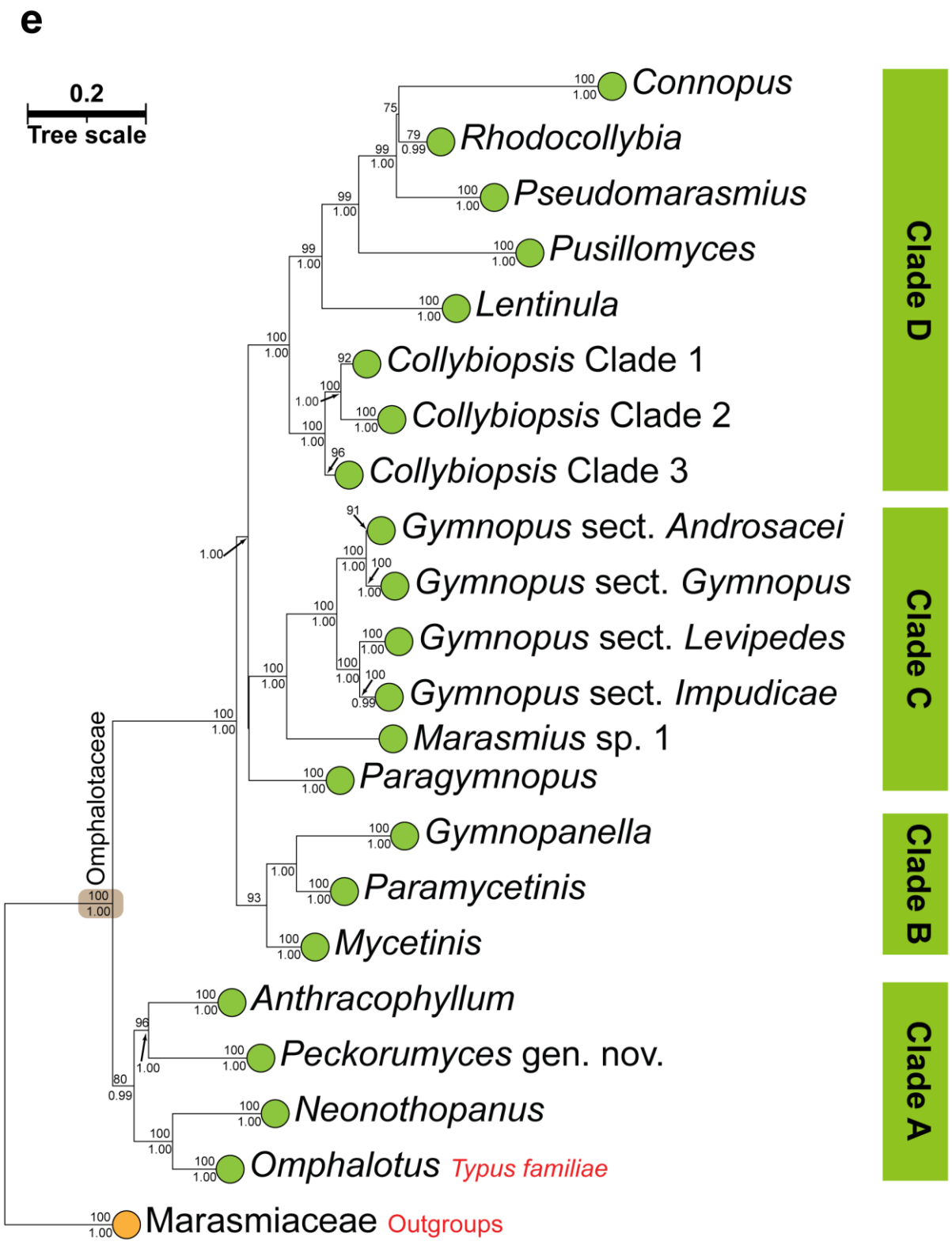

Figure 1 – Continued.

Clade C (not significant / not significant, Fig. 1b, c, e) lacks statistical support and comprises two genera, *Gymnopus* and *Paragymnopus*, along with an unassigned monotypic clade (*Marasmius* sp. 1 TENN–F–050116). Type species of each genus are included in this clade. The genus *Gymnopus* (Fig. 1b–c) forms a highly supported clade (100% / 1.00), and the type species of each section are included in this clade. Each section of the genus is monophyletic in both analyses, except for the *G.* sect. *Androsacei* (Kühner) Antonín & Noordel. clade. This clade is well–supported only by ML analysis (91% / not significant) but exhibits a polyphyletic nature with *G.* sect. *Gymnopus* in BI analysis. In the clade of *G.* sect. *Androsacei* (Fig. 1c), newly generated sequences have been assigned to two distinct lineages. One lineage consists of two samples from China (HMJAU 60412 and HMJAU 60448), showing high support (100% / 1.00). This lineage is found to be sister to another well–supported lineage (98% / 0.96). The latter lineage comprises two individuals from Africa (RAK 370, RAK 373.2), demonstrating significant statistical support (100% / 1.00). The other robust (100% / 1.00) new lineage, comprising sequences from HMJAU 60413 and HMJAU 60414, is highly supported (100% / 1.00) as the sister lineage to *G. pallipes* J.P. Li & Chun Y. Deng, a species originally described from China. In the clade of *G.* sect. *Impudicae* (Antonín & Noordel.) Antonín & Noordel. (100% / 1.00, Fig. 1c), newly generated sequences have been identified as forming four new lineages. Sequences from HMJAU 60417, HMJAU 60418, and HMJAU 60419 constitute a new lineage (100% / 1.00), which is sister to the reference sequence of *G. brassicolens* (Romagn.) Antonín & Noordel., with significant support (100% / 1.00). Sequences from GDGM70487 and GDGM76400 group as another lineage (100% / 1.00), which is sister to *G. pygmaeus* V. Coimbra, E. Larss., Wartchow & Gibertoni (95% / 0.99). The remaining two new lineages are sister to each other (100% / 1.00); sequences from HMJAU 60415 constitute one (100% / 1.00), and sequences from GDGM 28929 form another. In the clade of *G.* sect. *Levipedes* (Quél.) Halling (100% / 1.00, Fig. 1b), newly generated sequences are grouped into three new, robust lineages. The first new lineage is comprised of sequences from HMJAU 60421, HMJAU 60420, HMJAU 60422, HMJAU 60423, HMJAU 60424, HMJAU 60425, HMJAU 60426, and BRNM 718669 (100% / 1.00). The second new lineage includes sequences from HGASMF01–7006, HGASMF01–7009, HGASMF01–7019, HGASMF01–7024, HGASMF01–7957, HGASMF01–7961, and HGASMF01–8120 (99% / 0.99). The third new lineage is composed of sequences of HGASMF01–7003 and HGASMF01–7008 (100% / 1.00), and is sister to the second new lineage (100% / 1.00). *Marasmius* sp. 1 (TENN–F–050116) forms an unassigned clade that is sister to *Gymnopus* (100% / 1.00). The genus *Paragymnopus* displays a well–supported monophyletic clade (100% / 1.00, Fig. 1c). This genus has a paraphyletic relationship to *Gymnopus*, but it lacks significant statistical support from BI and ML analyses. Among this clade, sequences of HMJAU 60432 and HMJAU 60432 form a well–supported new lineage (100% / 1.00). Additionally, sequences of HMJAU 60434, HMJAU 60435, and HMJAU 60436 are grouped with the reference sequence of *Pg. pinophilus* (R.H. Petersen) J.S. Oliveira (TENN–F–067846) in a lineage but only significantly supported by ML analysis (100%, 1.00).

Clade D (100% / 1.00, Fig. 1a, e) includes six genera, namely *Collybiopsis*, *Connopus*, *Lentinula*, *Pseudomarasmius*, *Pusillomyces*, and *Rhodocollybia*. Type species of each genus are included in this clade. The genus *Collybiopsis* (Fig. 1a) exhibits a robust monophyletic clade (100% / 1.00) and comprises three major clades, including *Co. ramealis* (Bull.) Millsp., the type species of *Collybiopsis*. *Collybiopsis* Clade 1 is well–supported only by ML analysis (92% / not significant). The sequences, derived from the type specimens of three known species within the genera *Gymnopus* and *Maramiellus* (*G. billbowesii* Desjardin & B.A. Perry, *G. trogioides* A.W. Wilson, Desjardin & E. Horak, and *Ma. diaphanus* César, Bandala & Montoya, are grouped within this clade. Besides, the sequence of HMJAU 60446 forms a new independent lineage within this clade. *Collybiopsis* Clade 2 is well–supported by both ML and BI analyses (100% / 1.00). The sequences, derived from the type specimens of *G. cylindricus* J.L. Mata and *G. hirtelloides* Desjardin & B.A. Perry, are recognized within this clade. Additionally, a sequence annotated as *G. hirtellus* (Berk. & Broome) Desjardin & B.A. Perry is also included in this clade. *Collybiopsis* Clade 3 is well–supported only by ML analyses (100% / not significant). The sequences, derived from the type

specimens of *G. mustachius* Desjardin & B.A. Perry, *G. ocellus* Desjardin & B.A. Perry, and *G. pseudolodgeae* J.L. Mata, are nested within this clade. The reference sequences of *G. cervinus* (Henn.) Desjardin & B.A. Perry and *G. lodgeae* (Singer) J.L. Mata are placed in this clade. Additionally, the sequences of HMJAU 60410 and HMJAU 60411 together form a new distinct lineage (100% / 1.00) within this clade. The genus *Connopus* (Fig. 1b) displays a well–supported monotypic and monophyletic clade (100% / 1.00) and is a sister clade to *Rhodocollybia*; however, this relationship is unsupported by BI analysis (75% / not significant). The genera *Lentinula*, *Pseudomarasmius*, and *Pusillomyces* (Fig. 1b) separately cluster within three strongly supported monophyletic clades (100% / 1.00), each including its type species. Within the *Pseudomarasmius* clade, sequences of GDGM 70244, HMJAU 60439, and HMJAU 60440, a sequence denoted as *Ps. glabrocystidiatus* (KFRI1935), and a sequence from the type specimen of *Ps. quercophylloides* R.H Petersen (TENN–F–049177) constitute a firmly supported lineage (100% / 1.00). Sequences of HMJAU 60437 and HMJAU 60438, along with reference sequences of *Ps. pallidocephalus* (TENN–F–052401, TENN–F–065829), define a strongly supported branch (95% / 1.00) that is separate from the sequence from the type specimen of *Ps. glabrocystidiatus* (Antonín, Ryoo & Ka) R.H. Petersen (BRNM: 718676), which is considered its sister, but this relationship lacks support by BI analysis (92% / not significant). Within the *Pusillomyces* clade (Fig. 1b), sequences of HMJAU 60441, HGASMF01–10207, HGASMF01–10223, and HGASMF01–10239 cluster together as a new, distinct, and robust lineage (100% / 1.00). Additionally, a sequence from an undescribed sample (HMJAU 60458) forms a stable branch (100% / 1.00) with the reference sequence of *Setulipes afibulatus* Antonín (SFSU: DED 8208). This branch is highly supported as the sister to the branch that includes *Pu. manuripioides* J.S. Oliveira, the type species of the genus. Among the *Rhodocollybia* clade (Fig. 1b), sequences of HMJAU 60442 and HMJAU 60443 are grouped with the reference sequence of *R. variabilicolor* Antonín, Ryoo & Ka (BRNM 840482), and this grouping has significant statistical support (100% / 1.00).

Taxa identified in this study

Based on the morpho–molecular method, one new genus, 15 new species, five known species, and nine combinations were identified in this study. *Peckorumyces* gen. nov. is proposed as a new genus. The new species are *Co. alpina* sp. nov., *Co. schizophylloides* sp. nov., *G. aurantiofuscus* sp. nov., *G. brunneostipitatus* sp. nov., *G. chowii* sp. nov., *G. conifericola* sp. nov., *G. fuscus* sp. nov., *G. niveus* sp. nov., *G. stipitovirens* sp. nov., *G. tianbaoyanensis* sp. nov., *G. viridocephalus* sp. nov., *My. arbuscularis* sp. nov., *My. rufodiscus* sp. nov., *Pg. brunneodiscus* sp. nov., and *Pu. nodulocystidiatus* sp. nov., nov. *Paragymnopus pinophilus*, *Ps. glabrocystidiatus*, and *R. variabilicolor* are species new to China, while *Pe. umbonatus* comb. nov. and *Ps. quercophylloides* the other two known species. New combinations are *Co. billbowesii* comb. nov., *Co. cylindrica* comb. nov., *Co. diaphana* comb. nov., *Co. hirtelloides* comb. nov., *Co. mustachia* comb. nov., *Co. ocella* comb. nov., *Co. pseudolodgeae* comb. nov., *Co. trogioides* comb. nov., and *Pe. umbonatus* comb. nov.

Taxonomy

Collybiopsis Earle, Bull. New York Bot. Gard. 5: 415 (1909)

Type species – *Collybiopsis ramealis* (Bull.) Millsp.

Spectrum of reported species in China – *Collybiopsis baiyunensis* X.C. Liu & L.H. Qiu, *Co. bambusicola* Q.Y. Zhang, J. Si & H.J. Li, *Co. biformis* (Peck) R.H. Petersen, *Co. brunneigracilis* (Corner) R.H. Petersen, *Co. confluens* (Pers.) R.H. Petersen, *Co. dichroa* (Berk. & M.A. Curtis) R.H. Petersen, *Co. indocta* (Corner) R.H. Petersen, *Co. koreana* (Antonín, Ryoo & H.D. Shin) J.S. Kim & Y.W. Lim, *Co. luxurians* (Peck) R.H. Petersen, *Co. menehune* (Desjardin, Halling & Hemmes) R.H. Petersen, *Co. melanopus* (A.W. Wilson, Desjardin & E. Horak) R.H. Petersen, *Co. nonnulla* (Corner) R.H. Petersen, *Co. peronata* (Bolton) R.H. Petersen, *Co. polygramma* (Mont.) R.H. Petersen, *Co. quercophila* (Pouzar) R.H. Petersen, Co. ramealis (Bull.) Millsp., *Co.*

ramulicola (T.H. Li & S.F. Deng) J.S. Kim & Y.W. Lim, *Co. stenophylla* (Mont.) R.H. Petersen, *Co. subnuda* (Ellis ex Peck) R.H. Petersen, *Co. subpruinosa* (Murrill) R.H. Petersen, *Co. vaillantii* (Pers.) R.H. Petersen (Deng et al. 2011, Deng et al. 2016, Institute of Microbiology, Chinese Academy of Sciences 2024, Li 2020, Li et al. 2015, Liu et al. 2024, Zhang 2023, Zhang et al. 2023).

Notes – A total of 21 species within the genus were reported in China, but most of them lack molecular evidence. The genus *Collybiopsis*, first proposed by Earle (1909), has a type species, previously namely *Agaricus ramealis* Bull., which predates *Ma. juniperinus* Murrill, the type species of *Marasmiellus*, in nomenclatural precedence. This precedence is important under the International Code of Nomenclature, leading to the resurrection of the genus name "*Collybiopsis*" for the group referred to as "*Marasmiellus*" in Wilson & Desjardin (2005) and Oliveira et al. (2019). The taxonomy of *Collybiopsis* has been challenging due to its overlapping characteristics with other genera, such as *Marasmiellus* and *Gymnopus* However, recent advancements in molecular and phylogenetic studies, including ITS–based sequences, have started to shed more light on its precise classification, although the taxonomy continues to evolve. (Petersen & Hughes 2021).

Collybiopsis alpina J.P. Li, Chang–Tian Li & Y. Li, sp. nov. Figs 2–3

Fungal names: FN571827; Facesoffungi number: FoF15515

Etymology – The specific name "*alpina*" is derived from Latin, meaning "of the high mountains", and it refers to the mushroom's original discovery in high mountain regions.

Typification – CHINA. Yunnan Province, Diqing Tibetan Autonomous Prefecture, Xianggelila City, 28° 14' 52" N, 99° 58' 25" E, elev., 3937 m, 1 August 2022, M.C. Pan, PMC449 (HMJAU 60410, holotype).

Diagnosis – Similar to *Co. subnuda*, but differs by the rather small pileus/stipe ratio (Pileus 19–28 mm broad and Stipe 15–26 mm), distinct broad basidiospores (4.6–5.5 μm in width) and long basidia (39.9–54.3 μm in length).

Description – *Basidiomata* diminutive. *Pileus* 19–28 mm diam, membranous, hemispherical to truncately broadly conical, often depressed or occasional umbonate at centre, sometimes umbonate, expending to plano–convex to applanate, with central depression, with deflexed to reflexed, sometimes split margin, dry, radially sulcate at margin zone, brown (7E7) to dark brown (7F7) at disc, slightly paler otherwise, reddish grey (7B2) at margin. *Lamellae* close, L = 16–21, l = 2–3, up to 5 mm broad, adnate, adnexed, ventricose, reddish grey (7B2). *Stipe* 15–26 mm long, 3–4 mm thick at the apex, 2.5–3 mm thick at the base, centrally attached and instititious, cylindrical, broadened at apex and base, slightly compressed or not, dry, concolor to lamellae at apex, darken downward, concolor to pileus disc near base, pruinose or tomentum, concolor to stipe. *Odour* negligible.

Basidiospores [n = 40] (8.4–)8.8–10.7(–11.2) × (4.3–)4.6–5.5(–6.3) μm (average = 9.7 × 5.0 μm, E = (1.61–)1.72–2.17(–2.24), Q = 1.94), oblong to cylindric. *Basidia* [n = 10] 39.9–54.3 × 7.9–11.0 μm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 39.5–56.9 × 6.9–10.1 μm, clavate, cylindrical. *Cheilocystidia* [n = 10] 29.1–51.8 × 5.7–8.1 μm, irregularly cylindrical, stalked, with finger–like projections. *Pleurocystidia* [n = 10] 42.9–53.5 × 5.4–7.1 μm, fusiform. *Pileipellis* a cutis composed of cylindrical hyphae, thin–walled, incrusted to strongly incrusted, brown (7E7) in KOH; terminal cells cylindrical, more or less diverticulate, pileal hairs densely present, narrowly erect cylindrical hyphae. *Stipitipellis* a cutis composed of cylindrical, thin–walled, parallel–arranged hyphae, brown (6D7) in KOH. *Caulocystidia* [n = 10] more than 38.1 μm in length, 4.9–6.8 μm in width, densely present, irregularly cylindrical. *Clamp connections* present in all tissues.

Ecology – Saprotrophic, gregarious, arising on dead branches in mixed coniferous and broadleaf forest.

Additional material studied – CHINA. Yunnan Province, Diqing Tibetan Autonomous Prefecture, Xianggelila City, 28° 14' 39" N, 99° 58' 26" E, elev., 3877 m, 1 August 2022, J.P. Li, LJP1473 (HMJAU 60411).

Notes – Marco–morphologically, the new species is of highly similarity to *Co. subnuda*. Compared to the more comprehensive description of *Co. subnuda* based on a series of North American samples including type specimen contributed by Halling (1983), the species differs by the rather large pileus/stipe ratio (pileus 10–35 mm broad and stipe 20–70 mm), distinct narrow basidiospores (8.6–10.8(–12) × 3.2–4.4 μm) and short basidia (22.8–35 × 5.6–10.8 μm). Phylogenetically, the new species is close to *Co. orientisubnuda* J.S. Kim & Y.W. Lim and *Co. peronata*, however, the study of Kim et al. (2022) showed the former differs by rather long stipe (20–80 × 2.5–6 mm), smaller basidiospores (average 7.5 × 2.5 μm) and rather short basidia (19.8–28.7 × 3.7–7.3 μm), and the descriptions provided by Antonín & Noordeloos (2010) showed the latter is characterized by the crowded lamellae (L = 20–40), grooved stipe and distinct narrow basidiospores ((6.5–)8.5–10.0(–11.5) × 3.0–4.0(–4.5) μm).

Figure 2 – Basidiomata of *Collybiopsis alpina* (HMJAU 60410, holotype). Image credit goes to Mei–Chen Pan.

Collybiopsis schizophylloides J.P. Li, Chang–Tian Li & Y. Li, sp. nov. Figs 4–5

Fungal names: FN571828; Facesoffungi number: FoF15516

Etymology – The specific epithet "*schizophylloides*" is inspired by its resemblance to *Gymnopus schizophyllus*, reflecting similar macromorphological features.

Typification – CHINA. Guangxi Zhuang Autonomous Region, Hezhou City, Guposhan National Forest Park, 24° 37' 01" N, 111° 32' 29" E, elev., 715 m, 08 June 2022, J.P. Li, LJP1032 (HMJAU 60446, holotype).

Diagnosis – Similar to *G. schizophyllus*, but differs by the finely tomentose stipe, larger basidiospores (average = 8.5 × 4.3 μm), and cylindrical to irregularly pileipellis terminal cells.

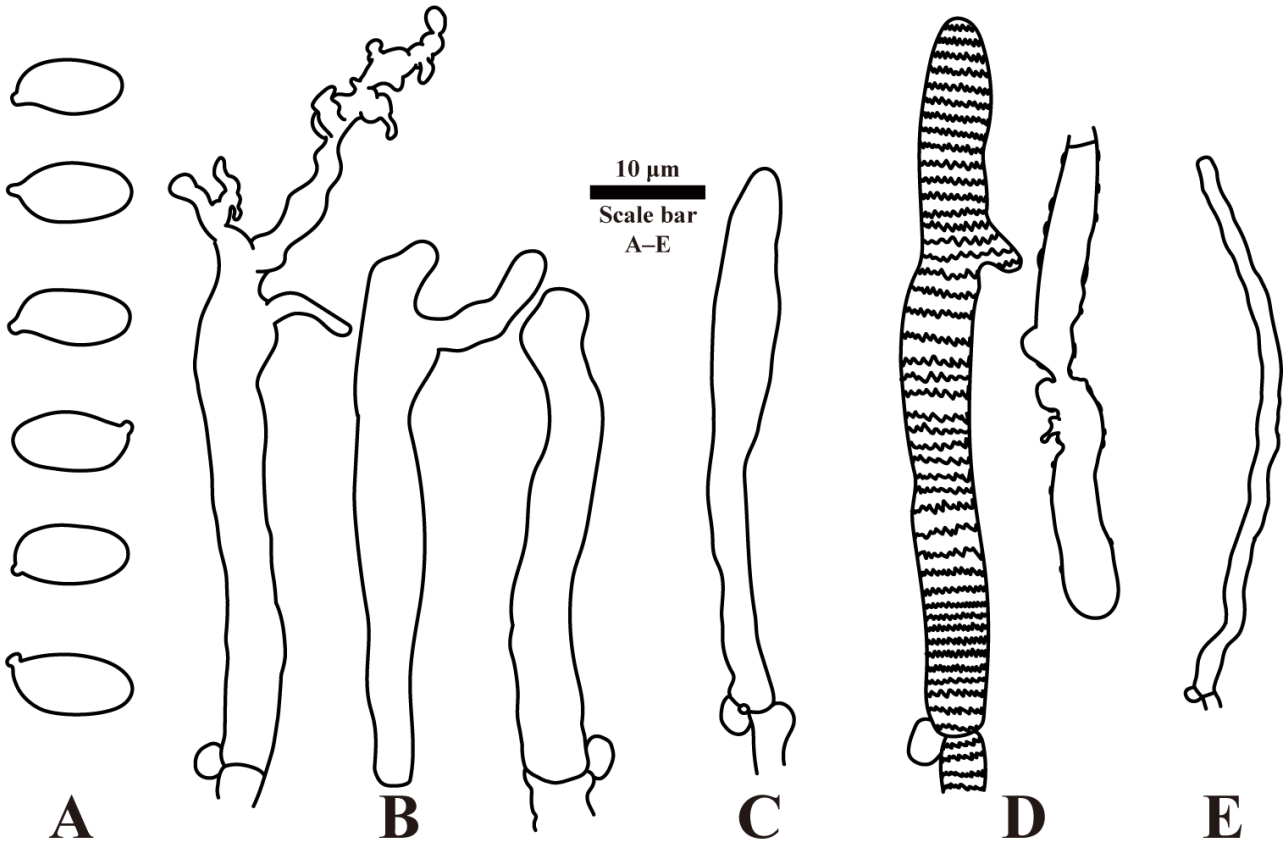

Figure 3 – Microscopic features of *Collybiopsis alpina* (HMJAU 60410, holotype). A Basidiospores. B Cheilocystidia. C Pleurocystidia. D Pileipellis terminal cells. E Pileal hair. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Description – Basidiomata marasmioid. Pileus 19–39 mm diam, membranous, campanulate to convex, slightly sulcate near margin, hygrophanous, then plano–convex with plane or slightly depressed centre, applanate at maturity, rugose deeply and sulcate, depressed at disc, margin undulating, dry, first reddish grey (7B2) at disc and brownish orange (7C6) other where, then almost reddish grey (7B2) to greyish red (7B3) overall, slightly deeper at disc and sulcate area, brownish orange (7C6) to brown (7E7) at central depression and sulcate area when mature. Lamellae subdistant, L = 18–21, l = 2–3, up to 8 mm broad, free, ventricose, attached to a pseudocollarium, slightly to generally venose with age, edge split, reddish white (7A2) with a tinge of reddish grey (7B2) somewhere. Stipe 20–23 mm long, 1.5–3.5 mm thick at the apex, 1–2 mm thick at the base, centrally attached, instititious, cylindrical when young, often apically broadened and slightly compressed with age, whitish to reddish white (7A2) when young, often paler at apex and darker at base, when mature gradually darkening towards base, ranging from brownish orange (7C6) to brown (7E7), cartilaginous when young, tough when old, dry, finely white tomentose, hollow. Odour negligible.

Basidiospores [n = 40] (7.2–)7.6–9.9(–10.3) × (3.4–)3.8–4.9(–6.3) µm (average = 8.5 × 4.3 µm, E = (1.57–)1.84–2.15(–2.21), Q = 1.98), oblong to cylindric. Basidia [n = 10] 20.1–27.7 × 6.2–7.3 µm, 4-spored, clavate, cylindrical. Basidioles [n = 10] 19.9–26.7 × 5.5–7.0 µm, clavate, cylindrical. Cheilocystidia [n = 10] 15.0–63.9 × 4.3–11.0 µm, narrowly and irregularly fusiform to clavate, with apically or laterally finger-like or rostrate–like projections. Pleurocystidia [n = 10] 19.7–32.1 × 4.6–6.8 µm, fusiform. Pileipellis a cutis composed of cylindrical hyphae, thin-walled, slightly incrusted, hyaline; terminal cells cylindrical to irregularly smooth, or diverticulate, lobed to irregularly short branched. Stipitipellis a cutis composed of cylindrical, thin–walled, hyaline, parallel–arranged hyphae, smooth. Caulocystidia [n = 10] 23.0–52.2 × 7.0–15.1 µm, broad clavate to cylindrical, sometimes irregularly. Clamp connections present in all tissues.

Ecology – Saprotrophic, scattered, arising on the trunk of broadleaf tree, currently known on *Castanopsis tibetana*.

Additional material studied – CHINA. Guangxi Zhuang Autonomous Region, Hezhou City, Guposhan National Forest Park, 24° 37' 00" N, 111° 32' 29" E, elev., 718 m, 08 June 2022, C.M. Pan, PMC016 (HMJAU 60447).

Notes – The new species exhibits macro–morphological features such as the brownish–tincted pileus, the split and venose lamellae, and a preference for rooting around stumps in broadleaf trees, markedly similar to those of *G. schizophyllus* J.P. Li, T.H. Li & Y. Li found in the adjacent provinces of Guangdong and Yunnan. Despite these similarities, *G. schizophyllus* is characterized by the glabrous stipe, rather small basidiospores (4.90 × 2.93 μm), vesiculose or pyriform pileipellis terminal cells (Li et al. 2022a). Besides, *Co. fulva* J.S. Kim & Y.W. Lim and *Co. ramulicola* are close to the new species, molecularly. Morphologically, *Co. fulva* has relatively smaller basidiospores (average 7.47 × 3.69 μm) and spheropedunculate to obovoid pleurocystidia (Kim et al. 2022); and *Co. ramulicola* has pale red to pinkish white pileus and irregularly clavate to cylindrical cheilocystidia (Deng et al. 2016).

Figure 4 – Basidiomata of *Collybiopsis schizophylloides* (HMJAU 60446). Image credit goes to Ji–Peng Li.

Gymnopus (Pers.) Gray, Nat. Arr. Brit. Pl. (London) 1: 604 (1821)

Type species – *Gymnopus fusipes* (Bull.) Gray

Spectrum of reported species in China – *Gymnopus alkalivirens* (Singer) Halling, *G. alliifoetidissimus* T.H. Li & J.P. Li, *G. alpinus* (Vilgalys & O.K. Mill.) Antonín & Noordel., *G. androsaceus* (L.) Della Magg. & Trassin., *G. aquosus* (Bull.) Antonín & Noordel., *G. brassicolens, G. brunneodiscus* Antonín, Ryoo & Ka, *G. castaneus* M. Villarreal, Heykoop &

Esteve–Rav., *G. changbaiensis* J.J. Hu, B. Zhang & Y. Li, *G. cystidiosus* J.J. Hu, B. Zhang & Y. Li, *G. densilamellatus* Antonín, Ryoo & Ka, *G. dryophilus* (Bull.) Murrill, *G. efibulatus* J.P. Li, Chang–Tian Li, Chun Y. Deng & Y. Li, *G. epiphyllus* J.J. Hu, B. Zhang & Y. Li, *G. erythropus* (Pers.) Antonín, Halling & Noordel., *G. fasciatus* (Penn.) Halling, *G. foetidus* (Sowerby) P.M. Kirk, *G. fuscopurpureus* (Pers.) Antonín, Halling & Noordel., *G. fusipes*, *G. globulosus* J.J. Hu, Y.L. Tuo, B. Zhang & Y. Li, *G. hariolorum* (Bull.) Antonín, Halling & Noordel., *G. iocephalus* (Berk. & M.A. Curtis) Halling, *G. iodes* J.P. Li, Chang–Tian Li, Chun Y. Deng & Y. Li, *G. lanipes* (Malençon & Bertault) Vila & Llimona, *G. longisterigmatus* J.J. Hu, B. Zhang & Y. Li, *G. longus* J.J. Hu, B. Zhang & Y. Li, *G. macrosporus* J.J. Hu, B. Zhang & Y. Li, *G. microsporus* (Peck) Murrill, *G. montagnei* (Berk.) Redhead, *G. ocior* (Pers.) Antonín & Noordel., *G. omphalinoides* J.P. Li, T.H. Li & Y. Li, *G. oreadoides* (Pass.) Antonín & Noordel., *G. pallipes* J.P. Li & Chun Y. Deng, *G. polyphyllus* (Peck) Halling, *G. putillus* (Fr.) Antonín, Halling & Noordel., *G. schizophyllus*, *G. semihirtipes* (Peck) Halling, *G. similis* Antonín, Ryoo & Ka, *G. sinopolyphyllus* J.P. Li, Chang–Tian Li & Y. Li, *G. striatus* J.J. Hu, B. Zhang & Y. Li, *G. strigosipes* J.P. Li, Chang–Tian Li, Yi Li & Y. Li, *G. subdensilamellatus* J.J. Hu, Y.L. Tuo, B. Zhang & Y. Li, *G. subpolyphyllus* J.J. Hu, B. Zhang & Y. Li, *G. terginus* (Fr.) Antonín & Noordel., *G. tiliicola* J.J. Hu, B. Zhang & Y. Li, *G. tomentosus* J.J. Hu, B. Zhang & Y. Li, *G. wutaishanensis* L. Fan & N. Mao (Bi 1983, Chen 2022, Hu et al. 2022a, 2022b, Institute of Microbiology, Chinese Academy of Sciences 2024, Li 2020, Li et al. 2021a, 2021b, Li et al. 2022a, 2022b, Lu et al. 2000, Mao et al. 2022, Wang et al. 2015, Zhang 2023).

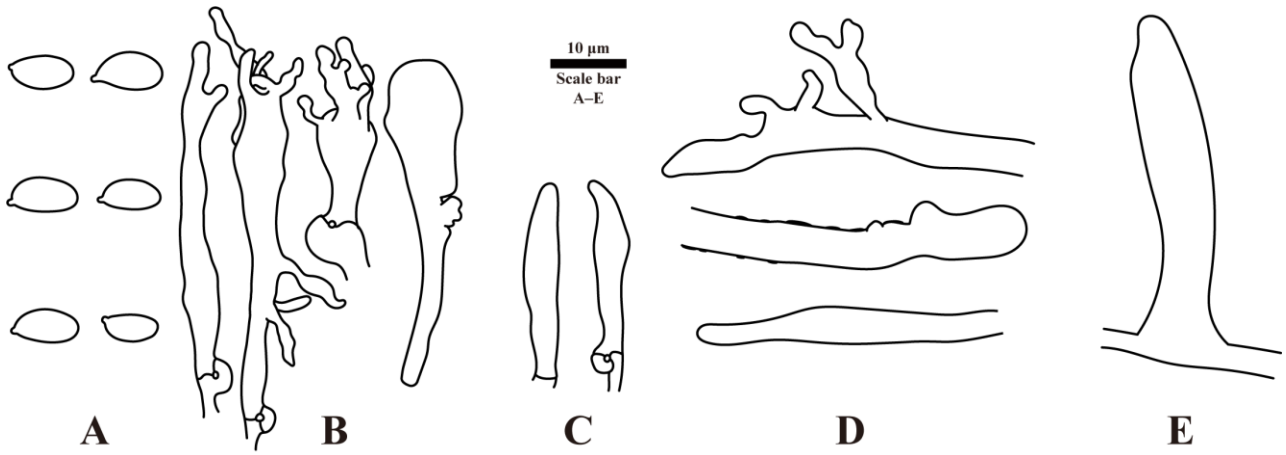

Figure 5 – Microscopic features of *Collybiopsis schizophylloides* (HMJAU 60446, holotype). A Basidiospores. B Cheilocystidia. C Pleurocystidia. D Pileipellis terminal cells. E Caulocystidia. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Notes – A total of 48 species within the genus were reported in China, but most of them lack molecular evidence. *Gymnopus fusipes* (Bull.) Gray, type of the genus, was formerly placed in *Collybia* sect. *Striipedes* (Fr.) Quél. (Singer 1986). Based on morphology, the species were removed from *Collybia* and placed in *Gymnopus*, and a morphological concept of *Gymnopus* was proposed by Antonín et al. (1997). Having undergone a series of revisions, *G.* sect. *Vestipedes* was transferred to *Collybiopsis*. Currently four sections, namely, *G.* sect. *Androsacei*, *G.* sect. *Impudicae*, and *G.* sect. *Levipedes* were accepted within *Gymnopus* (Oliveira et al. 2019, Petersen & Hughes 2021). Recent phylogenetic and taxonomic updates in Agaricales have shown that *Collybia* is a genus within the family Clitocybaceae, rather than Omphalotaceae (Wang et al. 2023, He et al. 2023). This highlights that *Collybia* and *Gymnopus* now have clear boundaries and no longer have any entanglements.

Gymnopus* sect. *Androsacei (Kühner) Antonín & Noordel., in Noordeloos & Antonín, Czech Mycol. 60(1): 25 (2008)

Type species – *Gymnopus androsaceus* (L.) Della Magg. & Trassin.

Notes – This section is supported morphologically and is characterized by marasmioid Basidiomata, a filiform stipe, cheilocystidia comprising *Siccus*-type broom cells or coralloid elements, and a pileipellis mixed with *Siccus*-type broom cells and coralloid elements, which are dextrinoid at least at the stipe apex (Antonín & Noordeloos 2010).

Gymnopus brunneostipitatus J.P. Li, Chang–Tian Li & Y. Li, sp. nov. Figs 6–7

Fungal names: FN 571844; Facesoffungi number: FoF 15517

Etymology – The specific name "*brunneostipitatus*" (Lat.) refers to the mushroom brownish stipe.

Typification – CHINA. Yunnan Province, Lijiang City, Yulong Naxi Autonomous County, 26° 39' 17" N, 99° 46' 45" E, elev., 3402 m, 28 July 2022, J.P. Li, LJP1405 (HMJAU 60412, holotype).

Diagnosis – Similar to *G. efibulatus*, but differs by the rather small pileus/stipe ratios, relatively close lamellae spacing, and the presence of caulocystidia.

Description – *Basidiomata* marasmioid. *Pileus* 5.5–8 mm diam, membranous, truncately broadly conical to convex when very young, evolving into plano-convex to applanate with age, often slightly depressed or rugose at centre, more or less radially sulcate towards margin, margin crenate to undulating, slightly reflexed when mature, dry, little brown (6D4) at disc, fading to orange grey (6B2) towards the margins. *Lamellae* close, L = 12–18, l = 1–3, up to 1 mm broad, adnate to free, sometimes attached to a pseudocollarium, orange grey (6B2). *Stipe* 21–32 mm long, around 0.5 mm thick, centrally attached and instititious, terete, sometimes minutely enlarged at apex or base, filiform, dry, smooth, almost little brown (7D6) overall, occasionally paler at the upper part, transitioning into a little orange (6A4) *Rhizomorphs* present, concolorous with stipe, simple, repent. *Odour* negligible.

Basidiospores [n = 40] (6.7–)7.0–9.2 × (3.5–)3.7–4.8(–5.0) μm (average = 7.9 × 4.2 μm, E = (1.62–)1.69–2.23(–2.32), Q = 1.89), oblong to cylindric. *Basidia* [n = 10] 20.5–31.7 × 5.3–7.6 μm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 19.0–31.5 × 4.8–7.1 μm, clavate, cylindrical. *Cheilocystidia* [n = 10] 8.8–33.6 × 4.3–8.9 μm, irregularly clavate, forming a *Siccus*–type broom cells. *Pleurocystidia* [n = 10] 21.1–33.3 × 4.3–7.1 μm, fusiform to fusiform–mammilate. *Pileipellis* a cutis composed of cylindrical hyphae, thin–walled, often slightly incrusted, intertwined, hyaline, some dextrinoid, smooth; mixed with *Siccus*–type broom cells, irregularly inflated cells and coralloid elements. *Stipitipellis* a cutis composed of cylindrical, slightly thick–walled, hyaline, parallel–arranged hyphae, dextrinoid, smooth. *Caulocystidia* scattered, up to 60.9 μm long, 5.4 μm thick, cylindrical to irregularly cylindrical, thick walled. *Clamp connections* absent.

Ecology – Saprotrophic, scattered, arising on dead twigs or branches under a *Rhododendron* tree.

Additional material studied – CHINA. Yunnan Province, Lijiang City, Yulong Naxi Autonomous County, 26° 39' 18" N, 99° 46' 45" E, elev., 3394 m, 28 July 2022, J.P. Li, LJP1406 (HMJAU 60448).

Notes – The two collections, along with *G. efibulatus* are all from the Holarctic realm, and would be conspecific if based on morphology. However, the new species is sister to two undescribed collections (RAK 370 and RAK 373.2) from the African realm (Cameroon) rather than *G. efibulatus* from the Holarctic realm, according to the phylogenetic results. Morphologically, *G. efibulatus* is characterized by rather a large pileus/stipe ratios indicating the closely sized pileus (5.4–8.8 mm) but rather short stipe (12.9–15.2 mm) and relatively distant lamellae spacing (L = 9–13) and the absence of caulocystidia (Li et al. 2022b). Additionally, *Co. aurantiobasalis* Desjardin & E. Horak is another similar species in morphology but differs by the smaller basidiospores (6–7.5 × 3–3.5 μm) and a pileipellis of subhymeniform that is made up of clavate to irregular, sometimes lobed, cells with dense diverticula (Desjardin & Horak 1997).

Gymnopus conifericola J.P. Li, Chang–Tian Li & Y. Li, sp. nov. Figs 8–9

Fungal names: FN571835; Facesoffungi number: FoF15518

Etymology – The specific name "*conifericola*" (Lat.) refers to the mushroom growth on the coniferous substrate.

Typification – CHINA. Yunnan Province, Deqin County, Diqing Tibetan Autonomous Prefecture, 28° 18' 29" N, 99° 7' 49" E, elev., 3616 m, 03 August 2022, J.P. Li, LJP1504, (HMJAU 60414, holotype).

Diagnosis – Similar to *G. androsaceus*, but differs by the smaller basidiospores, the presence of pleurocystidia and the differences in ITS sequence (with up to 95.80% similarity, PP151543 vs KY026749).

Description – *Basidiomata* marasmioid. *Pileus* up to 6.5 mm diam, membranous, hemispherical when very young, then convex to plano–convex with age, deeply depressed, broadly umbonate or umbilicate at the disc, dry, slightly sulcate at the margin, almost brownish orange (7C4) overall, often darker at disc, brownish orange to brown (7C6–7E8). *Lamellae* distant, L = 10–16, l = 1–2, adnate, sometimes attached to a pseudocollarium, greyish orange (6B3). *Stipe* up to 24 mm long, centrally attached and instititious, terete, filiform, dry, glabrous, almost dark brown (7F8) overall, lighter in colour at the upper part, gradually transitioning to reddish–white (7A2) towards the apex. *Rhizomorphs* present, blackish, shiny, simple, or branched, repent. *Odour* negligible.

Figure 6 – Basidiomata of *Gymnopus brunneostipitatus* (HMJAU 60412). Image credit goes to Ji–Peng Li.

Basidiospores [n = 40] (5.9–)6.1–7.7(–10.2) × (3.4–)3.7–4.8(–4.9) µm (average = 6.8 × 4.1 µm, E = (1.40–)1.44–1.89(–2.55), Q = 1.67), ellipsoid to oblong. *Basidia* [n = 10] 19.4–25.2 × 6.1–8.2 µm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 18.4–24.3 × 5.2–7.8 µm, clavate, cylindrical. *Cheilocystidia* [n = 10] 12.9–24.1 × 5.5–8.6 µm, irregularly clavate, often mostly as *Siccus*-type broom cells, sometimes only lobed or with more or less finger-like projections aside.

Pleurocystidia [n = 10] 21–26.4 × 4.6–6.6 μm, fusiform to fusiform–mammilate. *Pileipellis*, a cutis, composed of cylindrical hyphae, thin-walled, incrusted, intertwined, hyaline; terminal cells more or less diverticulate, of *Siccus*–type broom cells, mixed with some coralloid structure. *Stipitipellis*, a cutis, composed of cylindrical, thin-walled, hyaline, parallel–arranged hyphae, some dextrinoid, smooth. *Caulocystidia* not observed. *Clamp connections* present.

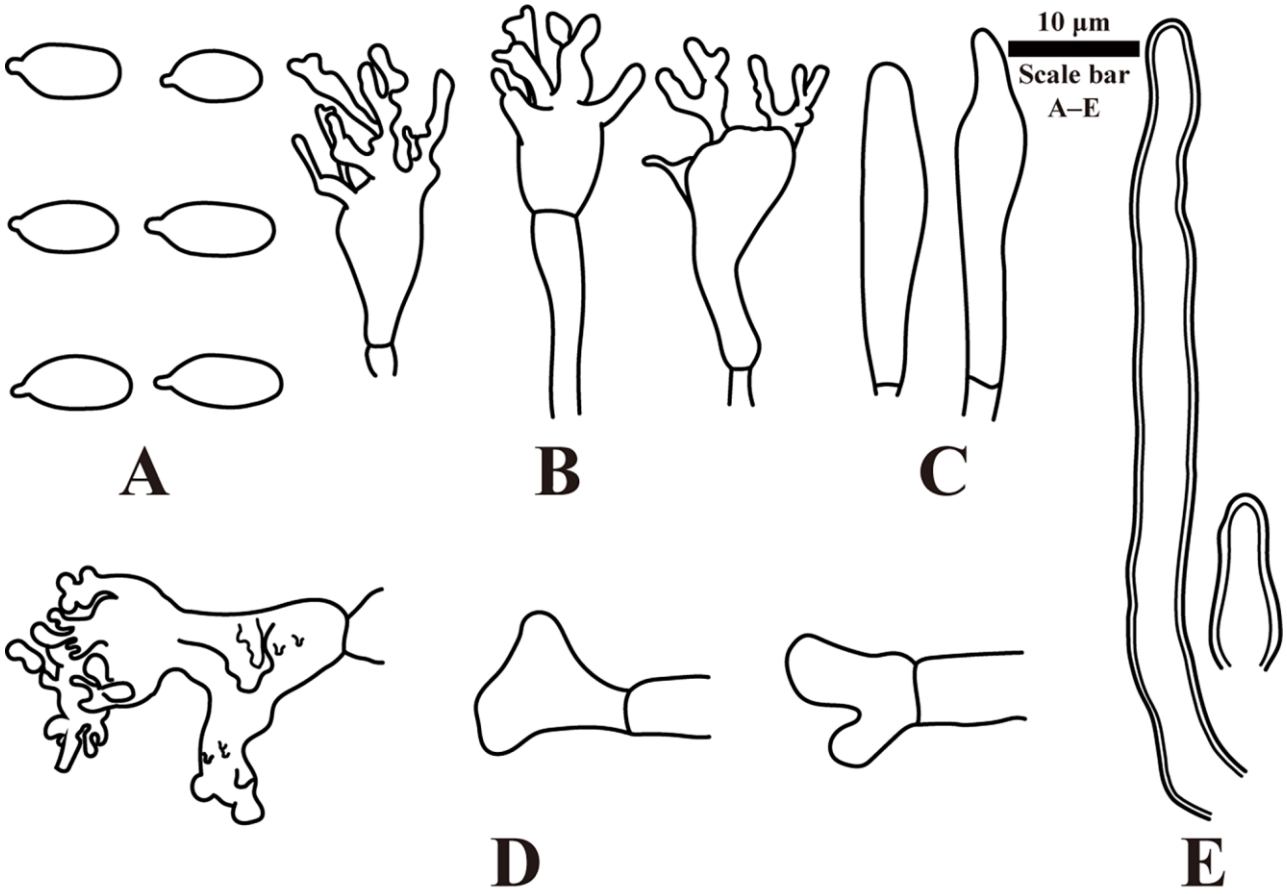

Figure 7 – Microscopic features of *Gymnopus brunneostipitatus* (HMJAU 60412, holotype). A Basidiospores. B Cheilocystidia. C Pleurocystidia. D Pileipellis terminal cells. E Caulocystidia. Scale bars = 10 μm. Image credit goes to Ji–Peng Li.

Ecology – Saprotrophic, gregarious, currently known to arise on dead needles.

Additional material studied – CHINA. Yunnan Province, Deqin County, Diqing Tibetan Autonomous Prefecture, 28° 18' 29" N, 99° 7' 49" E, elev., 3615 m, 03 August 2022, J.P. Li, LJP1503 (HMJAU 60413).

Notes – The brownish pileus and long blackish stipe recall *G. androsaceus* in the field. However, it differs from the new species by having larger basidiospores (7.0–9.0 × 3.5–4.5 μm), the absence of pleurocystidia, and at least a 4% difference in the ITS sequence compared to similar sequences in the GenBank database (Antonín & Noordeloos 2010). Phylogenetically, the new species is close to a species, *G. pallipes*, also originally described from China. However, it is distinctly different from the new species in morphology, characterized by a yellowish stipe, rhizomorphs, and the pileipellis that lacks broom cells (Li et al. 2021b).

Gymnopus* sect. *Impudicae (Antonín & Noordel.) Antonín & Noordel., A monograph of marasmioid and collybioid fungi in Europe (Eching): 222 (2010)

Type species – *Gymnopus impudicus* (Fr.) Antonín, Halling & Noordel.

Notes – This section is supported both morphologically and phylogenetically, and is characterized by collybioid or marasmioid basidiomata with a strong garlic–like odour,

cheilocystidia that are often inconspicuous, and a pileipellis composed of diverticulate cells but never forming *Dryophila*–type cells (Antonín & Noordeloos 2010).

Figure 8 – Basidiomata of *Gymnopus conifericola* (HMJAU 60413). Image credit goes to Ji–Peng Li.

Gymnopus chowii J.P. Li, Chang–Tian Li & Y. Li, sp. nov. Figs 10–11

Fungal names: FN571831; Facesoffungi number: FoF15521

Etymology – The specific epithet "*chowii*" is dedicated in honor of Chung–Hwang Chow (Zong–Huang Zhou) in recognition of his contributions to mycology, because the mushroom's discovery in proximity to a statue of the mycologist Chung–Hwang Chow (Zong–Huang Zhou).

Typification – CHINA. Jilin Province, Changchun City, Jilin Agricultural University, in the green space opposite Zong–Huang Zhou's (Chung–Hwang Chow) statue, 43° 48' 47" N, 125° 24' 43" E, elev., 223 m, 10 July 2023, M.C. Pan & J.P. Li, PMC581 (HMJAU 60415, holotype).

Diagnosis – Similar to *G. variicolor*, but differs by its narrower spores (Q = 2.11) and a significantly different ITS sequence (with up to 94.30% similarity, PP151495 vs KX926134).

Description – *Basidiomata* gymnopoid. *Pileus* 16.5–32.5 mm diam, relatively fleshy, convex, plano–convex to applanate, slightly to deeply depressed at the centre, occasionally rugose somewhere, with deflexed to reflexed, finally more or less undulate margin, dry, slightly sulcate at margin, reddish brown (8E8) at disc when young, pale red (7A3) to pastel red (7A4) paler near the margin zone, mostly brown (7D7/7E7) overall when mature, somewhat paler somewhere. *Lamellae* close, L = 17–23, l = 4, up to 2 mm broad, adnate, reddish white (7A2). *Stipe* 37–55 mm long, 2–3.5 mm thick at the apex, 1–2 mm thick at the base, centrally attached, cylindrical, sometimes slightly enlarged at apex or base, or tapering towards base forming a reduced pseudorrhiza, relatively fibrillose–sulcate lengthwise, solid, gradually deepening in colour from reddish white (7A2) at apex to reddish brown (8E8) towards base, becoming almost black at the pseudorrhiza. *Odour* distinct, rotten cabbage–like.

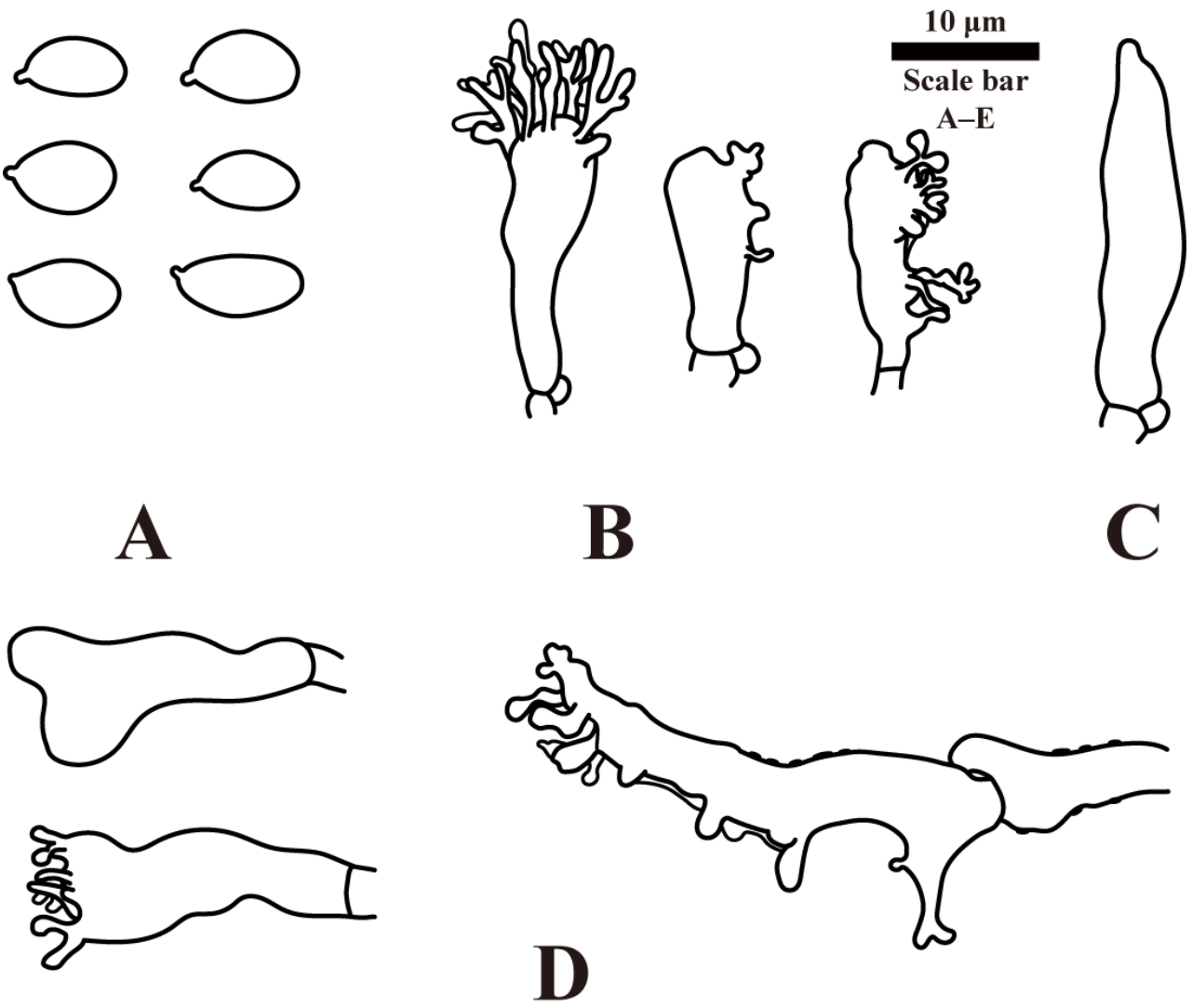

Figure 9 – Microscopic features of *Gymnopus conifericola* (HMJAU 60414, holotype). A Basidiospores. B Cheilocystidia. C Pleurocystidia. D Pileipellis terminal cells. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Basidiospores [n = 40] (5.8–)6.1–7.2(–8.4) × (2.7–)2.8–3.6(–3.8) µm (average = 6.6 × 3.1 µm, E = (1.75–)1.80–2.38(–2.56), Q = 2.11), oblong to cylindric. *Basidia* [n = 10] 21.1–25.8 × 5.5–6.5 µm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 17.2–26.1 × 4.5–6.4 µm, clavate, cylindrical. *Cheilocystidia* [n = 10] 12.2–25.7 × 3.6–5.5 µm, irregularly cylindrical or irregularly clavate, lobed or with more or less projections. *Pileipellis* a cutis, composed of cylindrical hyphae, thin-walled, slightly incrusted, parallel–arranged, hyaline; terminal cells often more or less diverticulate, cylindrical or coralloid–like, brownish in KOH. *Stipitipellis* a cutis, composed of cylindrical, thin-walled, slightly incrusted, hyaline, parallel–arranged hyphae, brownish in KOH. *Caulocystidia* [n = 10] 16.7–56.8 × 4.3–6.6 µm, irregular cylindrical, sometimes with apical flagelliform. *Clamp connections* present in all tissues.

Ecology – Saprotrophic, gregarious, arise on the humus layer beneath mixed coniferous and broadleaf trees.

Additional material studied – CHINA. Jilin Province, Changchun City, Jilin Agricultural University, in the green space opposite Zong–Huang Zhou's (Chung–Hwang Chow) statue, 43° 48' 47" N, 125° 24' 43" E, elev., 223 m, 10 July 2023, M.C. Pan & J.P. Li, PMC582, (HMJAU 60416).

Notes – The new species is most closely related to *G. variicolor* Antonín, Ryoo, Ka & Tomšovský, and *G. similis*, morphologically. However, they are different because of the relatively

broader basidiospores (3.2–4.5 μm in width, Q = 1.73) of *G. variicolor*, and the paler basidiomata of the latter one (Ryoo et al. 2016). More than a 5% difference in ITS sequences is noted between the type specimens, with KP336692 (type specimen of *G. similis*, BRNM 766739) showing 94.46% similarity and KX926134 (type specimen of *G. variicolor*, BRNM 781307) showing 94.3% similarity. *Gymnopus fuscus* is close to the new species as sister; however, it is characterized by the relatively closer lamellae spacing (L = 14–30), large and narrow basidiospores (7.2 × 2.8 μm, Q = 2.55) and some structure turn green in KOH (in this study, see below). *Gymnopus bunerensis* Ishaq, M, Fiaz, M & Khalid, another molecularly closely related species, has rather small basidiospores (4.9 × 3.1 μm) and grows on branches or leaves of *Pinus roxburghii* (Manawasinghe et al. 2022).

Figure 10 – Basidiomata of *Gymnopus chowii* (HMJAU 60415, holotype). Image credit goes to Mei–Chen Pan & Ji–Peng Li.

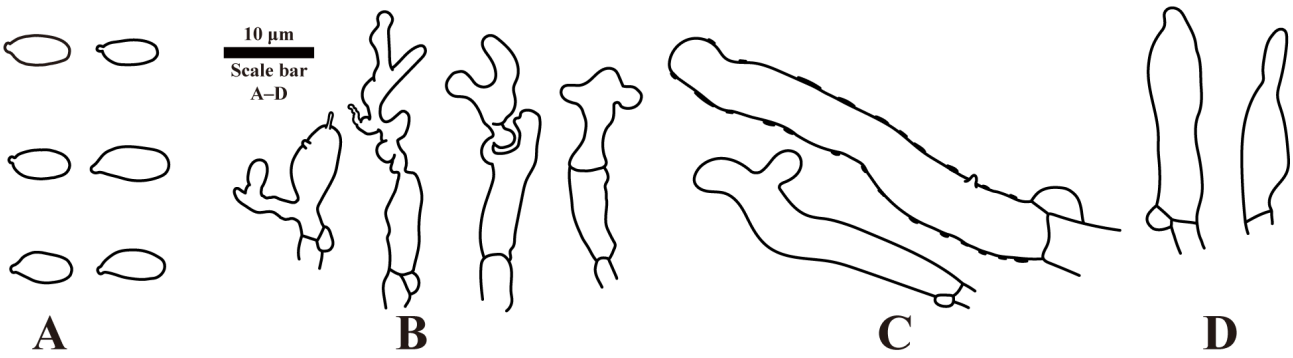

Figure 11 – Microscopic features of *Gymnopus chowii* (HMJAU 60415, holotype). A Basidiospores. B Cheilocystidia. C Pileipellis terminal cells. D Caulocystidia. Scale bars = 10 μm. Image credit goes to Ji–Peng Li.

Gymnopus fuscus J.P. Li, T.H. Li & Y. Li, sp. nov. Figs 12–13

Fungal names: FN571829; Facesoffungi number: FoF15519

Etymology – The specific name "*fuscus*" is derived from Latin, meaning 'dark brown', referring to the dark brown colour of the pileus surface.

Typification – CHINA. Qinghai Province, Guoluo Tibetan Autonomous Prefecture, Maqin County, 34° 16' 39" N, 99° 31' 15" E, elev., 4069 m, 1 June 2011, M. Zhang, J. Xu (GDGM 28929, holotype).

Diagnosis – Similar to *G. alkalivirens*, but differs by larger basidiospores (6.5–8.2 × 2.6–3.2 μm) and non *Dryophila*–type pileipellis.

Description – *Basidiomata* gymnopoid. *Pileus* 8–20 mm diam when dry, convex, plano-convex to applanate, often distinctly umbonate at the disc, sometimes with slightly papilla or depression at the disc, glabrous, occasionally stiate at the margin and very short, dark brown (7F7), paler at centre or margin, greyish red (7B4) to brown (7E8). *Lamellae* subcrowded, L = 24–30, l = 2–5, free, adnate, ventricose, greyish red (7B4) to brownish orange (7C6). *Stipe* 10–25 mm long when dry, 1–3 mm when dry, centrally attached, sometimes grooved lengthwise, cylindrical, sometimes slightly broadened or compressed at apex and tapering towards base, dry, possibly glabrous, greyish red (7B4) to dark brown (7F8). *Odour* not recorded.

Basidiospores [n = 40] (6.3–)6.5–8.2(–8.3) × (2.5–)2.6–3.2 μm (average = 7.2 × 2.8 μm, E = (2.24–)2.29–2.92(–3.06), Q = 2.55), cylindric. *Basidia* [n = 10] 21.9–26.8 × 5.1–6.4 μm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 20.0–27.5 × 4.4–7.0 μm, clavate, cylindrical, turning green in KOH. *Cheilocystidia* [n = 10] 14.8–26 × 2.3–3.9 μm, irregularly cylindrical or narrowly clavate, often with finger-like apical projections, sometimes apically forked, turning green in KOH. *Pleurocystidia* absent. *Pileipellis* a cutis, composed of cylindrical hyphae, thin-walled, incrusted, intertwined, and hyaline; terminal cells often more or less diverticulate, lobed to irregularly branched to form a coralloid structure, turning green in KOH. *Stipitipellis* a cutis, composed of cylindrical, thin-walled, hyaline, parallel–arranged hyphae, turning green in KOH. *Caulocystidia* not observed. *Clamp connections* present in all tissues.

Ecology – Saprotrophic, gregarious, arising on humus.

Additional material studied – CHINA. Qinghai Province, Guoluo Tibetan Autonomous Prefecture, Maqin County, 34° 16' 39" N, 99° 31' 15" E, elev., 4069 m, 1 June 2011, *M. Zhang, J. Xu* (GDGM 28927).

Notes – This species was initially described in the Master's thesis of Ji–Peng Li but was not officially published (Li 2020). The microscopic structures of collections were reobserved except for the pileipellis in this study. Phylogenetic results suggest that this species is a member of the *G.* sect. *Impudicae*, although the character of odour was absent in the field notes. The new species is similar to *G. alkalivirens* and *G. fuscopurpureus* in morphology. The two species can be easily distinguished by their *Dryophila*–type pileipellis, with the former having smaller basidiospores (5.4–6.5 × 2.6–3.2 μm) and the latter featuring a densely tomentose stipe and abundant caulocystidia (Halling 1979, 1981, Antonín & Noordeloos 2010). The new species is very close to *G. bunerensis* in phylogeny; however, the species from Pakistan has rather small basidospores (4.9 × 3.1 μm) and 2–4-spored basidia (Manawasinghe et al. 2022).

Gymnopus niveus J.P. Li, T.H. Li & Y. Li, sp. nov. Figs 14–15

Fungal names: FN571830; Facesoffungi number: FoF 15520

Etymology – The specific epithet "*niveus*" is derived from Latin, meaning "snowy" or "resembling snow", referring to the almost entirely white basidiomata of the mushroom.

Typification – CHINA. Hunan Province, Chenzhou City, Mangshan National Forest Park, latitude and longitude not recorded, elev., 1000 m, 30 July 2017, *H. Huang*, (GDGM 70487, holotype).

Diagnosis – Similar to *G. alliifoetidissimus*, but differs by its rugose pileus and trichoderm–type pileipellis.

Figure 12 – Basidiomata of *Gymnopus fuscus* (GDGM 28929, holotype). Image credit goes to Zheng–Duan Xiao.

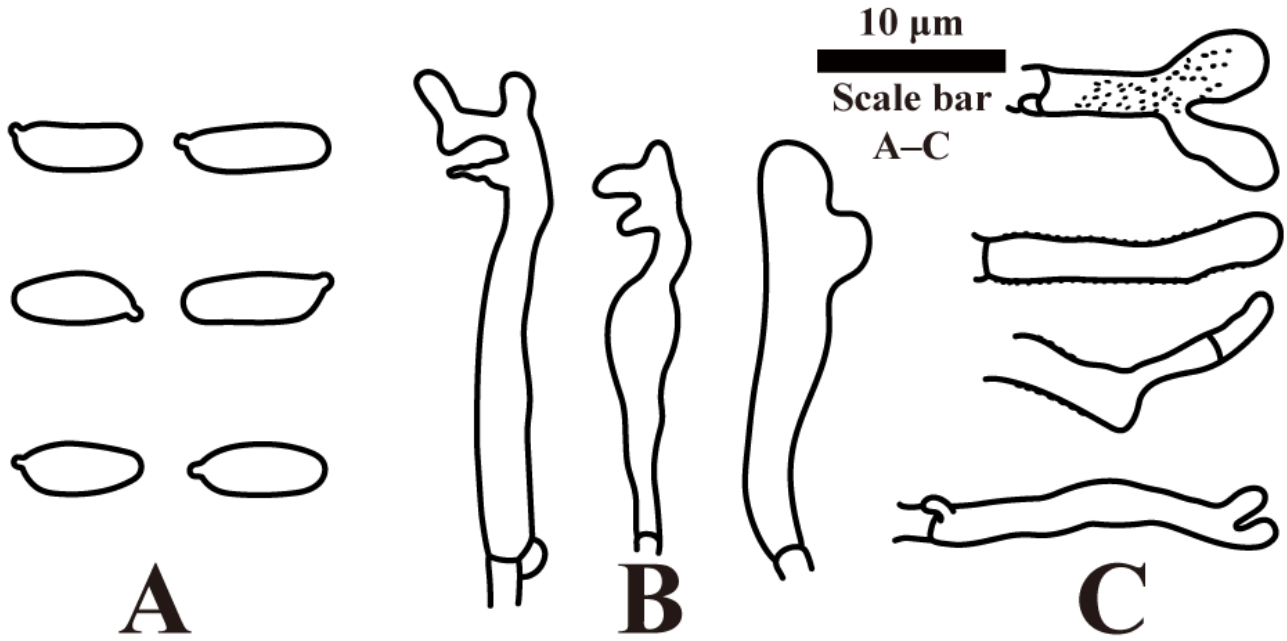

Figure 13 – Microscopic features of *Gymnopus fuscus* (GDGM 28929, holotype). A Basidiospores. B Cheilocystidia. C Pileipellis terminal cells. Scale bars = 10 μm. Image credit goes to Ji–Peng Li.

Description – *Basidiomata* marasmioid. *Pileus* 4–11 mm diam, membranous, hemispherical when young, smooth, then convex to plano-convex, often slightly depressed or umbilicate at disc,

sulcate to deeply sulcate towards margin, rugose somewhere, expanding to applanate at maturity, radially sulcate from centre towards margin, rugose, slightly depressed to depressed at disc, margin deflexed to reflexed, dry, whitish overall when young, then greyish yellow (3C3) at disc, sometimes with more or less greyish yellow (3C3) tint somewhere or entire. *Lamellae* close, L = 10–19, l = 1–3, adnate, sometimes attached to a pseudocollarium, occasionally venose, white, sometimes with a slightly tinge of pale yellow (3A2). *Stipe* 5–10 mm long, centrally attached, instititious, apically broadened, tapering downward, white pruinose, white, darkening at base ranging from pale yellow (3A2), olive yellow (3C8) to brown (6E6) with age. *Odour* not recorded.

Basidiospores [n = 40] (5.9–)6.1–7.7(–8.3) × 2.9–3.9 μm (average = 6.9 × 3.2 μm, E = (1.83–)1.87–2.39(–2.48), Q = 2.13), oblong to cylindric, thin-walled, hyaline. *Basidia* [n = 10] 19.0–33.8 × 4.6–5.9 μm, 4-spored, clavate, cylindrical, thin-walled, hyaline. *Basidioles* [n = 10] 20.6–34.7 × 4.4–6.1 μm, clavate, cylindrical, thin-walled, hyaline. *Cheilocystidia* [n = 10] 13.5–28.9 × 2.9–4.5 μm, irregularly fusiform to irregularly clavate, sometimes forked at the upper part, with finger-like apical projections. *Pleurocystidia* [n = 10] 21.0–31.1 × 3.8–5.0 μm, fusiform to fusiform–mammilate. *Pileipellis* a trichoderm composed of cylindrical hyphae, thin-walled, diverticulate, intertwined, hyaline; terminal cells cylindrical to irregular cylindrical, diverticulate, slightly lobed forming a coralloid structure. *Stipitipellis* a cutis composed of cylindrical, thin-walled, hyaline, parallel–arranged hyphae. *Caulocystidia* [n = 10] 15.6–67.7 × 4.6–6.0 μm, cylindrical to irregular cylindrical, sometimes forked or slightly lobed. *Clamp connections* present in all tissues.

Ecology – Saprotrophic, gregarious, arising on dead twigs or branches in broadleaf forests.

Figure 14 – Basidiomata of *Gymnopus niveus* (GDGM 70487, holotype). Image credit goes to Tai–Hui Li.

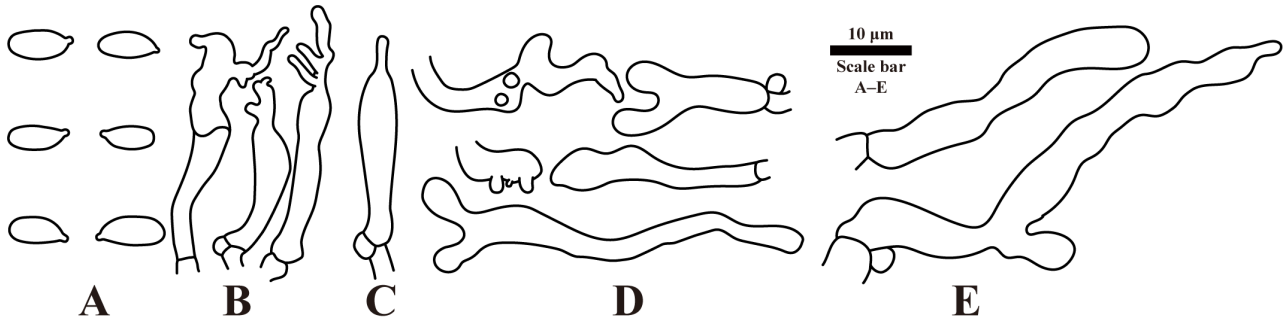

Figure 15 – Microscopic features of *Gymnopus niveus* (GDGM 70487, holotype). A Basidiospores. B Cheilocystidia. C Pleurocystidia. D Pileipellis terminal cells. E. Caulocystidia. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Additional materials studied – CHINA. Hunan Province, Chenzhou City, Mangshan National Forest Park, latitude and longitude not recorded, elev., 1000 m, 30 July 2017, H. Huang, (GDGM 70488). Guangdong Province, Xinyi City, Yunkaishan National Nature Reserve, latitude and longitude not recorded, elev., not recorded, 29 May 2019, B. Song, J.P. Li & H.S. Wen (GDGM 76400). Guangdong Province, Xinyi City, Yunkaishan National Nature Reserve, latitude and longitude not recorded, elev., not recorded, 25 July 2019, B. Song, J.P. Li & H.S. Wen (GDGM 77044).

Notes – This species was initially described in the Master's thesis of Ji–Peng Li but was not officially published (Li 2020). The microscopic structures of collections were observed in this study. Phylogenetic results suggest that this species is a member of the *G.* sect. *Impudicae*, although the odour was absent in the field notes. The white basidiomata of the new species is easily confused with *G. alliifoetidissimus* in the field. However, it is different from the new species by having a hardly non-rugose pileus and a cutis type–pileipellis (Li et al. 2021a).

Gymnopus tianbaoyanensis J.P. Li, Chang–Tian Li & Y. Li, sp. nov. Figs 16–17

Fungal names: FN571845; Facesoffungi number: FoF15522

Etymology – refers to the location, Tianbaoyan National Nature Reserve, Yong'an City, Fujian Province, China, where the holotype was collected.

Typification – CHINA. Fujian Province, Yong'an City, Tianbaoyan National Nature Reserve, latitude and longitude not recorded, elev., 1400 m, 24 September 2023, J.P. Liao, H.X. Luo, TBYLJP5165 (HMJAU 60417, holotype).

Diagnosis – Similar to *G. brassicolens*, but differs by small pileus/stipe ratio, smaller basidiospores (5.5–6.8 × 2.9–3.5), and a significantly different ITS sequence (with similarity of 96.18% to Austrian material, DQ449991).

Description – *Basidiomata* gymnopoid. *Pileus* 10–28 mm diam, relatively fleshy, hemispherical to convex when young, finally plano-convex to applanate when mature, rounded to plane, sometimes slightly depressed at the disc, more or less finely rugose near the margin zone, sometimes with small, with deflexed to reflexed, finally more or less undulate margin, dry, hygrophanous, radially sulcate–striate at the margin, almost greyish orange (6B6) overall, sometimes deepening to rust brown (6E8) at centre, paler near margin, ranging from orange white (6A2) to nearly white. *Lamellae* slightly crowded, L = 28–36, l = 4–5, up to 1 mm broad, free or narrowly adnate, whitish. *Stipe* 14–70 mm long, 1.5–5.5 mm thick at the apex, 1–3 mm thick at the base, centrally attached, cylindrical, enlarged and more or less compressed at apex, usually tapering at base, fibrillose, covered with finely white pruinose, whitish to greyish orange (6B3) at the upper part, paler towards the apex, progressively darkening towards the base to almost black. *Odour* distinct, rotten cabbage-like.

Basidiospores [n = 40] (5.4–)5.5–6.8(–7.5) × (2.8–)2.9–(3.4–)3.5 µm (average = 6.2 × 3.1 µm, E = (1.78–)1.82–2.15(–2.16), Q = 1.98), oblong to cylindric. *Basidia* [n = 10] 22.6–27.6 × 5.0–

6.0 μm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 15.8–24.5 × 4.1–5.6 μm, clavate, cylindrical. *Cheilocystidia* [n = 20] 12.9–26.6 × 3.1–7.6 μm, irregularly clavate, slightly lobed to forming coralloid–like shape, or with one or more bladder–like or finger-like apical projections, or with a narrowly flagelliform outgrowth at apex. *Pileipellis* a cutis, composed of cylindrical hyphae, thin-walled, incrusted, parallel–arranged, hyaline; terminal cells often more or less diverticulate, cylindrical, mixed with some coralloid structure. *Stipitipellis* a cutis, composed of cylindrical, thin-walled, hyaline, incrusted, parallel–arranged hyphae, dark brown pigment. *Caulocystidia* [n = 10] 16.2–44.4 × 4.9–7.3 μm, irregularly clavate, often tapering towards the apex to form a rostrate–like projection. *Clamp connections* present in all tissues.

Ecology – Saprotrophic, cespitose, beneath a mixed forest of broadleaf and coniferous trees.

Additional materials studied – CHINA. Guizhou Province, Qiannan Buyi and Miao Autonomous Prefecture, Longli Country, latitude and longitude not recorded, elevation not recorded, 12 June 2022, J.P. Li, LJP1101 (HMJAU 60418). Guizhou Province, Qiannan Buyi and Miao Autonomous Prefecture, Longli Country, latitude and longitude not recorded, elevation not recorded, 12 June 2022, J.P. Li, LJP1102 (HMJAU 60419). Fujian Province, Yong'an City, Fujian Tianbaoyan National Nature Reserve, latitude and longitude not recorded, elev., 1400 m, 24 September 2023, J.P. Liao, H.X. Luo, TBYLJP5091 (HMJAU 60449).

Notes – This species is very close to *G. brassicolens* in morphology and phylogeny. However, the European and North African species have quite different ITS sequences (reference sequence from Austrian material: DQ449991 with similarity of 96.18%), larger pileus/stipe ratio (obviously larger pileus in size of 15–45 mm, but similar sized stipe of 15–75 mm long) and relatively long basidiospores of 5.5–7.5 × 2.5–4.0 μm (Antonín & Noordeloos 2010). Besides, *Co. dichroa* is the morphological species, but it differs in the basidiomata lacking distinct odour and having larger basidiospores of 9.8–11.8 μm (Halling 1983).

Figure 16 – Basidiomata of *Gymnopus tianbaoyanensis* (HMJAU 60449). Image credit goes to Jin–Peng Liao.

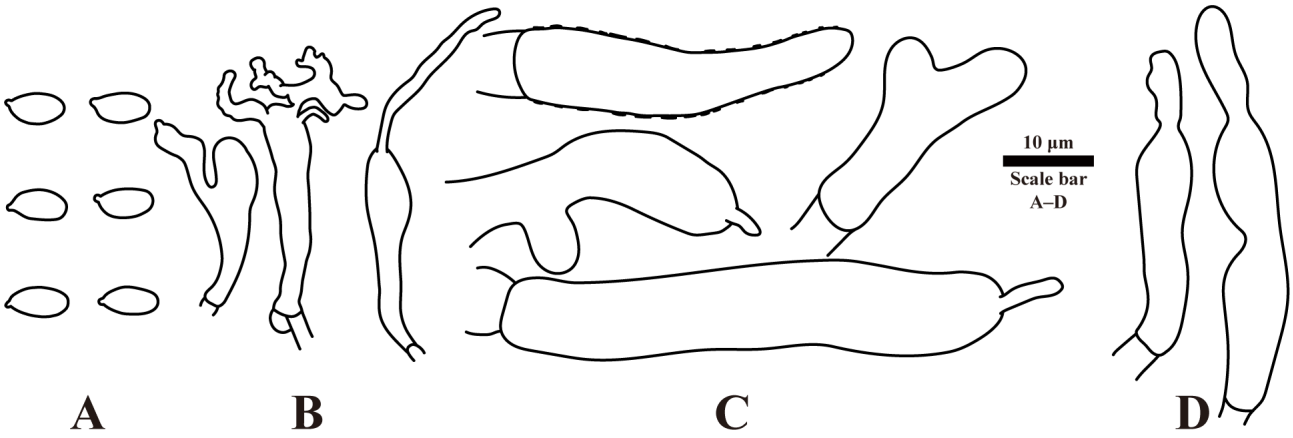

Figure 17 – Microscopic features of *Gymnopus tianbaoyanensis* (HMJAU 60417, holotype). A Basidiospores. B Cheilocystidia. C Pileipellis terminal cells. D Caulocystidia. Scale bars = 10 μm. Image credit goes to Ji–Peng Li.

Gymnopus* sect. *Levipedes (Quél.) Halling, Brittonia 48(4): 487 (1996)

Type species – *Gymnopus dryophilus* (Bull.) Murrill

Notes – This section is supported both morphologically and phylogenetically and is characterized by smooth, polished, or pubescent stipe and *Dryophila*-type pileipellis (Antonín & Noordeloos 2010).

Gymnopus aurantiofuscus J.P. Li, Chang–Tian Li & Chun Y. Deng, sp. nov. Figs 18–19

Fungal names: FN571836; Facesoffungi number: FoF15523

Etymology – The specific name "*aurantiofuscus*" is derived from two Latin words: "*aurantius*", meaning "orange", and "*fuscus*", meaning "dark" or "brown". This name reflects the distinctive colour changes of the fungus, particularly its cap, which transitions from orange–grey to dark brown as it matures.

Typification – CHINA. Guizhou Province, Tongren City, Fanjingshan National Nature Reserve, 27° 54' 23" N, 108° 42' 8" E, elev., 1929 m, 22 April 2020, H. Gao, J. Zhang, Z.Q. Shu, D.J. Ou, 520621MF279 (HGASMF01–7024, holotype).

Diagnosis – Similar to *G. earleae*, *G. semihirtipes* and *G. subsulphureus*, but differs by its pileipellis having pileal hairs.

Description – *Basidiomata* gymonpoid. *Pileus* 27.5–44.5 mm diam, relatively fleshy, hemispherical when very young, then convex, sometimes with slightly depressed centre, then plano-convex, finally becoming applanate when mature, umbilicate or shallowly depressed at the disc, margin often reflexed, dry, hygrophanous, translucently striate at the margin, orange grey (5B2) varying in depth at the disc and dark brown (7F8/8F8) otherwise when very young, then gradually fading towards the margin to become orange grey (5B2) to greyish orange (5B3) mostly overall, finally dark brown (7F8/8F8) or shallowly paler at disc and gradually fading towards margin to almost orange white (5A2). *Lamellae* crowded, L = 35–44, l = 5–7, emarginate, whitish to orange white (5A2). *Stipe* 20–59 mm long, 2.5–5 mm thick in middle, centrally attached, cylindrical, broadened and occasionally compressed at apex, smooth or grooved lengthwise, often twist with a broadened base, dry, covered with scattered white hairs, hollow, pale orange (5A3) when young, darken downward to greyish orange (5B6) or light brown (6D6) when mature. *Odour* negligible.

Basidiospores [n = 40] (5.0–)5.2–6.5(–7.0) × 3.0–3.8(–4.2) μm (average = 5.9 × 3.4 μm, E = (1.56–)1.58–1.97(–2.05), Q = 1.74), ellipsoid to oblong. *Basidia* [n = 10] 18.7–25 × 6.1–7.4 μm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 18.4–22.4 × 4.5–7.6 μm, clavate, cylindrical. *Cheilocystidia* [n = 10] 13.3–31.1 × 3.6–10.6 μm, irregularly clavate, lobed. *Pleurocystidia* [n = 10]

17.1–26.5 × 4.1–6.5 μm, fusiform. *Pileipellis* a cutis, of *Dryophila*–structure, thin–walled, some hyphae incrusted, intertwined, hyaline, terminal cells with one end extending into erect, cylindrical cystidia–like projections forming pileal hairs. *Stipitipellis* a cutis, composed of cylindrical, thin–walled, hyaline, parallel–arranged hyphae, with scattered diverticula. *Caulocystidia* absent. *Clamp connections* present in all tissues.

Ecology – Saprotrophic, gregarious, arising on humus, dead twigs, or branches in broadleaf forests.

Additional materials studied – CHINA. Guizhou Province, Tongren City, Fanjingshan National Nature Reserve, 27° 53' 58" N, 108° 42' 27" E, elev., 1627 m, 22 April 2022, H. Gao, J. Zhang, Z.Q. Shu, D.J. Ou, 520621MF296–6 (HGASMF01–7006). Guizhou Province, Tongren City, Fanjingshan National Nature Reserve 27° 54' 49" N, 108° 38' 29" E, elev., 1477 m, 29 May 2022, H. Gao, J. Zhang, Z.Q. Shu, W.J. Luo, 520625MF325–12 (HGASMF01–7961). Guizhou Province, Tongren City, Fanjingshan National Nature Reserve, 27° 53' 59" N, 108° 42' 16" E, elev., 1718 m, 22 April 2022, H. Gao, J. Zhang, Z.Q. Shu, D.J. Ou, 520621MF294 (HGASMF01–7009). Guizhou Province, Tongren City, Fanjingshan National Nature Reserve, 27° 54' 8" N, 108° 42' 13" E, elev., 1756 m, 22 April 2022, H. Gao, J. Zhang, Z.Q. Shu, D.J. Ou, 520621MF283 (HGASMF01–7019). Guizhou Province, Tongren City, Yinjiang Tujia and Miao Autonomous County, 27° 54' 43" N, 108° 39' 23" E, elev., 1926 m, 30 May 2022, H. Gao, J. Zhang, W.J. Luo, Z.Q. Shu, 520625MF331–14 (HGASMF01–7957). Guizhou Province, Tongren City, Fanjingshan National Nature Reserve, 27° 54' 0" N, 108° 42' 15" E, elev., 1709 m, 27 May 2022, H. Gao, J. Zhang, W.J. Luo, Z.Q. Shu, 520621MF522–5 (HGASMF01–8120).

Figure 18 – Basidiomata of *Gymnopus aurantiofuscus* (HGASMF01–7024, holotype). Image credit goes to Chun–Ying Deng.

Notes – Several species originally described in the USA morphologically resemble the new species. *Gymnopus earleae* Murrill differs by having a non–striate pileus, cheilocystidia that are often absent or rarely present and rarely diverticulate, and a pileipellis without pileal hairs (Halling

1983). *Gymnopus semihirtipes* is distinguished by its larger basidiospores (7.5–8.6(–9.8) × 3.2–4.2(–5.0) μm), the absence of hymenial cystidia and pileal hairs (Halling 1983). *Gymnopus subsulphureus* (Peck) Murrill is different due to the absence of pileal hairs (Vilgalys & Miller 1983).

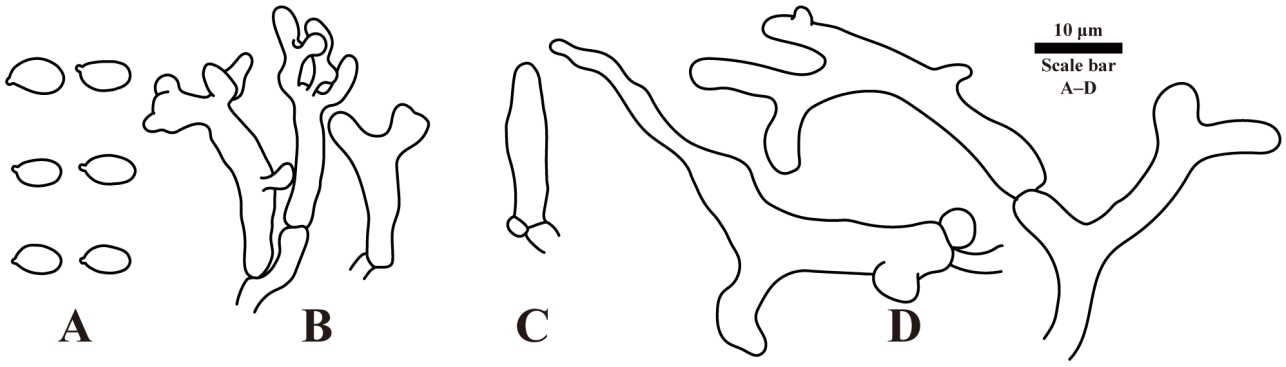

Figure 19 – Microscopic features of *Gymnopus aurantiofuscus* (HGASMF01–7024, holotype). A Basidiospores. B Cheilocystidia. C Caulocystidia. D Pileipellis terminal cells. Scale bars = 10 μm. Image credit goes to Ji–Peng Li.

Gymnopus stipitovirens J.P. Li, Chang–Tian Li & Antonín sp. nov. Figs 20–21

Fungal names: FN571846; Facesoffungi number: FoF15524

Etymology – "*stipitovirens*" from the Latin "*stipitatus*" (refers to stipe) and "*virens*" (turning green), indicating the stipe turns green in KOH.

Typification – CHINA. Hunan Province, Zhangjiajie City, near Wulingyuan Scenic and Historic Interest Area, 29° 17' 33" N, 110° 26' 13" E, elev., 651 m, 27 June 2022, J.Y. Yao, YJY231 (HMJAU 60420, holotype).

Diagnosis – Similar to *G. aurantiofuscus*, but differs by the stipitipellis turn green in KOH.

Description – *Basidiomata* gymnopoid. *Pileus* 14.5–43 mm diam, relatively fleshy, hemispherical when very young, then convex, depressed or umbilicate at disc, becoming plano–convex to applanate with age, depressed to umbilicate at disc, with deflexed to reflexed, finally more or less undulate margin, dry, slightly translucently striate at margin, then sulcate when old, reddish brown (8D7–8) overall when very young, then fading to light orange (6A4) with age, finally dull white overall tinged with orange white (6A2) tint when mature. *Lamellae* relatively crowded, L = 40–54, l = 4–6, up to 2 mm broad, adnate, emarginate with slightly decurrent tooth or not, whitish, with reddish brown (8D7–8) tint somewhere when mature. *Stipe* 31–71 mm long, 1–4 mm thick at the middle, centrally attached, cylindrical, tapering at apex when young, broadened at apex and base with age, sometimes compressed at apex, fibrillose, fibrillose–sulcate lengthwise, dry, light orange (6A4) to pastel red (7A4) at upper part, brownish red (8C6) at lower part, reddish brown (8D7) overall when mature, with white hairs at lower part when young, becoming concolor to stipe when mature. *Odour* negligible.

Basidiospores [n = 40] (4.9–)5.1–5.9(–6.1) × (2.4–)2.6–3.1(–3.2) μm (average = 5.5 × 2.8 μm, E = (1.70–)1.77–2.14(–2.34), Q = 1.94), oblong to cylindric. *Basidia* [n = 10] 17.3–21.7 × 4.3–5.8 μm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 17.3–20.7 × 3.7–5.6 μm, clavate, cylindrical. *Cheilocystidia* [n = 10] 17.1–76.7 × 2.2–10.9 μm, irregularly clavate, lobed. *Pleurocystidia* not observed. *Pileipellis* a cutis, composed of cylindrical hyphae, thin-walled, intertwined, hyaline, smooth; terminal cells lobed to irregularly branched forming *Dryophila*–structure. *Stipitipellis* a cutis, composed of cylindrical, thin-walled, hyaline, parallel–arranged hyphae with brownish granules on their walls which become greenish in KOH and eventually dissolve, smooth. *Caulocystidia* [n = 10] more than 98 μm in length, 3.2–6.7 μm in width, abundant, irregularly cylindrical or flexuous, obtuse, greenish in KOH. *Clamp connections* present in all tissues.

Ecology – Saprotrophic, solitary, scattered to gregarious, arising on humus in mixed broadleaf and conifers forests.

Additional materials studied – CHINA. Hunan Province, Zhangjiajie City, near Wulingyuan Scenic and Historic Interest Area, 29° 17' 17" N, 110° 26' 3" E, elev., 687 m, 27 June 2022, B. Song, M.C. Pan, PMC254 (HMJAU 60421). Hunan Province, Zhangjiajie City, near Wulingyuan Scenic and Historic Interest Area, 29° 17' 26" N, 110° 26' 8" E, elev., 699 m, 30 June 2022, F.F. Li, LFF298 (HMJAU 60422). Guizhou Province, Tongren City, Fanjingshan National Nature Reserve, 27° 53' 47" N, 108° 43' 19" E, elev., 1090 m, 20 June 2022, M.C. Pan, PMC109 (HMJAU 60423). Hunan Province, Zhangjiajie City, Wulingyuan Scenic and Historic Interest Area, 29° 21' 27" N, 110° 25' 12" E, elev., 1043 m, 25 June 2022, M.C. Pan, PMC199 (HMJAU 60424). Anhui Province, Shucheng County, Wanfoshan National Forest Park, 31° 2' 26" N, 116° 32' 20" E, elev., 736 m, 7 July 2022, M.C. Pan, PMC301 (HMJAU 60425). Anhui Province, Shucheng County, Wanfoshan National Forest Park, 31° 2' 15" N, 116° 32' 20" E, elev., 756 m, 7 July 2022, J.Y. Yao, YJY275 (HMJAU 60426). Korea. Yangyang County, c. 440 m, 26 June, 2008, Micheongol Natural Resort Forest, V. Antonín, VA 08.29 (BRNM 718669).

Figure 20 – Basidiomata of *Gymnopus stipitovirens* (HMJAU 60426). Image credit goes to Jing–Yue Yao.

Notes – Although Ryoo et al. (2020) described the characteristics of this species, namely '*Gymnopus* sp. 2', they did not officially publish it as a new species due to having only one specimen. Several specimens, conspecific with '*Gymnopus* sp. 2', were found in China and are thus published herein. Many species within the sect. *Levipedes* such as *G. aquosus*, *G. aurantiofuscus*, *G. earleae*, *G. ocior*, *G. semihirtipes* and *G. subsulphureus* are close to the new species. However, the brownish granules present on the stipitipellis of the new species, which turn green when

exposed to KOH, are quite different from the above species (Halling 1983, Vilgalys & Miller 1983, Antonín & Noordeloos 2010). Besides, the fairly crowded lamellae (L = 20–30) and the absence of caulocystidia of *G. aquosus*, the absent caulocystidia of *G. aurantiofuscus*, the narrowly cylindric to flexuously contorted cheilocystidia of *G. earleae*, the lamellae spacing (L = 25–30) and the absent caulocystidia of *G. ocior*, and the larger basidiospores (7.5–8.6(–9.8) × 3.2–4.2(–5.0) μm) and the absent hymenial cystidia of *G. semihirtipes* are distinguished from the new species (Halling 1983, Antonín & Noordeloos 2010).

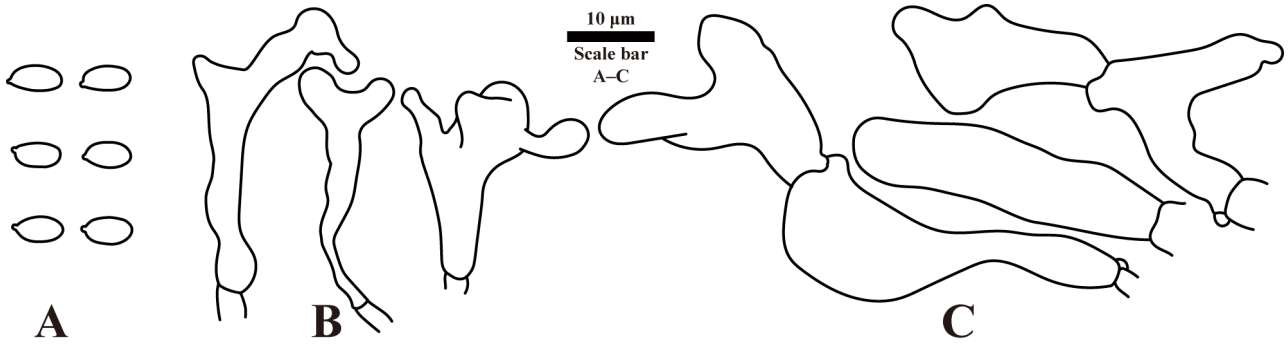

Figure 21 – Microscopic features of *Gymnopus stipitovirens* (HMJAU 60420, holotype). A Basidiospores. B Cheilocystidia. C Pileipellis terminal cells. Scale bars = 10 μm. Image credit goes to Ji–Peng Li.

Gymnopus viridocephalus J.P. Li, Chang–Tian Li & Chun Y. Deng, sp. nov. Figs 22–23

Fungal names: FN571837; Facesoffungi number: FoF15525

Etymology – The specific name "*viridocephalus*" combines "*virido*", from the Latin "*viridis*", meaning green, and "*cephalus*", from the Greek "κεφαλή" (kephalē), meaning head, indicating pileus. It refers to the mushroom having a green pileus in its young stage.

Typification – CHINA. Guizhou Province, Tongren City, Fanjingshan National Nature Reserve, 27° 53' 58" N, 108° 42' 27" E, elev., 1577 m, 22 April 2020, Z.Q. Shu, J. Zhang, H. Gao, D.J. Ou, 520621MF301–6 (HGASMF01–7003, holotype).

Diagnosis – Similar to *G. aquosus*, but differs by more crowded lamellae (L = 42–50) and the presence of caulocystidia.

Description – *Basidiomata* gymnopoid. *Pileus* 20.5–26.5 mm diam, relatively fleshy, convex with rounded umbo at centre or not when young, becoming plano–convex to applanate, slightly umbilicate at the disc or not, dry, translucently striate at the margin, deep green (29E8/30E8) overall tinged with yellowish green tint (30A6) when very young, then transition to straw yellow (3B4), finally olive brown (4D7/4E7) at disc when mature, paler towards margin to yellowish white (4A2). *Lamellae* crowded, L = 42–50, l = 3–7, adnate, emarginate, yellowish white (4A2). *Stipe* 51–68 mm long, 1.8–2.9 mm thick in middle, centrally attached, slightly broadened at the apex, twist and broadened at base, smooth, polished, finely pubescent, hollow, yellowish white (4A2) to greyish yellow (4B5) at upper part, with darken transition towards base then finally light orange (6A4) to gradually pastel red (7A4) at basal part. *Odour* negligible.

Basidiospores [n = 10] (5.4–)5.6–7.5(–8.0) × (2.5–)2.7–3.5(–3.6) μm (average = 6.4 × 3.1 μm, E = (1.83–)1.87–2.28(–2.38), Q = 2.07), oblong to cylindric. *Basidia* [n = 10] 18.8–24.0 × 4.2–6.4 μm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 16.5–23.1 × 4.7–6.1 μm, clavate, cylindrical. *Cheilocystidia* [n = 10] 12.7–53.9 × 3.5–5.8 μm, irregularly clavate, lobed or with rostrate–like apical projections. *Pleurocystidia* [n = 10] 19.8–25.6 × 3.9–5.4 μm, fusiform. *Pileipellis* a cutis, with transition to trichoderm composed of *Dryophila*–structure, thin–walled, intertwined, hyaline; terminal cells with erect hyphal cystidia–like projection sized of 33.9–58.2 × 3.1–4.4 μm (pileal hairs). *Stipitipellis* a cutis, composed of cylindrical, thin–walled, hyaline, parallel–arranged hyphae. *Caulocystidia* [n = 10] 17.4–56.7 × 1.9–4.1 μm, cylindrical. *Clamp connections* present in all tissues.

Figure 22 – Basidiomata of *Gymnopus viridocephalus* (HGASMF01–7003, holotype). Image credit goes to Chun–Ying Deng.

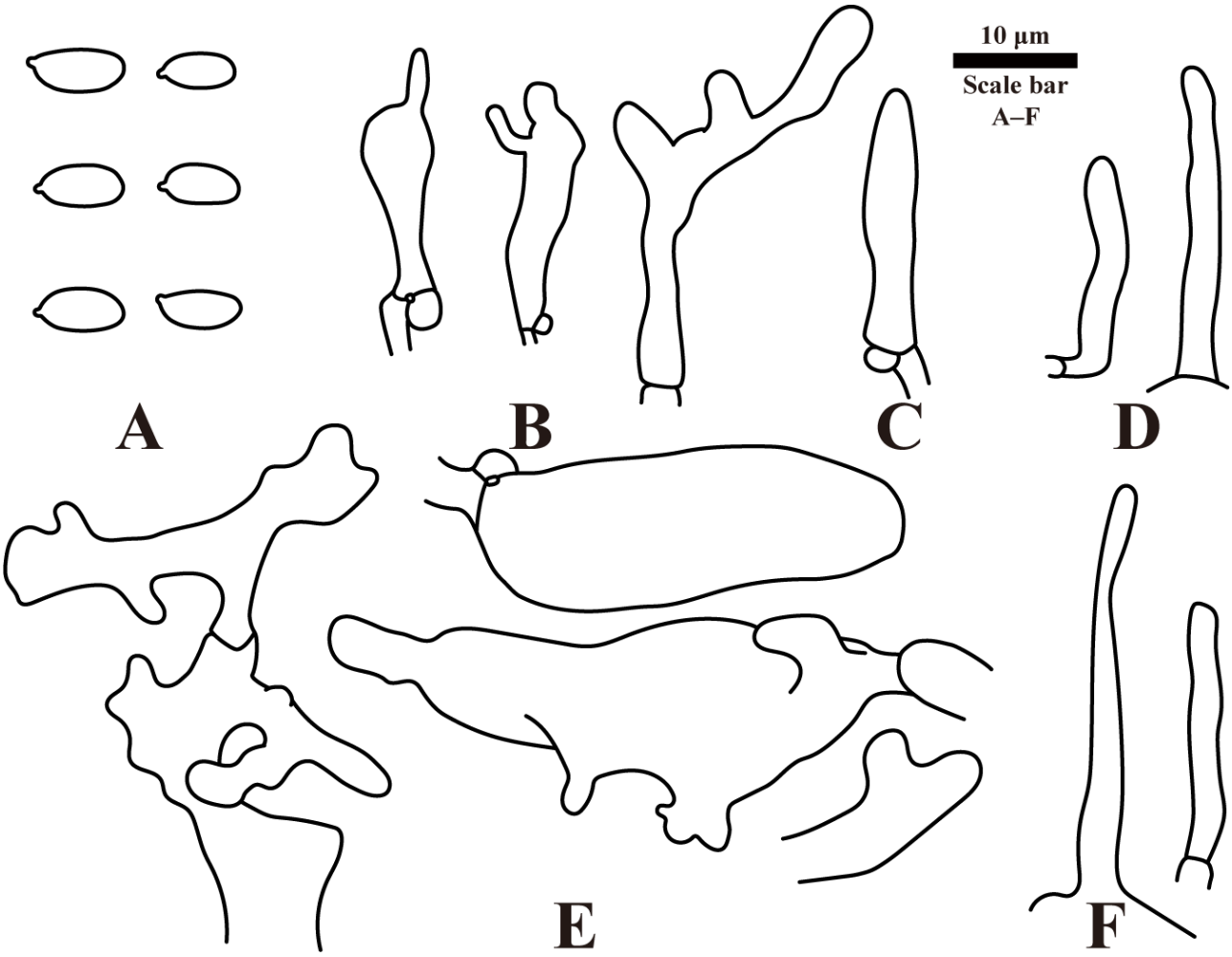

Figure 23 – Microscopic features of *Gymnopus viridocephalus* (HGASMF01–7003, holotype). A Basidiospores. B Cheilocystidia. C Pleurocystidia. D. Caulocystidia. E. Pileipellis terminal cells. F Pileal hairs. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Ecology – Saprotrophic, gregarious on humus in broadleaf forests.

Additional material studied – CHINA. Guizhou Province, Tongren City, Fanjingshan National Nature Reserve, 27° 53' 58" N, 108° 42' 26" E, elev., 1603 m, 22 April 2020, H. Gao, J. Zhang, Z.Q. Shu, D.J. Ou, 520621MF295–6 (HGASMF01–7008).

Notes – Morphologically and also phylogenetically, *G. aquosus*, *G. aurantiofuscus*, *G. ocior*, and *G. stipitovirens* are similar to the new species. However, *G. aquosus* differs by the lamellae spacing (L = 20–30), the absence of caulocystidia, and pileipellis without pileal hairs; *Gymnopus ocior* differs by lamellae spacing (L = 25–30) and the absence of caulocystidia (Antonín & Noordeloos 2010); *Gymnopus aurantiofuscus* differs by ellipsoid to oblong basidiospores (broader, Q = 1.74) and pileipellis without a transition to trichoderm (this study); and *G. stipitovirens* differs by brownish basidiomata and stipitipellis turning green in KOH (this study).

Mycetinis Earle, Bull. New York Bot. Gard. 5: 414 (1909)

Type species – *Mycetinis alliaceus* (Jacq.) Earle ex A.W. Wilson & Desjardin

Spectrum of reported species in China – *Mycetinis alliaceus* (Jacq.) Earle ex A.W. Wilson & Desjardin, *My. scorodonius*, *My. yunnanensis* R.H. Petersen (Institute of Microbiology, Chinese Academy of Sciences 2024, Li et al. 2015, Petersen & Hughes 2017, Zhang et al. 2017).

Notes – A total of three species within the genus were reported in China. The genus is typified by *Marasmius alliaceus* (Jacq.) Fr. (Earle 1909). However, its members were classified in *Marasmius* sect. *Alliacei* for an extended period (Kühner 1936), until Wilson & Desjardin (2005) resurrected and redefined *Mycetinis*.

Mycetinis arbuscularis J.P. Li, Chang–Tian Li & Y. Li, sp. nov. Figs 24–25

Fungal names: FN571832; Facesoffungi number: FoF15526

Etymology – The specific epithet "*arbuscularis*" is derived from the Latin "*arbuscula*", meaning a small tree or shrub. It refers to the mushroom having arbuscular–like cheilocystidia.

Typification – CHINA. Yunnan Province, Dali Bai Autonomous Prefecture, Jianchuan County, 26° 38' 14" N, 99° 46' 11" E, elev., 3480 m, 27 July 2022, J.P. Li LJP1399, (HMJAU 60427, holotype).

Diagnosis – Similar to *My. ignobilis*, but differs by the rather large basidiomata, broader basidiospores, and rather long basidia.

Description – *Basidiomata* pleurotoid. *Pileus* 28–70 mm broad, membranous, hemispherical on side view when very young, gradually expanding to reniform with age, depressed to umbilicate at the area near stipe, radially sulcate towards margin, more or less rugose somewhere, deflexed or reflexed at margin zone, dry, mostly whitish to orange white (6A2) overall, somewhere with a tinge of light orange (6A4) to light brown (6D8) at disc when young, then brownish orange (6C7) overall, somewhere with dark brown (6F8) tint in some place, change paler with age to almost whitish overall, with dark brown (6F8) tint remains. *Lamellae* subclose to close, L = 11–19, l = 3–5, up to 10.5 mm broad, adnate, subdecurrent, whitish, with dark brown (6F8) tint somewhere. *Stipe* 4–9 mm long, 2.5–4 mm thick at the apex, 1–2 mm thick at the base, lateral and reduced, instititious, apically broadened, tapering downward, compressed, sometimes grooved lengthwise, dry, whitish to greyish orange (6B4), with whitish tomentum at the apex. *Rhizomorphs* not observed. *Odour* distinct, garlic-like.

Basidiospores [n = 40] (8.9–)9.8–10.9(–12.2) × 7.6(–7.8)–8.9(–9.3) μm (average = 10.4 × 8.3 μm, E = (1.04–)1.19–1.31(–1.34), Q = 1.24), often broadly ellipsoid, sometimes slightly ellipsoid. *Basidia* [n = 10] 40.5–62.8 × 9.3–11.2 μm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 40.6–66.4 × 7.9–12 μm, clavate, cylindrical. *Cheilocystidia* [n = 10] 20.1–37.7 × 6.2–10.5 μm, irregularly clavate, diverticulate, often bifurcate to stalked forming arbuscular broom cell-like cells. *Pleurocystidia* [n = 10] 38.4–52.8 × 4.9–6.8 μm, fusiform, or mammilate to bifurcate apically. *Pileipellis* a cutis, composed of cylindrical hyphae, thin-walled, slightly incrusted, parallel–arranged, hyaline; terminal cells often more or less diverticulate, lobed to irregularly branched, sometimes cylindrical, mixed with some coralloid structure. *Stipitipellis* a cutis, composed of

cylindrical, thin–walled to slightly thick–walled, hyaline, parallel–arranged hyphae, diverticulate. *Caulocystidia* [n = 4] 33.1–43.7 × 4.2–7.7 μm, irregular cylindrical to fusiform, lobed, or more or less diverticulate. *Clamp connections* present in all tissues.

Ecology – Saprotrophic, scattered to gregarious, arising on dead twigs or branches in broadleaf forests.

Additional materials studied – CHINA. Yunnan Province, Dali Bai Autonomous Prefecture, Jianchuan County, 26° 38' 14" N, 99° 46' 12" E, elev., 3497 m, 27 July 2022, *J.P. Li*, LJP1398 (HMJAU 60450). Yunnan Province, Lijiang City, Yulong Naxi Autonomous County, 26° 38' 58" N, 99° 48' 53" E, elev., 2969 m, 26 July 2022, *J.P. Li*, LJP1363(HMJAU 60428). Yunnan Province, Xianggelila City, Diqing Tibetan Autonomous Prefecture, 27° 20' 46" N, 99° 53' 33" E, elev., 3060 m, 31 July 2022, *M.C. Pan*, PMC421 (HMJAU 60429).

Notes – Among the known species within *Mycetinis*, only *My. ignobilis* (Berk. & Broome) Desjardin & B.A. Perry described originally from Sri Lanka is characterized by a pleurotoid habit. However, based on a study by Desjardin & Perry (2017), it is different from the new species by having rather diminutive basidiomata, (4–17 mm for pileus), narrow basidiospores (8–9 × 4.8–5.8 μm) and rather short basidia (28–32 × 8–9 μm).

Figure 24 – Basidiomata of *Mycetinis arbuscularis* (HMJAU 60427, holotype). Image credit goes to Ji–Peng Li.

Mycetinis rufodiscus Ji–Peng Li, Chang–Tian Li & Y. Li, sp. nov. Figs 26–27

Fungal names: FN571848; Facesoffungi number: FoF15527

Etymology – named for the reddish–brown pileus disc.

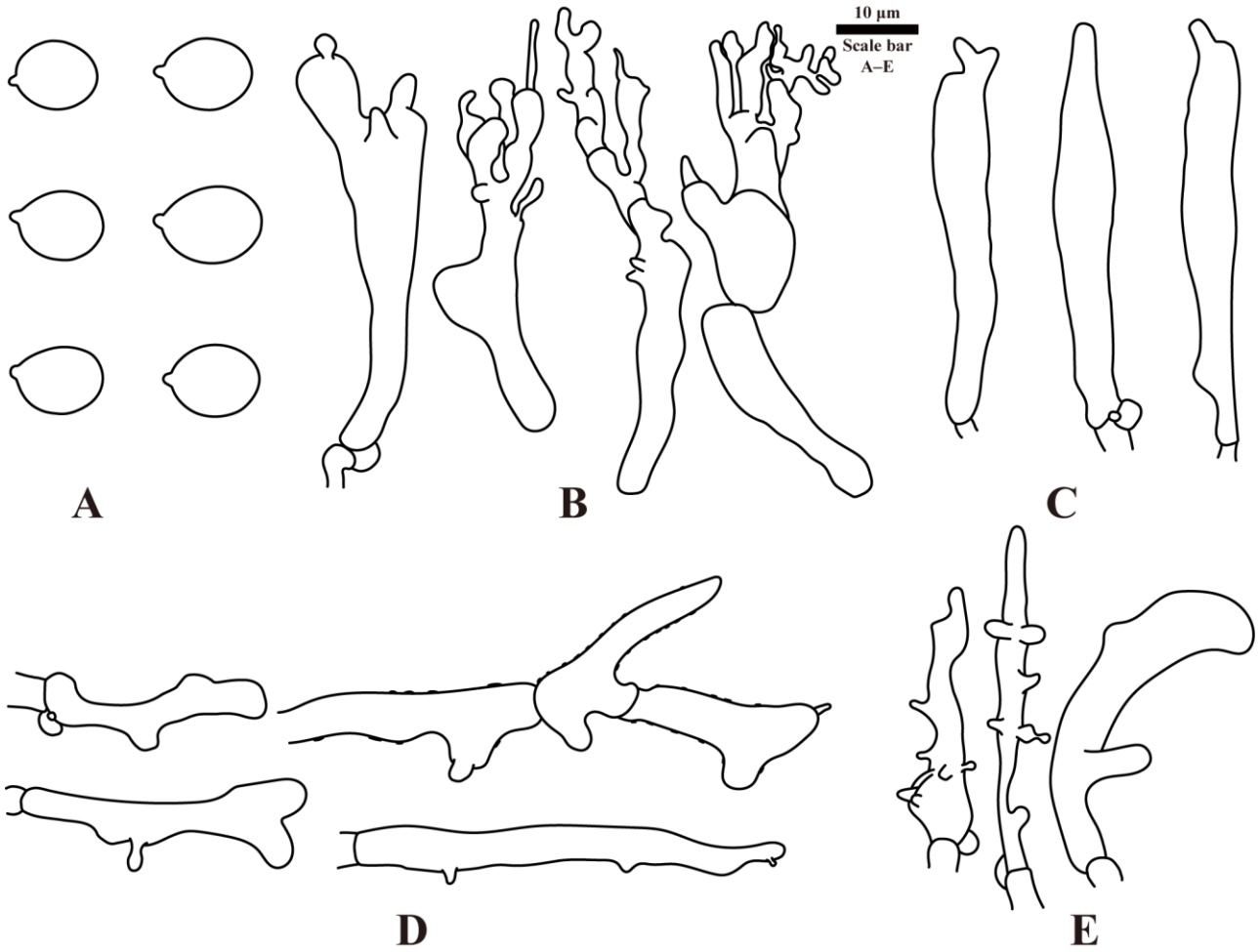

Figure 25 – Microscopic features of *Mycetinis arbuscularis* (HMJAU 60427, holotype). A Basidiospores. B Cheilocystidia. C Pleurocystidia. D. Pileipellis terminal cells. E. Caulocystidia. Scale bars = 10 μm. Image credit goes to Ji–Peng Li.

Typification – CHINA. Guizhou Province, Tongren City, near Fanjingshan National Nature Reserve, 27° 50' 32" N, 108° 46' 10" E, elev., 625 m, 18 June 2022, J.P. Li, LJP1154 (HMJAU 60430, holotype).

Diagnosis – Similar to *My. curraniae*, but differs by more complete lamellae (L = 18–23) and whitish to pinkish white at the stipe apex.

Description – *Basidiomata* marasmioid. *Pileus* 12.5–27 mm diam, membranous, hemispherical when young, then convex to plano–convex, applanate when mature, often slightly depressed at centre, dry, rugose at disc or near the margin zone, radially sulcate towards the margin, reddish brown (8D8/8E8) at the disc, fading towards margin to finally becoming mostly pinkish white (7A2). *Lamellae* close, L = 18–23, l = 2–3, up to 3 mm broad, adnate, whitish. *Stipe* 12–25 mm long, 1–2 mm thick at the apex, 0.5–1.2 mm thick at the base, centrally attached and instititious, cylindrical, usually broadened apically and tapering towards base, dry, glabrous, whitish to pinkish white (7A2) at apical area only, darkening downward from orange (6A7), reddish-orange (7A7) to finally reddish brown (8E8) dark brown (8F8) at base. *Odour* distinct, garlic-like.

Basidiospores [n = 40] (6.0–)6.4–8.5(–9.2) × 3.7–4.4 μm (average = 7.8 × 4.1 μm, E = (1.60–)1.67–2.07(–2.16), Q = 1.90), oblong, sometimes slightly cylindric. *Basidia* [n = 10] 19.9–29.1 × 6.2–8.7 μm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 18.0–33.4 × 5.1–7.2 μm, clavate, cylindrical. *Cheilocystidia* [n = 10] 14.2–20.8 × 5.7–13.0 μm, irregularly clavate, with apical outgrowth, often finger-like projections. *Pleurocystidia* [n = 10] 21.4–29.0 × 4.8–6.5 μm, fusiform. *Pileipellis* a cutis, composed of cylindrical hyphae, thin-walled, with terminal cells of inflated cells

in the form of clavate to pyriform, sometimes more or less diverticulate similar to cheilocystidia, or irregular lobed. *Stipitipellis* a cutis, composed of cylindrical, thin-walled, hyaline, parallel–arranged hyphae, smooth. *Caulocystidia* not differentiated. *Clamp connections* present in all tissues.

Ecology – Saprotrophic, scattered, arising on dead wood in broadleaf forests.

Additional material studied – CHINA. Guizhou Province, Tongren City, near Fanjingshan National Nature Reserve, 27° 50' 32" N, 108° 46' 10" E, elev., 622 m, 18 June 2022, J.P. Li, LJP1155 (HMJAU 60431).

Notes – This species closely resembles *My. curraniae* and *My. scorodonius* in macro–morphological features and phylogeny, the former species only different by less complete lamellae (L = 7–9) and cinnamon stipe apex and the latter one having distinctive large basidiospores with an average length of 9.0 µm (Petersen & Hughes 2017). *Mycetinis arbuscularis* described in this study, is another phylogenetically similar species but different by the pleurotoid basidiomata and ellipsoid spores (see above).

Paragymnopus J.S. Oliveira, in Oliveira, Vargas–Isla, Cabral, Rodrigues & Ishikawa, Mycol. Progr. 18(5): 730 (2019)

Type species – *Paragymnopus perforans* (Hoffm.) J.S. Oliveira

Spectrum of reported species in China – *Paragymnopus perforans* (Institute of Microbiology, Chinese Academy of Sciences 2024, Li 2020).

Notes – The only species within the genus was reported in China, but it lacks molecular evidence. The genus *Paragymnopus*, which was previously classified within *G.* sect. *Perforantia*, has been established as a distinct genus based on phylogenetic analysis, thereby signifying its unique taxonomic status as separate from *Gymnopus* (Oliveira et al. 2019). Currently, the genus comprises two sections, sect. *Paragymnopus* and sect. *Pinophili* (R.H. Petersen) J.S. Oliveira (Oliveira et al. 2019).

Figure 26 – Basidiomata of *Mycetinis rufodiscus* (HMJAU 60430, holotype). Image credit goes to Ji–Peng Li.

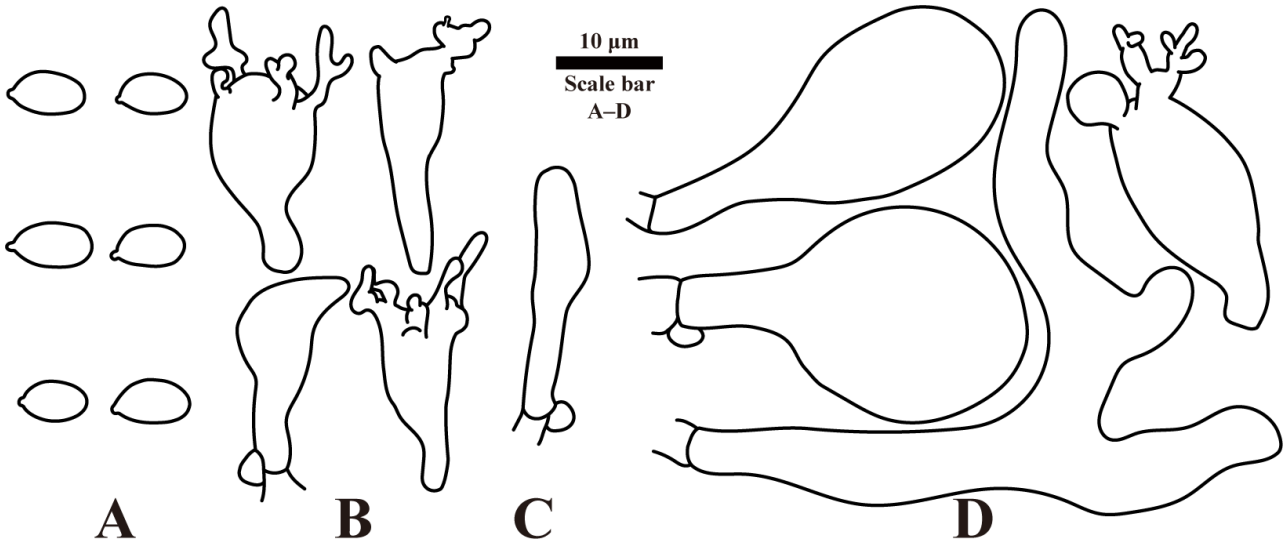

Figure 27 – Microscopic features of *Mycetinis rufodiscus* (HMJAU 60431, holotype). A Basidiospores. B Cheilocystidia. C Pleurocystidia. D. Pileipellis terminal cells. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Paragymnopus magnisporus J.P. Li, Chang–Tian Li & Y. Li, sp. nov. Figs 28–29

Fungal names: FN571833; Facesoffungi number: FoF15528

Etymology – The specific name "*magnisporus*" combines "*magni*" (derived from Latin *"magnus*", meaning large or great) and "*sporus*" (from Latin "*sporus*", meaning spore), referring to the species within the genus that is characterized by distinctly large spores.

Typification – CHINA. Yunnan Province, Lijiang City, Yulong Naxi Autonomous County, 26° 38' 29" N, 99° 43' 20" E, elev., 3911 m, 27 July 2022, M.C. Pan, PMC340 (HMJAU 60432, holotype).

Diagnosis – Distinguished from all known *Paragymnopus* species by its noticeably long basidiospores, basidia, and pleurocystidia.

Description – *Basidiomata* marasmioid. *Pileus* 6.5–18 mm diam, membranous, hemispherical to convex when young, umbilicate at the disc, radially sulcate towards the margin, rugose at the disc, then plano-convex to applanate at maturity, slightly depressed to depressed at the disc, radially sulcate towards the margin, margin reflexed, dry, reddish brown (8E8) at disc when young, more or less paler in some places, paler with age, reddish brown (8E8) at the centre or at disc when maturity, paler towards the margin, orange white (6A2) at margin zone or with a tinge of reddish brown (8E8) somewhere, dark at the groove. *Lamellae* subdistant, L = 12–16, l = 1–2, up to 4.5 mm broad, adnate, ventricose when mature, split, sometimes forked, off–white to greyish red (7B3). *Stipe* 5–8.5 mm long, 1–2 mm thick, centrally attached, instititious, cylindrical, broadened and sometimes compressed at apex, tapering downward, reddish brown (8E8) overall, fibrillose, tough, rough, hollow, dry, covered with whitish tomentum. *Odour* distinct, garlic-like.

Basidiospores [n = 40] (9.7–)10.1–12.5(–12.9) × (4.5–)4.6–6.8(–7.2) µm (average = 11.2 × 5.7 µm, E = (1.59–)1.69–2.27(–2.28), Q = 1.97), oblong to cylindric. *Basidia* [n = 10] 32.3–58.1 × 8.5–10.8 µm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10]38.7–56.3 × 6.6–10.3 µm, clavate, cylindrical. *Cheilocystidia* [n = 10] 17.3–46.1 × 4.0–9.6 µm, irregularly cylindrical to irregularly clavate, diverticulate, stalked, often with more or less apical projections. *Pleurocystidia* [n = 10] 35.7–46.6 × 5.4–6.7 µm, fusiform. *Pileipellis* a cutis, composed of cylindrical hyphae, thin-walled, incrusted, diverticulate, parallel–arranged, brownish in KOH; terminal cells often more or less diverticulate, irregularly cylindrical, slightly lobed. *Stipitipellis* a cutis, composed of cylindrical, thin-walled, parallel–arranged hyphae, diverticulate, incrusted, and brownish in KOH. *Caulocystidia* up to 45^{+} × 3.1–6.5 µm, cylindrical to irregular cylindrical. *Clamp connections* present in all tissues.

Figure 28 – Basidiomata of *Paragymnopus magnisporus* (HMJAU 60432, holotype). Image credit goes to Mei–Chen Pan.

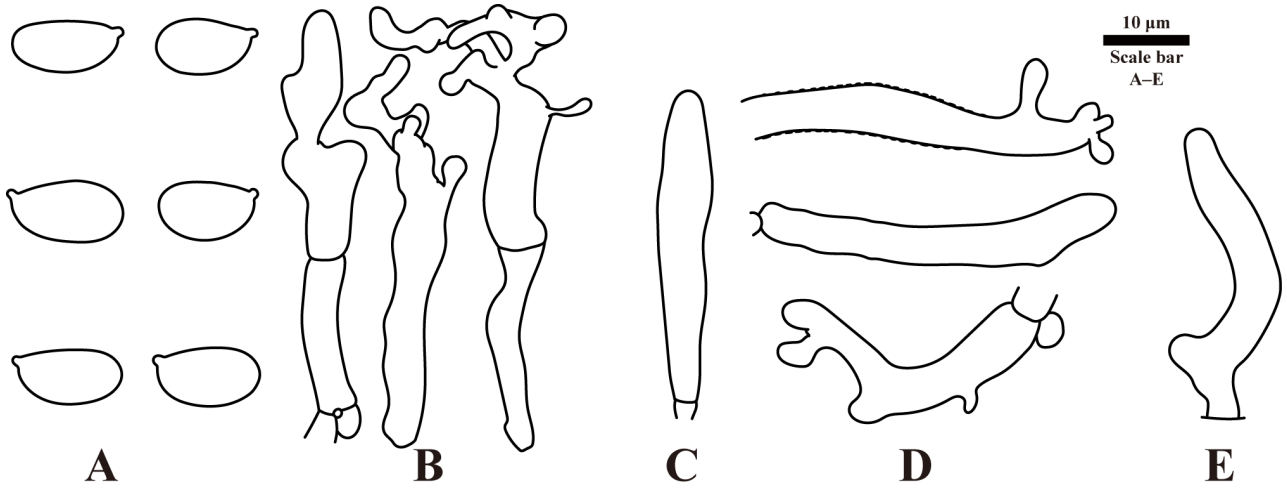

Figure 29 – Microscopic features of *Paragymnopus magnisporus* (HMJAU 60432, holotype). A Basidiospores. B Cheilocystidia. C Pleurocystidia. D. Pileipellis terminal cells. E. Caulocystidia. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Ecology – Saprotrophic, gregarious, usually arising on dead twigs or branches.

Additional material studied – CHINA. Yunnan Province, Xianggelila City, Diqing Tibetan Autonomous Prefecture, 28° 14' 54" N, 99° 58' 31" E, elev., 3964 m, 1 August 2022, M.C. Pan, PMC451 (HMJAU 60433).

Notes – Currently, according to MycoBank database, only eight taxa were accepted within the genus *Paragymnopus*: *Pg. foliiphilus* (R.H. Petersen) J.S. Oliveira, *Pg. foliiphilus* var. *costaricensis* (R.H. Petersen & J.L. Mata) J.S. Oliveira, *Pg. foliiphilus* var. *foliiphilus* (R.H. Petersen) J.S. Oliveira, *Pg. perforans*, *Pg. perforans* subsp. *perforans* (Hoffm.) J.S. Oliveira, *Pg. perforans* subsp. *transatlanticus* (R.H. Petersen) J.S. Oliveira, *Pg. pinophilus* (R.H. Petersen) J.S. Oliveira, *Pg. ponderosae* (R.H. Petersen) J.S. Oliveira, *Pg. sequoiae* (Desjardin) J.S. Oliveira, and *Pg. sublaccatus* (R.H. Petersen) J.S. Oliveira. Compared to the new species, all the known *Paragymnopus* species can be easily distinguished by the short basidiospores, basidia, and pleurocystidia shown in Table 2 (Petersen & Hughes 2016).

Table 2 Comparative microscopic features of *Paragymnopus* species.

Specific Epithet	Lm	BL	PL
magnisporus	11.20 µm	32.3–58.1 µm	35.7–46.6 µm
foliiphilus	6.85 µm	27–32 µm	25–33 µm
foliiphilus var. *costaricensis*	7.20 µm	18–22 µm	17–24 µm
perforans	8.10 µm	36–45 µm	35–42 µm
perforans subsp. *transatlanticus*	7.13 µm	20–29 µm	22–32 µm
pinophilus	5.15/7.19 µm	23–31 µm	24–32 µm
ponderosae	6.2/7.7 µm	32–38 µm	24–37 µm
sequoiae	6.50 µm	25–30 µm	21–31 µm
sublaccatus	7.20 µm	24–27 µm	25–35 µm

Lm = Mean length of basidiospores, BL = Basidia Length, PL = Pleurocystidia Length.

Paragymnopus pinophilus (R.H. Petersen) J.S. Oliveira, in Oliveira, Vargas–Isla, Cabral, Rodrigues & Ishikawa, Mycol. Progr. 18(5): 731 (2019) Figs 30–31

MycoBank number: MB828412; Facesoffungi number: FoF15529

Description – *Basidiomata* marasmioid. *Pileus* up to 6 mm diam, membranous, hemispherical when young, radially sulcate from centre towards margin, with central depression, rugose somewhere, then convex with depressed to deeply depressed centre, finally plano–convex to applanate, depressed or umbilicate at the disc, somewhat rugose in some places, radially sulcate at the margin, light brown overall with a tinge of rust brown (6E8) in some places, greyish brown (7D3) overall or paler at maturity. *Lamellae* subdistant, L = 10–12, l = 2, up to 1.5 mm broad, adnate, sometimes attached to a pseudocollarium, greyish brown (7D3), whitish at the edge. *Stipe* up to 35 mm long, filiform, centrally attached, instititious, terete, slightly broadened and compressed at apex, dry, smooth, concolor to pileus near apex, otherwise blackish. *Sterile stipes* or *telepods* not found. *Rhizomorphs* present, of colour similar to the stipe, simple, repent. *Odour* not recorded.

Basidiospores [n = 40] (6.7–)7.0–9.0(–9.3) × (3.0–)3.1–4.1(–4.7) µm (average = 8.0 × 3.5 µm, E = (1.67–)1.79–2.74(–2.80), Q = 2.27), oblong to cylindric. *Basidia* [n = 10] 25.2–33.8 × 5.6–7.6 µm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 22.9–33.0 × 4.6–7.5 µm, clavate, cylindrical. *Cheilocystidia* [n = 10] 16.1–29.0 × 3.9–8.8 µm, irregularly clavate, broom cell-like, stalked, with densely finger–like apical projections. *Pleurocystidia* 15.7–31.3 × 4.0–5.1 µm, fusiform. *Pileipellis* a cutis, composed of cylindrical hyphae, thin-walled, incrusted, intertwined, hyaline, often with blackish pigment in KOH; terminal cells irregularly cylindrical, often more or less diverticulate, lobed to irregularly branched, forming coralloid structure, mix with some broom cells or cells more like cheilocystidia but having thinner main body (arbuscular–like); pileal hairs of erect or repent irregularly cylindrical. *Stipitipellis* a cutis, composed of cylindrical, slightly thick–walled, hyaline, parallel–arranged hyphae, with black pigment in KOH. *Caulocystidia* [n = 4] 11.4–16.8 × 2.0–3.3 µm, scattered, cylindrical, thin–walled, hyaline. *Clamp connections* present in all tissues.

Ecology – Saprotrophic, gregarious, arising on fallen broadleaf leaves or needles in mixed conifer and broadleaf forests.

Materials studied – CHINA. Yunnan Province, Diqing Tibetan Autonomous Prefecture, Deqin County, 28° 18' 16" N, 99° 9' 19" E, elev., 3554 m, 2 August 2022, F.F. Li, LFF493 (HMJAU 60434). Yunnan Province, Diqing Tibetan Autonomous Prefecture, Deqin County, 28° 19' 53" N, 99° 7' 19" E, elev., 4166 m, 3 August 2022, J.P. Li, LJP1510 (HMJAU 60435). Yunnan Province, Diqing Tibetan Autonomous Prefecture, Deqin County, 28° 19' 52" N, 99° 07' 19" E, elev., 4166 m, 3 August 2022, J.P. Li, LJP1511 (HMJAU 60436).

Notes – The collections fit well with the description of the type specimen of *Pg. pinophilus* (Petersen & Hughes 2016). Although caulocystidia were not observed in the type specimen of *Pg. pinophilus*, the observation of caulocystidia in this study provides additional detail, enriching the existing description of the species (Petersen & Hughes 2016). This species represents a new record for China.

Figure 30 – Basidiomata of *Paragymnopus pinophilus* (HMJAU 60434). Image credit goes to Feng–Fu Li.

Peckorumyces J.P. Li, J.S. Oliveira & Chang–Tian Li, gen. nov.

Fungal names: FN571649; Facesoffungi number: FoF15514

Etymology – The generic epithet refers to Charles Horton Peck, a mycologist who collected and described *Marasmius contrarius* Peck.

Type species – *Peckorumyces umbonatus* (Peck) J.P. Li, J.S. Oliveira & Chang–Tian Li

Spectrum of reported species in China – *Peckorumyces umbonatus* (Sun et al. 2021).

Definition – Basidiomata gymnopoid, solitary to gregarious. Pileus convex to applanate, radially striate–sulcate, dry, glabrous. Lamellae adnate or subdecurrent, whitish. Stipe central,

cylindrical, vestured. Odour distinct, garlic-like. Rhizomorphs: often absent, when present, arising from the substrate, very short, soft, black. Basidiospores oblong to cylindric, hyaline, non–amyloid, thin-walled. Basidia 4-spored, clamped. Cheilocystidia inconspicuous, irregularly cylindrical to irregularly clavate. Pleurocystidia absent. Pileipellis a cutis, of radially arranged cylindric hyphae, made up of cylindrical terminal cells, sometimes with less and scattered knobs or branchlets (not densely diverticulate), smooth or slightly encrusted, thin-walled. Stipitipellis a cutis, composed of cylindrical, slightly thick-walled, hyaline, parallel-arranged hyphae, smooth. Caulocystidia abundant, irregularly cylindrical or flexuous, obtuse, hyaline, with quite thick-walls. Clamp connections present in all tissues. On Pinaceae leafy debris.

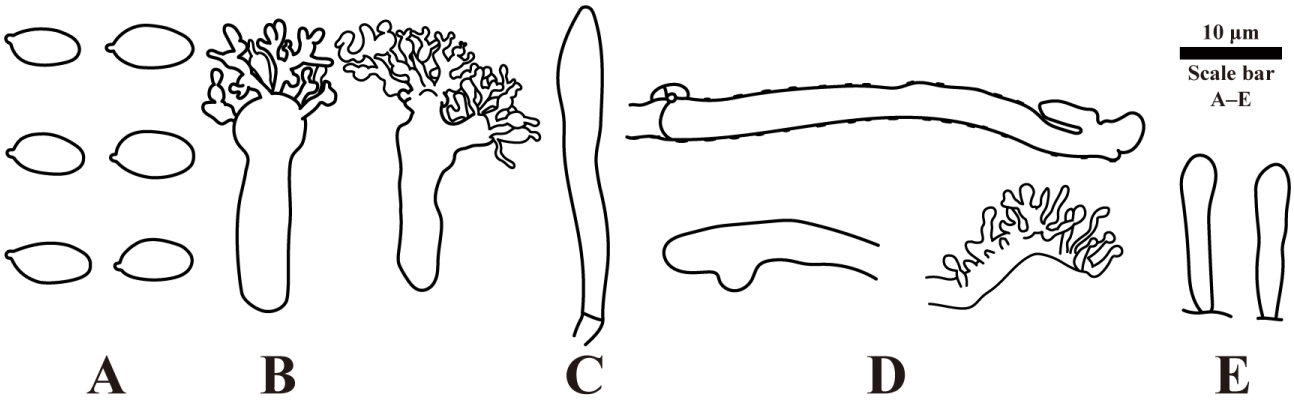

Figure 31 – Microscopic features of *Paragymnopus pinophilus* (HMJAU 60434). A Basidiospores. B Cheilocystidia. C Pleurocystidia. D. Pileipellis terminal cells. E. Caulocystidia. Scale bars = 10 μm. Image credit goes to Ji–Peng Li.

Diagnosis – Distinguished from *Anthracophyllum* by its adnate or subdecurrent lamellae, context lacking pigment granules, and basidiomata with a distinct garlic odour; distinguished from *Collybiopsis* by its preference for Pinaceae leaves, basidiomata with a distinct garlic odour, and highly distant phylogenetic relationship; distinguished from *Connopus* by its solitary to gregarious habit, basidiomata with a distinct garlic odour, and cutis–type pileipellis; distinguished from *Gymnopanella* by its non–reticulate lamellae, central stipe, and simple cylindrical pileipellis terminal cells; distinguished from *Gymnopus* sect. *Gymnopus* by its basidiomata with garlic odour, vestured stipe, and simple cylindrical pileipellis terminal cells; distinguished from *G.* sect. *Androsacei*, by its basidiomata with garlic odour, non–filiform stipe, and simple cylindrical pileipellis terminal cells; distinguished from *G.* sect. *Impudicae* by its abundant, long and thick-walled caulocystidia, non-filiform stipe, and highly distant phylogenetic relationship; distinguished from *G.* sect. *Levipedes* by its basidiomata with garlic odour, vestured stipe, and simple cylindrical pileipellis terminal cells; distinguished from *Hymenoporus* by its non–tubular hymenophore, lacking dendriform cheilocystidia and pileipellis cells; distinguished from *Lentinula* by its non–fleshy basidiomata, vestured stipe but not squamulose or scaled, non–inflated cheilocystidia; distinguished from *Mycetinis* by its simple cylindrical pileipellis terminal cells, and highly distant phylogenetic relationship; distinguished from *Neonothopanus* by its adnate or subdecurrent lamellae, central stipe, and basidoimata with a distinct garlic odour; distinguished from *Omphalotus* by its adnate or subdecurrent lamellae, and basidoimata without bioluminescent trait; distinguished from *Paragymnopus* sect. *Paragymnopus*, by its gelatinized pileipellis, and highly distant phylogenetic relationship; distinguished from *Pg.* sect. *Pinophili* by its vestured stipe, absence of Siccus-type cheilocystidia, and absence of *Rameales* structure in pileipellis; distinguished from *Paramycetinis* by pileipellis without slime or gelatinised features, and highly distant phylogenetic relationship; distinguished from *Pseudomarasmius* by its basidiomata with a distinct garlic odour, clamped hyphae, and absence of *Rameales* structure in pileipellis; distinguished from *Pusillomyces* by its non-filiform stipe, clamped hyphae, and absence of *Siccus*–type or *Rameale*s–type structure

in pileipellis; distinguished from *Rhodocollybia* by its absence of dextrinoid basidiospores, and highly distant phylogenetic relationship.

Note – See the discussion part below.

***Peckorumyces umbonatus* (Peck)** J.P. Li, J.S. Oliveira & Chang–Tian Li, comb. nov.

Figs 32–36

Basionym – *Marasmius umbonatus* Peck, Bull. Buffalo Soc. Nat. Sci. 1:58. 1874, non *Collybia umbonata* Peck, Bull. Torrey Bot.Club 31: 178. 1904.

= *Gymnopus contrarius* (Peck) Halling, in Antonín, Halling & Noordeloos, Mycotaxon 63: 364. 1997

= *Marasmius contrarius* Peck. Bull. N.Y. St. Mus. 150: 34. 1911

= *Collybia contraria* (Peck) Halling, Mycol. Mem. 8: 75. 1983

≡ *Collybia umbonatella* Singer, Mycologia 35: 156. 1943

Fungal names: FN571648; Facesoffungi number: FoF15530

Typification – United States, New York, Essex Co., North Elba, July, 1873, C. H. Peck, NYSf 3270 (holotype)

Revision of the specimen from the USA – Basidiomata gregarious. Pileus 4–12 mm diam., plano-convex, glabrous, even, disc dark brown, margin dark ochraceous. Lamellae adnate or subdecurrent, L = 16–24, l = 1–3, forked, sometimes split or venose–connected, ventricose, close or subdistant, narrow, greyish orange. Stipe 20–30 × 1–1.5 mm, terete or compressed, equal above a slightly enlarged base, pubescent above, tomentose at the base, dark ochraceous or brown, non–insititious.

Basidiospores [n = 80] 6.9(–7.2)–10.2(–10.8) × (3.4–)3.5–4.6(–5.1) µm (average = 8.5 × 3.9 µm, E = (1.72–)1.81–2.50(–2.73), Q = 2.17), oblong to cylindric, hyaline, thin-walled. Basidia [n = 20] 22.9–43.4 × 5.9–8.0 µm, clavate, 4-spored. Basidioles [n = 30] 22.5–37.2 × 5.6–8.0 µm, clavate. Cheilocystidia absent to inconspicuous present, variable in shape and size, [n = 20] 9.4–33.6 × 4.4–8.6 µm, irregularly cylindrical to irregularly clavate, with forked, rostrate or irregular filiform apical projection(s). Pleurocystidia absent. Pileipellis a layer of radially oriented, repent, cylindric hyphae; cells 4.1–8.3 µm in diam., with less and scattered knobs or branchlets (not densely diverticulate), smooth or slightly encrusted with yellow to brown pigment, thin-walled. Stipitipellis a cutis, composed of cylindrical, slightly thick-walled, hyaline, parallel–arranged hyphae, smooth, pale brown in KOH. Caulocystidia [n = 10] more than 119 µm in length, 5.1–8.3 µm in width, abundant, irregularly cylindrical or flexuous, obtuse, hyaline or yellow-brown in KOH, with quite thick walls up to 2.5 µm. Clamp connections present in all tissues.

Additional material studied – United States, New York, Essex Co., North Elba, 18 June, 1910, C. H. Peck, NYSf 859.

Additional DNA sequences – OP895028 (LSU, NYSf 859), OP896739 (TEF1–α, NYSf 859).

Notes – The macromorphological description was cited from Peck (1873, 1911) and Desjardin (1989) with supplements based on dry type specimens. Halling (1983) argued that *C. pinastris* (Kauffman) Mitchel & A.H. Sm. (≡ *M. pinastris* Kauffman) bears a striking resemblance to *G. contrarius*, with the only notable distinction being the garlic-like odour, a characteristic not mentioned by Peck (1911). After a morphological examination, the findings align with Halling (1983) and Desjardin (1989) in that *M. contrarius* is conspecific with *M. umbonatus*. According to the International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code), "*umbonatus*" is the earliest legitimate species epithet for the same taxon in the new genus (Turland et al. 2018). Cheilocystidia were only observed in one basidioma of NYSf 859, and were not observed in NYSf 3270.

Description of specimens from China – Basidiomata solitary or in small clusters to gregarious. Pileus 9–26 mm in diam., convex when young, gradually expanding to plano-convex to applanate with age, rounded at centre when young, then slightly depressed to depressed or mamillated at centre, radially striate–sulcate, occasionally somewhat rugulose, margin entire or crenate, dry, glabrous, brownish orange (6C8), brown (7E7) to dark brown (8F8) at the disc, paler

towards the margin, whitish at the margin, darker at stria–sulci. Lamellae adnate or subdecurrent, L = 17–27, l = 1–4, forked, ventricose, sometimes split, whitish. Stipe 12–67 mm long, 1–2.5 mm thick at apex, 1–3 mm at base, central, cylindrical, almost equal, occasionally broadened at apex or base, tomentose, strigose at base, orange white (6A2) to light orange (6A5) at upper potion, darker towards base, brown (7E7) to dark brown (7F8) at base. Odour distinct, garlic-like, sometimes negligible but becomes distinct when the stipe has been cut longitudinally in half. Rhizomorphs: present, arising from the substrate, very short, soft, black.

Basidiospores [n = 80] (6.7–)7.0–9.8(–10.6) × (3.3–)3.6–4.3(–4.5) µm (average = 8.10 × 3.90 µm, E = (1.68–)1.84–2.31(–2.43), Q = 2.06), oblong to cylindric, hyaline, thin-walled. Basidia [n = 40] 20.0–41.6 × 4.8–7.4 µm, clavate, 4-spored. Basidioles [n = 30] 22.4–32.8 × 4.6–6.5 µm, clavate. Cheilocystidia variable in shape and size, inconspicuous, [n = 30] 14.0–32.2 × 2.1–8.3 µm, irregularly cylindrical to irregularly clavate, with forked, rostrate or irregular filiform apical projection(s). Pleurocystidia absent. Pileipellis a layer of radially oriented, repent, cylindric hyphae; cells 3–13 µm in diam., with less and scattered knobs or branchlets (not densely diverticulate), smooth or slightly encrusted with yellow to brown pigment, thin-walled. Stipitipellis a cutis, composed of cylindrical, slightly thick-walled, hyaline, parallel–arranged hyphae, smooth, pale brown in KOH. Caulocystidia [n = 10] more than 139 µm in length, 5.8–7.4 µm in width, abundant, irregularly cylindrical or flexuous, obtuse, hyaline or yellow-brown in KOH, with quite thick walls up to 2.8 µm. Clamp connections present in all tissues.

Figure 32 – Basidiomata of *Marasmius contrarius* (NYSf 859, holotype). Image credit goes to New York State Museum, New York, U.S.A.

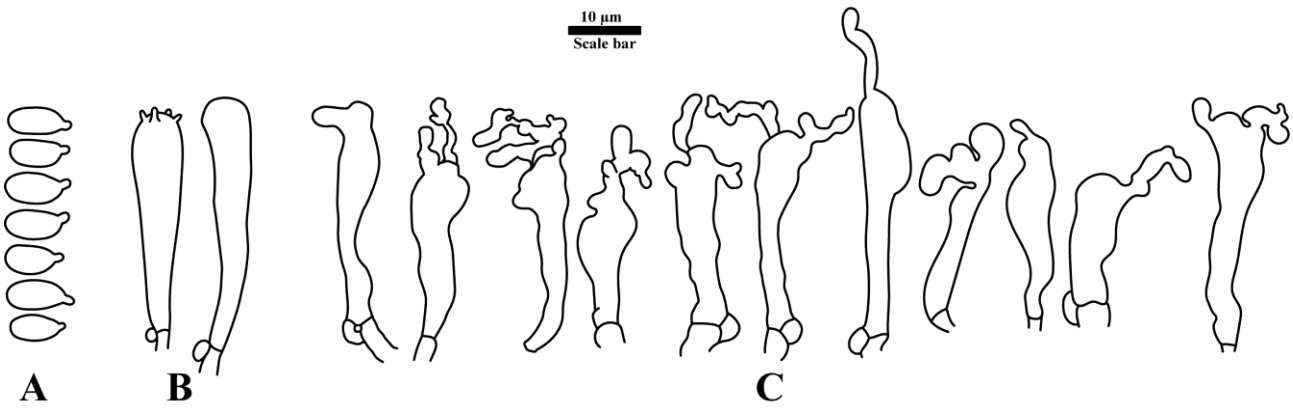

Figure 33 – Microscopic features of *Marasmius contrarius* (NYSf 859, holotype). A Basidiospores. B Basidia and Basidioles. C Cheilocystidia. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Figure 34 – Basidiomata of *Marasmius umbonatus* (NYSf 3270, holotype). Image credit goes to New York State Museum, New York, U.S.A.

Materials studied – China, Yunnan Province, Diqing Tibetan Autonomous Prefecture, Deqin County, near No. 9 Bridge in Baimang Snow Mountain, 28° 18' 06" N, 99° 09' 23" E, elev. 3439 m, on needles *Abies* sp. mixed with *Pinus* sp., 2 August 2022, J.P. Li, LJP 1491 (HMJAU 60389); Yunnan Province, Diqing Tibetan Autonomous Prefecture, Xianggelila City, near Dongju, 27° 22' 26" N, 99° 54' 60" E, elev. 3165 m, on needles of *Abies* sp., 31 July 2022, J.P. Li, LJP 1456

(HMJAU 60391); Yunnan Province, Diqing Tibetan Autonomous Prefecture, Deqin County, near No. 9 Bridge in Baimang Snow Mountain, 28° 18' 41" N, 99° 07' 46" E, elev. 3700 m, on needles of *Pinus* sp., 3 August 2022, M.C. Pan, HMJAU 60394 (PMC 474); Yunnan Province, Diqing Tibetan Autonomous Prefecture, Deqin County, near No. 9 Bridge in Baimang Snow Mountain, 28° 18' 28" N, 99° 07' 48" E, elev. 3611 m, on needles of *Abies* sp., 3 August 2022, J.P. Li, LJP 1499 (HMJAU 60396); Yunnan Province, Diqing Tibetan Autonomous Prefecture, Deqin County, near No. 9 Bridge in Baimang Snow Mountain, 28° 18' 28" N, 99° 07' 49" E, elev. 3604 m, on needles of *Abies* sp., 3 August 2022, J.P. Li, HMJAU LJP 1500 (60399); Jilin Province, Yanbian Korean Autonomous Prefecture, Dunhua City, Beishan Park, 43° 22' 48" N, 128° 13' 24" E, elev. 576 m, on needles of *Pinus* sp., 15 August 2021, J.P. Li, P222403013 (HMJAU 60400); Jilin Province, Yanbian Korean Autonomous Prefecture, Antu County, near Toudaohezi, 42° 56' 02" N, 128° 51' 56" E, elev. 644 m, on needles of *Pinus* sp., 19 August 2021, J.P. Li, P222426120 (HMJAU 60402); Tibet Autonomous Region, Linzhi City, Linzhi Town, Sejra Mountain, 29° 33' 53" N, 94° 32' 33" E, elev. 3310 m, on needles of *Abies* sp., 30 August 2019, M.L. Xie, Xie19–11012 (HMJAU 60403).

Notes – Sun et al. (2021) provided a description of *G. contrarius* based on a sample collected in China. Morphology and molecular phylogeny support the conclusion that the samples from China are conspecific with species *G. contrarius* (Peck 1873, 1911, Desjardin 1989), thus bridging and including them within the *M. umbonatus* group. In addition, the distinct garlic-like odour found in the Chinese specimens serves as a supplementary factor in resolving the discrepancy between *C. pinastris* and *G. contrarius*, suggesting they could indeed be conspecific (Peck 1911).

Figure 35 – Basidiomata of *Peckorumyces umbonatus* (HMJAU 60389). Image credit goes to Ji–Peng Li.

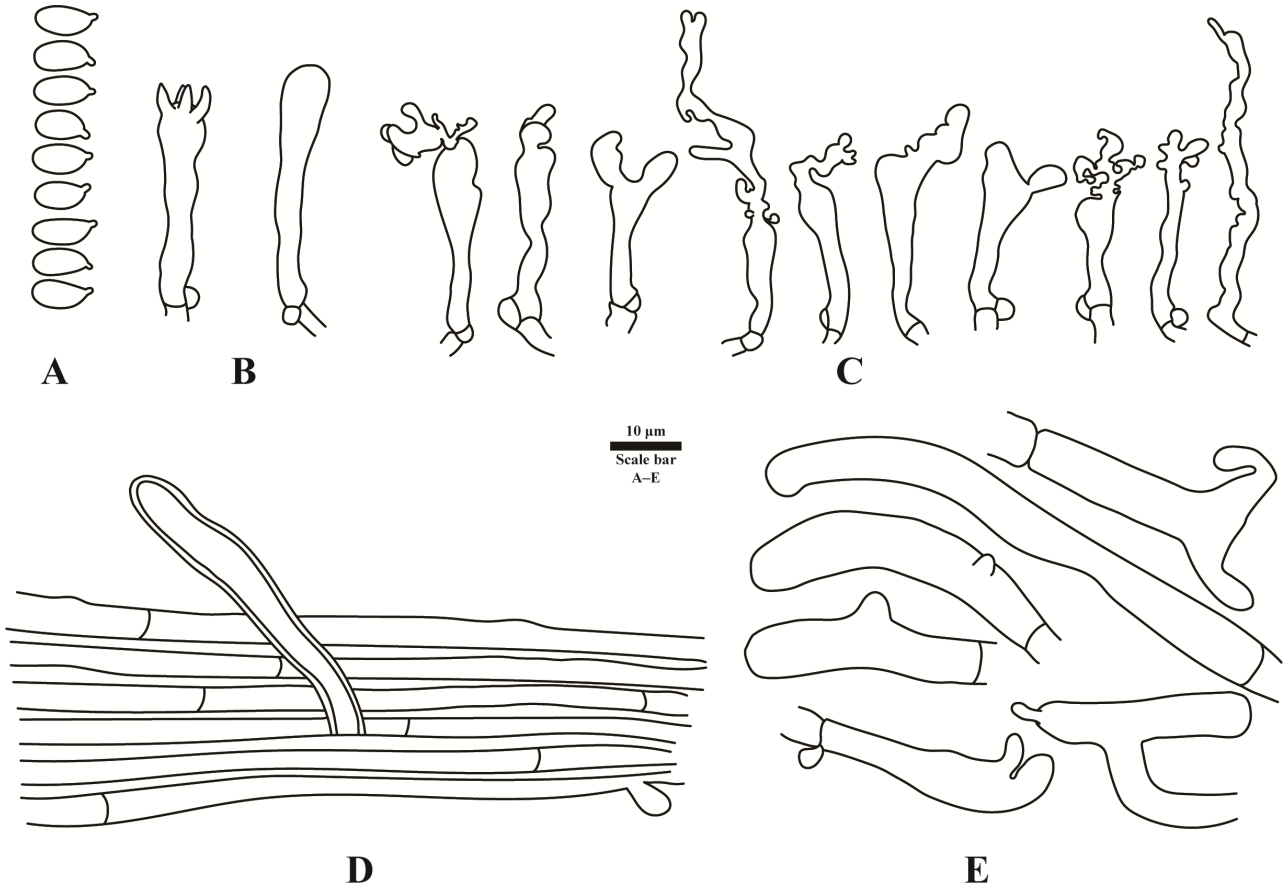

Figure 36 – Microscopic features of *Peckorumyces umbonatus* (HMJAU 60389). A Basidiospores. B Basidia and Basidioles. C Cheilocystidia. D Caulocystidia. E Pileipellis terminal cells. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Pseudomarasmius R.H. Petersen & K.W. Hughes, Mycotaxon 135: 28 (2020)

Type species – *Pseudomarasmius pallidocephalus* (Gilliam) R.H. Petersen

Spectrum of reported species in China – *Pseudomarasmius pallidocephalus*, and *Ps. quercophylloides* R.H. Petersen (Institute of Microbiology, Chinese Academy of Sciences 2024, Petersen & Hughes 2020, Zhang et al. 2017).

Notes – Two species within the genus were reported in China. The phylogram inferred from the LSU dataset showed *M. pallidocephalus* forming an independent clade close to *Rhodocollybia* with segregation of *G. sect. Androsacei* (Petersen & Hughes 2016). Soon after, Petersen & Hughes (2017) argued this marasmioid species might represent a monotypic genus, while Oliveira et al. (2019) mentioned that at least two additional members should be added to this potential genus. In response to these studies, the genus was proposed to accommodate several generally clampless species previously placed in *Marasmius* and *Gymnopus* (Petersen & Hughes 2020).

Pseudomarasmius glabrocystidiatus (Antonín, Ryoo & Ka) R.H. Petersen, in Petersen & Hughes, Mycotaxon 135: 37 (2020) Figs 37–38

MycoBank number: MB555747; Facesoffungi number: FoF15531

Description – *Basidiomata* marasmioid. *Pileus* 6–8 mm diam, membranous, hemispherical to convex, slightly depressed or umbonate at the disc, sometimes rugose at centre, sulcate towards the margin, dry, brown (6E8) at the disc, orange white (6A2) otherwise. *Lamellae* subdistant, L = 10–14, l = 1–3, up to 1 mm broad, adnate, often attached to a pseudocollarium, orange white (6A2). *Stipe* 15–42 mm long, centrally attached, instititious, cylindrical, apically broadened at apex and tapering towards base, dry, smooth, dark brown (8F8) to blackish overall, paler at apex and

concolor to pileus margin. *Rhizomorphs* present, concolorous with stipe, matt, simple, repent. *Odour* negligible.

Basidiospores [n = 40] (6.2–)6.4–8.1(–8.7) × (2.8–)2.9–3.5(–3.9) μm (average = 7.2 × 3.2 μm, E = (2.03–)2.06–2.66(–2.69), Q = 2.29), cylindric. *Basidia* [n = 10] 22.8–31.8 × 5.4–7.9 μm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 20.6–30.9 × 4.9–7.9 μm, clavate, cylindrical. *Cheilocystidia* [n = 10] 11.9–40.8 × 4.5–8.9 μm, irregularly clavate, sometimes forked, knobby, diverticulate, with finger-like apical projections, sometimes slightly lobed forming a coralloid structure. *Pleurocystidia* [n = 10] 19.6–31.6 × 4.5–6.1 μm, fusiform. *Pileipellis* a cutis, composed of cylindrical hyphae, thin-walled, incrusted, hyaline; terminal cells cylindrical, clavate to broadly clavate, incrusted, diverticulate, knobby, sometimes slightly lobed, mixed with some coralloid structure and *Siccus*–type broom cells. *Stipitipellis* a cutis, composed of cylindrical, thin-walled, hyaline, incrusted, parallel–arranged hyphae, dextrinoid. *Caulocystidia* not observed. *Clamp connections* absent in all tissues.

Ecology – Saprotrophic, scattered, arising on dead fallen needles.

Materials studied – CHINA. Jilin Province, Yanbian Korean Autonomous Prefecture, Dunhua City, 43° 5' 55" N, 128° 10' 15" E, elev., 699 m, 16 August 2021, J.P. Li, P222403044 (HMJAU 60437). Gansu Province, Gannan Tibetan Autonomous Prefecture, Zhouqu County, Lagashan Scenic Area, 33° 51' 21" N, 104° 6 29" E, elev., 2520 m, 1 October 2023, C. Chen, CC002 (HMJAU 60438).

Figure 37 – Basidiomata of *Pseudomarasmius glabrocystidiatus* (HMJAU 60437). Image credit goes to Ji–Peng Li.

Notes – This species represents a new record for China. The collections fit well with the description of the type specimen of *Ps. glabrocystidiatus* except for the smaller basidiospores (average 8.8×4.4 μm for type) and non–smooth cheilocystidia (Antonín et al. 2014, as *G. glabrocystidiatus*). Based on ITS sequence analysis, Petersen & Hughes (2020) argued that the culture KFRI 1935 (GenBank No. KP251072) which was reported in Antonín et al. (2014), is only

distantly related to the type specimen (BRNM 718676). For detailed analysis, see the *Pseudomarasmius* species below.

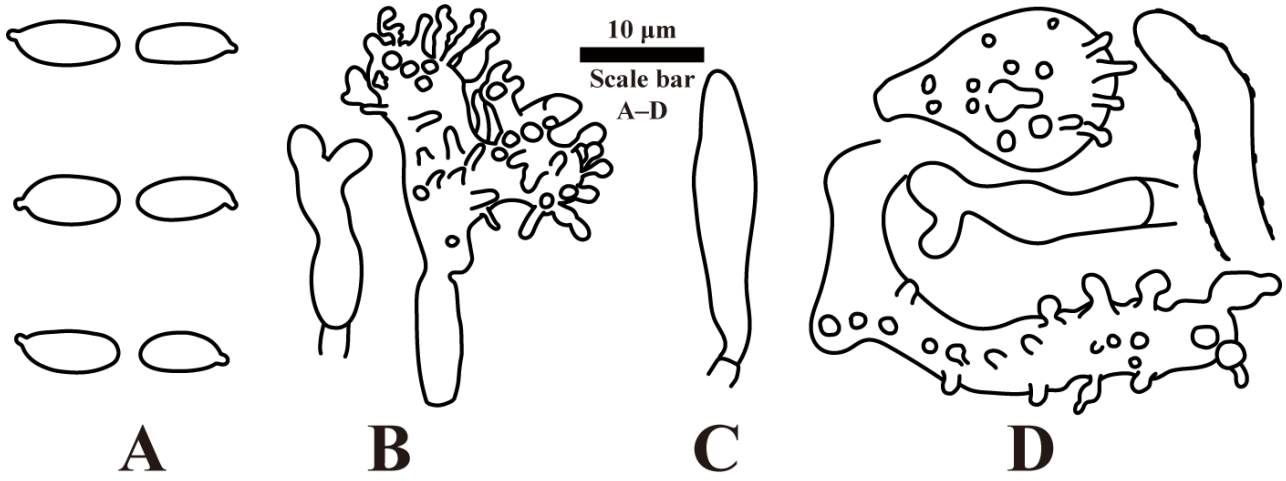

Figure 38 – Microscopic features of *Pseudomarasmius glabrocystidiatus* (HMJAU 60437). A Basidiospores. B Cheilocystidia. C. Pleurocystidia. D. Pileipellis terminal cells. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Pseudomarasmius quercophylloides R.H. Petersen, in Petersen & Hughes, Mycotaxon 135: 73 (2020) Figs 39–40

MycoBank number: MB555732; Facesoffungi number: FoF15532

Description – *Basidiomata* marasmioid. *Pileus* 3–12 mm diam, membranous, hemispherical when young, then convex to plano–convex, slightly depressed to depressed or umbilicate at disc or not, slightly to markedly radially sulcate towards margin, rugose somewhere, applanate at maturity, deeply depressed at the disc, markedly radially sulcate, margin deflexed to reflexed, dry, dark brown (8F8) overall when young, then fading to reddish brown (8E8) at the disc, gradually paler from greyish red (7B6) to orange white (6A2) towards margin, varied shades of cinnamon (6D6) overall, from dark to light. *Lamellae* subdistant, L = 9–13, l = 1–3, adnate, ventricose, sometimes venose, often attached to a pseudocollarium, orange white (6A2) to pale orange (6A3). *Stipe* 4–10 mm long, filiform, cylindrical, centrally attached, instititious, apically broadened and sometimes slightly compressed, tapering towards base, tough, dry, smooth, dark brown (8F8) to blackish overall, paler at apex and concolor to pileus margin. *Rhizomorphs* present, concolorous with stipe, matt, simple, repent. *Odour* negligible.

Basidiospores [n = 40] (6.2–)6.4–8.6(–9.5) × 2.9–3.8(–4.3) µm (average = 7.7 × 3.3 µm, E = (1.88–)2.02–2.63(–2.66), Q = 2.30), cylindric. *Basidia* [n = 10] 19.4–34.4 × 5.2–10.6 µm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 20.0–26.9 × 5.0–7.8 µm, clavate, cylindrical. *Cheilocystidia* [n = 10] 21.2–71.9 × 6.0–14.3 µm, trending to inflation from cylindrical, clavate, fusiform to spheropedunculate, often irregularly, apically diverticulate, stalked, with finger-like apical projections, knobby, sometimes slightly lobed. *Pleurocystidia* fusiform. *Pileipellis* a cutis, composed of cylindrical hyphae, thin-walled, slightly incrusted, intertwined, hyaline, densely diverticulate, and knobby on the outer layer; terminal cells irregularly cylindrical, sometimes slightly lobed forming a coralloid structure, covered with more or less diverticula and knobs. *Stipitipellis* a cutis, composed of cylindrical, thin-walled, hyaline, parallel–arranged hyphae, smooth, dextrinoid. *Caulocystidia* [n = 10] 21.1–60.7 × 6.7–12.5 µm, cylindrical to irregularly cylindrical. *Clamp connections* absent.

Ecology – Saprotrophic, gregarious, arising on dead twigs or fallen leaves of broadleaf and conifer trees.

Materials studied – CHINA. Fujian Province, Yong'an City, Tianbaoyan National Nature Reserve, latitude and longitude not recorded, elev., 700 m, 14 October 2023, J.P. Liao, H.X Luo,

TBYLJP6351 (HMJAU 60439). Fujian Province, Yong'an City, Tianbaoyan National Nature Reserve, latitude and longitude not recorded, elev., 700 m, 14 October 2023, J.P. Liao, H.X Luo, TBYLJP6336 (HMJAU 60440). Guangdong Province, Shaoguan City, Nanling Botanical Garden, latitude and longitude not recorded, elevation not recorded, 31 July 2017, B. Song, M. Zhang & H. Huang (GDGM70244). Guangdong Province, Shaoguan City, near Nanling National Forest Park Administration, latitude and longitude not recorded, elevation not recorded, 31 July 2017, B. Song, M. Zhang & H. Huang (GDGM70516). Guangdong Province, Shaoguan City, Nanling Botanical Garden, latitude and longitude not recorded, elevation not recorded, 31 July 2017, B. Song, M. Zhang & H. Huang (GDGM70522). CHINA. Guangdong Province, Xinyi City, Yunkaishan National Nature Reserve, latitude and longitude not recorded, elevation not recorded, 30 May 2019, J.P. Li, H.S. Wen & B. Song (GDGM76410). CHINA. Guangdong Province, Xinyi City, Yunkaishan National Nature Reserve, latitude and longitude not recorded, elevation not recorded, 26 July 2019, J.P. Li, H.S. Wen & B. Song (GDGM77155). CHINA. Guangdong Province, Xinyi City, Yunkaishan National Nature Reserve, latitude and longitude not recorded, elevation not recorded, 11 June 2020, B. Song, Z.Y. Wu & H.S. Wen (GDGM81729). Hunan Province, Chenzhou City, Mangshan National Forest Park, latitude and longitude not recorded, elev., 1000 m, 30 July 2017, B. Song, M. Zhang & H. Huang (GDGM70344).

Figure 39 – Basidiomata of *Pseudomarasmius quercophylloides* (GDGM 70522). Image credit goes to Tai–Hui Li.

Notes – Molecularly, the ITS sequences of these collections are nearly identical to *Ps. quercophylloides*, which was originally described from China, and to a culture named KFRI 1935, known as *Ps. glabrocystidiatus*, from South Korea. Petersen & Hughes (2020) argue that KFRI 1935 may represent a misidentification based on ITS phylogeny. Since no available specimen of KFRI 1935 can be traced, morphological examination is impossible. Nine new collections from China, along with a sequence of KFRI 1935 (KF251072) were very close to *Ps. quercophylloides* in the combined ITS and LSU tree. Compared to the original description, the morphological

characteristics closely align. The basidiospores described in the type (6–7 × 3–4 µm, Q = 1.40–1.86) are smaller than those observed in this study. Additionally, the cheilocystidia were described and measured in this study, which were not observed in the original descriptions by Petersen & Hughes (2020). This study has enhanced the overall understanding of the species concept of this species.

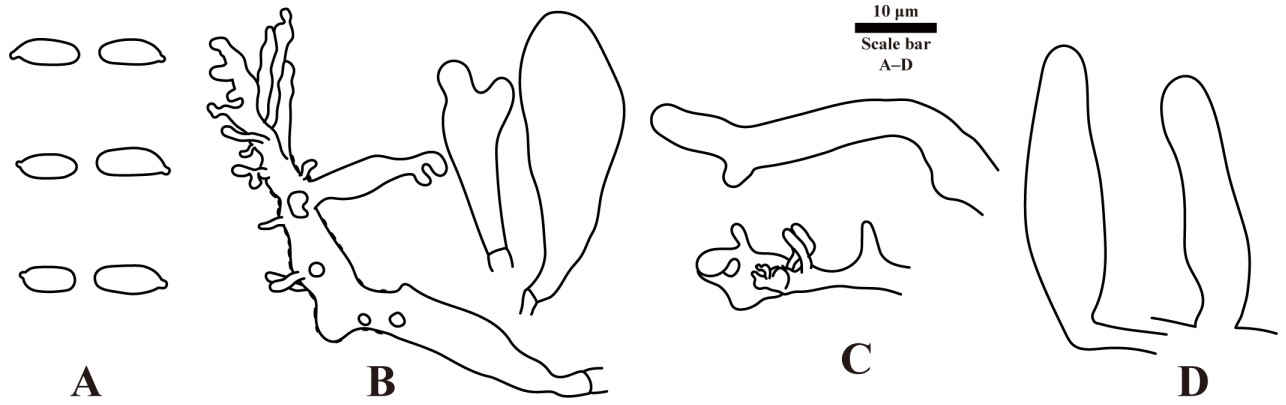

Figure 40 – Microscopic features of *Pseudomarasmius quercophylloides* (HMJAU 60439). A Basidiospores. B Cheilocystidia. C. Pileipellis terminal cells. D. Caulocystidia. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Pusillomyces J.S. Oliveira, in Oliveira, Vargas–Isla, Cabral, Rodrigues & Ishikawa, Mycol. Progr. 18(5): 718 (2019)

Type species – *Pusillomyces manuripioides* J.S. Oliveira

Spectrum of reported species in China – *Pusillomyces funalis* (Har. Takah.) J.S. Oliveira (Chen 2022).

Notes – Only one species within the genus was reported in China, but it lacks molecular evidence. The genus was proposed to include two species, *G. asetosus* Antonín, Ryoo & Ka, and *G. funalis* (Har. Takah.) Antonín, Ryoo & Ka, previously placed in *G.* sect. *Androsacei* (Oliveira et al. 2019). It is characterized by marasmoid basidiomata, pileipellis mixed with elements similar to *Siccus*–type broom cells and dextrinoid on part of stipe tissue (Oliveira et al. 2019). The samples from Africa, identified as *S. afibulatus* Antonín, would be considered a species within this group based on their phylogenetic placement, the absence of clamp connections, the pileipellis of *Rameales*–structure and a dextrinoid stipitipellis in morphology (Desjardin & Perry 2017).

Pusillomyces nodulocystidiatus J.P. Li, Chang–Tian Li & Chun Y. Deng, sp. nov. Figs 41–42

Fungal names: FN571834; Facesoffungi number: FoF15533

Etymology – The specific epithet "*nodulocystidiatus*" combines "*nodulo*" from Latin "*nodulus*", meaning small knob or nodule, with "*cystidiatus*", relating to cystidia, to denote the presence of knobby cheilocystidia.

Typification – CHINA. Guizhou Province, Liupanshui City, Shuicheng District, 26° 16' 10" N, 104° 46' 35" E, elev., 1612 m, 15 September 2020, J.P. Li (HGASMF01–10207, holotype).

Diagnosis – Similar to *Pu. funalis*, but differs by the densely knobby cheilocystidia and quite different ITS sequence.

Description – *Basidiomata* marasmioid. *Pileus* 2.5–7 mm diam, membranous, hemispherical to convex when young, depressed or slightly rugose at disc, slightly sulcate towards margin, then plano–convex and expending to applanate with age, depressed at the disc, radially sulcate from centre towards margin, occasionally rugose in some places, sometimes deflexed to reflexed at margin, dry, brown (6E8) overall when young, then brownish orange (6C6) to dark brown (6F8) at disc, paler towards margin, orange white (6A2) at margin, finally dark brown (6F8) or paler at centre, darker or paler in some places of margin zone, darker at groove. *Lamellae* distant, L = 8–11,

l = 1–2, adnate, adnexed, ventricose when mature, white. *Stipe* 8.5–19 mm long, filiform, centrally attached, instititious, cylindrical, more or less broadened or compressed at apex, dry, smooth, cover with white tomentum, often black overall, or more or less dark brown (6F8) overall, rather paler at the apex to nearly white. *Rhizomorphs* present, concolorous with stipe, matt, simple, repent. *Odour* negligible.

Figure 41 – Basidiomata of *Pusillomyces nodulocystidiatus* (HGASMF01–10207, holotype). Image credit goes to Ji–Peng Li & Chun–Ying Deng.

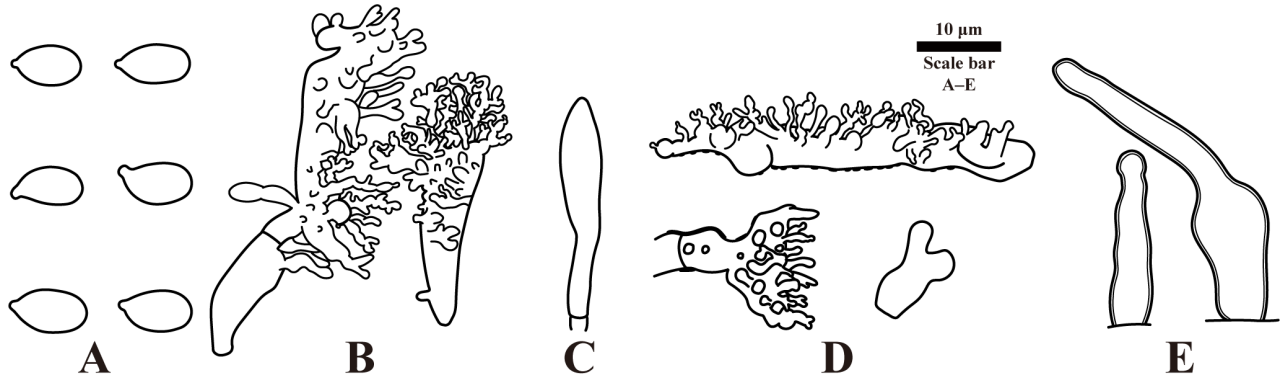

Figure 42 – Microscopic features of *Pusillomyces nodulocystidiatus* (HGASMF01–10207, holotype). A Basidiospores. B Cheilocystidia. C Pleurocystidia. D Pileipellis terminal cells. E Caulocystidia. Scale bars = 10 µm. Image credit goes to Ji–Peng Li.

Basidiospores [n = 40] (7.2–)7.6–9.1(–9.2) × 4.2–5.1(–5.5) µm (average = 8.2 × 4.7 µm, E = (1.56–)1.58–1.91(–2.04), Q = 1.75), ellipsoid to oblong. *Basidia* [n = 10] 21.8–29.4 × 5.6–6.9 µm, 2–spored, clavate, cylindrical. *Basidioles* [n = 10] 19.5–28 × 5.2–6.8 µm, clavate, cylindrical. *Cheilocystidia* [n = 10] 11.3–25.0 × 6.0–11.3 µm, irregularly clavate, forked or stalked, with more

or less apically and laterally finger-like projections, knobby, sometimes forming a structure resembling *Siccus*–type bloom cells. *Pleurocystidia* [n = 10] 17.9–30.2 × 4.5–5.3 μm, fusiform. *Pileipellis* a cutis, composed of cylindrical hyphae, thin to thick-walled, incrusted, densely diverticulate, and knobby on the outer layer forming *Rameales*–structure, brownish in KOH; terminal cells irregularly cylindrical, lobed, covered with densely diverticula and knobs, sometimes resembling *Siccus*–type bloom cells, mixed with some coralloid structure. *Stipitipellis* a cutis, composed of cylindrical, thick-walled, parallel–arranged hyphae, brownish in KOH, dextrinoid, rough. *Caulocystidia* [n = 10] 30.9–79.7 × 6.3–7.3 μm, cylindrical, thick-walled or slightly. *Clamp connections* absent in all tissues.

Ecology – Saprotrophic, gregarious, usually arising on dead twigs or stump in mixed coniferous and broad–leaved forest.

Additional materials studied – CHINA. Guizhou Province, Liupanshui City, Shuicheng District, 26° 16' 12" N, 104° 46' 36" E, elev., 1641 m, 14 September 2020, J.P. Li (HGASMF01–10239). Guizhou Province, Liupanshui City, Shuicheng District, 26° 16' 10" N, 104° 46' 36" E, elev., 1633 m, 15 September 2020, J.P. Li (HGASMF01–10223). Guangxi Province, Hezhou City, Guposhan National Forest Park, 24° 36' 03" N, 111° 33' 46" E, elev., 604 m, 08 June 2022, J.P. Li (LJP1043).

Notes – Currently, only four species were described within the genus *Pusillomyces* worldwide. One species of this genus was previously reported within *Gymnopus* in China. Thus, by proposing this new species, this is the first report of the genus in China. The comparisons are as follows: *Pusillomyces asetosus* (Antonín, Ryoo & Ka) J.S. Oliveira has smaller basidiospores (6.5 × 3.2 μm) and short basidia (16–22 × 5–8.5 μm) and the absence of caulocystidia (Antonín et al. 2014); *Pusillomyces funalis* (Har. Takah.) J.S. Oliveira has the smaller and sparsely knobby cheilocystidia and has the ITS sequence with similarity less than 96%; *Pusillomyces manuripioides* J.S. Oliveira, type of the genus, has the tiny basidiomata (pileus 0.3–1.8 mm diam., stipe 1–4 mm), smooth Hymenophore (lamellae absent) and narrow basidiospores with Q ratio of 2.6 (Oliveira et al. 2019); and *Pu. spinulosus* César, Bandala & Montoya has more brownish basidiomata and narrower basidiospores of 5.5–9 × 2.5–4 μm in size (César 2020).

Rhodocollybia Singer, Schweiz. Z. Pilzk. 17: 71 (1939)

Type species – *Rhodocollybia maculata* (Alb. & Schwein.) Singer

Spectrum of reported species in China – *Rhodocollybia butyracea* (Bull.) Lennox, *R. maculata*, *R. meridana* (Dennis) Halling (Institute of Microbiology, Chinese Academy of Sciences 2024, Li et al. 2015, Mao 2000)

Notes – Three species within the genus were reported in China. Based on the pinkish spore print, Singer (1939) separated this group from *Collybia* by proposing the genus *Rhodocollybia*.

Rhodocollybia variabilicolor Antonín, Ryoo & Ka, in Ryoo, Ka & Antonín, Phytotaxa 642(2): 120 (2024) Figs 43–44

MycoBank number: MB852257; Facesoffungi number: FoF15534

Type Locality – South Korea

Description – *Basidiomata* gymnopoid. *Pileus* up to 43 mm diam, relatively fleshy than membranous, convex to plano-convex, depressed or umbonate at the disc, expanding to applanate, deeply depressed to umbilicate at the disc, with deflexed to reflexed, finally more or less undulate margin, dry, hygrophanous, striate–sulcate towards the margin, at first reddish brown (8E8) at the disc, paler towards margin, pale orange (6A3) at the margin, fading with age, light brown (6D8) overall, pale orange (6A3) in some places, whitish at the margin. *Lamellae* crowded, L = 42–50, l = 5–6, up to 4 mm broad, emarginate with a slightly decurrent tooth, whitish. *Stipe* up to 67 mm long, 5.5 mm thick at the apex, 8.5 mm thick at the base, centrally attached, non-instititious, broadened and compressed at apex, twist and inflated at the base, fibrillose, hollow, dry, glabrous, smooth, pale orange (6A3) to light brown overall. *Odour* negligible.

Figure 43 – Basidiomata of *Rhodocollybia variabilicolor* (HMJAU 60442). Image credit goes to Jin–Peng Liao.

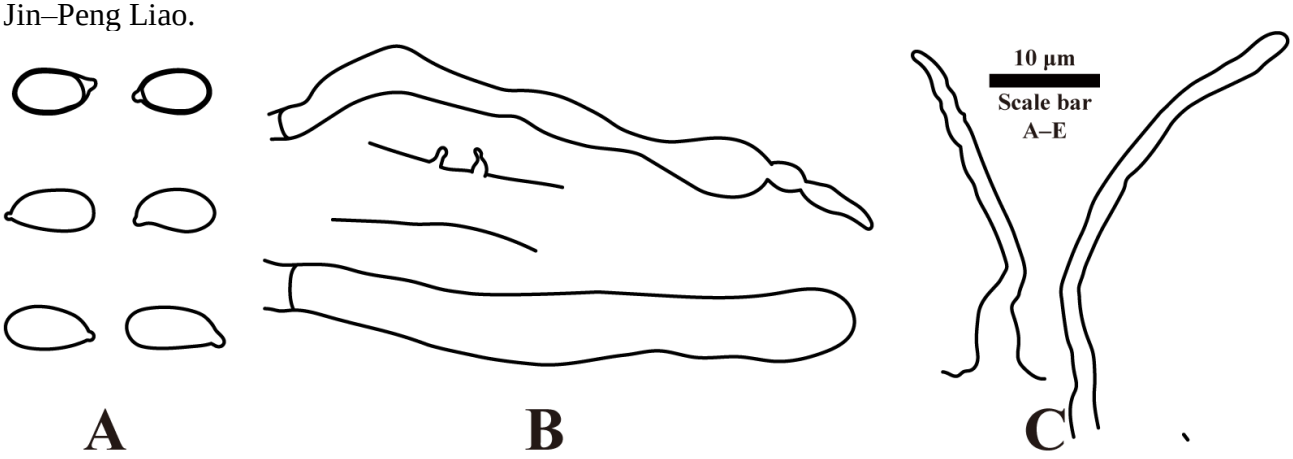

Figure 44 – Microscopic features of *Rhodocollybia variabilicolor* (HMJAU 60443). A Basidiospores. B Pileipellis terminal cells. C Pileal hairs. Scale bars = 10 μm. Image credit goes to Ji–Peng Li.

Basidiospores [n = 40] 6.4–8.1(–8.8) × (3.0–)3.1–4.1(–4.3) μm (average = 7.2 × 3.6 μm, E = (1.61–)1.72–2.29(–2.46), Q = 1.99), oblong to cylindric, inamyloid or dextrinoid, thin to slightly thickened in dextrinoid spores. *Basidia* [n = 10] 20.5–24.5 × 4.7–6.0 μm, 4-spored, clavate, cylindrical. *Basidioles* [n = 10] 20.0–29.4 × 4.9–6.9 μm, clavate, cylindrical. *Hymenial cystidia* not observed. *Pileipellis* a cutis, composed of cylindrical hyphae, thin-walled, slightly incrusted, parallel–arranged, hyaline, smooth, diverticulate but less, outer cells often with erect, narrowly

cylindrical hyphae forming pileal hairs more than 79.8 μm in length and 2.2–4.6 μm in width; terminal cells cylindrical, or irregular cylindrical with apical mammilla–like projections. *Stipitipellis* a cutis, composed of cylindrical, thin-walled, hyaline, parallel–arranged hyphae, with scarred diverticula, smooth. *Caulocystidia* not observed. *Clamp connections* present in all tissues.

Ecology – Saprotrophic, solitary to scarred, arising on the debris of broadleaf trees and conifer trees.

Materials studied – CHINA. Yunnan Province, Diqing Tibetan Autonomous Prefecture, Deqin County, 28° 17' 58" N, 99° 10' 12" E, elev., 3389 m, 2 August 2022, J.Y. Yao, YJY483 (HMJAU 60442). Fujian Province, Yong'an City, Tianbaoyan National Nature Reserve, latitude and longitude not recorded, elev., 1300 m, 25 October 2023, J.P. Liao & H.X. Luo, TBYLJP7688 (HMJAU 60443).

Notes – Because collection HMJAU 60443 was provided by two Chinese mycophiles and the field notes are incomplete, the size of the basidiomata in the description was based on collection HMJAU 60442. Phylogenetic results strongly support that the two samples from China are conspecific with *R. variabilicolor* recently described from South Korea. The Chinese collections share a remarkable resemblance with the Korean material of *R. variabilicolor* described by Ryoo et al. (2024), which differs by its larger basidia (24–32 × 6.0–9.0 μm), its larger basidioles (12–33 × 2.5–8.0 μm) and the presence of cheilocystidia. The hymenial cystidia were not observed in the materials sourced from China. No typical cheilocystidia observed might be due to the preservation or developmental conditions of specimens in this study. This species represents a new record for China.

Notes on other genera within Omphalotaceae

Anthracophyllum Ces., Atti Accad. Sci. fis. mat. Napoli 8(no. 3): 3 (1879)

Type species – *Anthracophyllum beccarianum* Ces.

Spectrum of reported species in China – *Anthracophyllum archeri* (Berk.) Pegler, *A. lateritium* (Berk. & M.A. Curtis) Singer, *A. nigritum* (Lév.) Kalchbr., *A. sinense* W.J. Yang, H.Y. Song & D.M. Hu (Wang et al. 2024, Li et al. 2015, Yang et al. 2024, Zhang 2023)

Notes – Four species within the genus were reported in China, but most of them lack molecular evidence. The genus was proposed by Cesati (1879), and then monographed by Pegler & Young (1989).

Connopus R.H. Petersen, in Hughes, Mather & Petersen, Mycologia 102(6): 1467 (2010)

Type species – *Connopus acervatus* (Fr.) K.W. Hughes, Mather & R.H. Petersen

Spectrum of reported species in China – *Connopus acervatus* (Li et al. 2015).

Notes – The only species within the genus was reported in China, but it lacks molecular evidence. The genus was established as monotypic to accommodate *Gymnopus acervatus* and is generally distributed across moist regions of northwestern North America, eastern North America, and western Europe (Hughes et al. 2010). Currently, no molecular data from Chinese samples is available.

Gymnopanella Sand – Leiva, J.V. McDonald & Thorn, Mycologia 108(4): 821 (2016)

Type species – *Gymnopanella nothofagi* P. Sandoval–Leiva, J.V. McDonald & Thorn

Spectrum of reported species in China – No records have been found regarding reports of this genus in China.

Notes – The genus is monotypic, known only from Chilean *Nothofagus* forest, which is part of the Chile–Patagonian floristic realms (Sandoval–Leiva et al. 2016, Liu et al. 2023). No evidence showed this genus distribute in China.

Hymenoporus Tkalčec, Mešić & Chun Y. Deng, in Tkalčec, Mešić, Deng, Pleše & Ćetković, Phytotaxa 204(3): 205 (2015)

Type species – *Hymenoporus paradoxus* Tkalčec, Mešić & Chun Y. Deng

Spectrum of reported species in China – *Hymenoporus paradoxus* (Tkalčec et al. 2015).

Notes – The genus is monotypic, known only from Guangxi Province of China, which is part of the Holarctic floristic realms (Tkalčec et al. 2015, Liu et al. 2023).

Lentinula Earle, Bull. New York Bot. Gard. 5: 416 (1909)

Type species – *Lentinula cubensis* (Berk. & M.A. Curtis) Earle ex Pegler [= *Lentinula boryana* (Berk. & Mont.) Pegler]

Spectrum of reported species in China – *Lentinula edodes* (Berk.) Pegler (Chow 1935).

Notes – The genus was initially proposed by Earle (1909) but often treated as a synonym for *Lentinus* Fr. (Singer 1936, 1949, 1986). Pegler (1975) accepted this genus based on the non-decurrent lamellae and the monomitic hyphae system. Later, the genus was monographed by Pegler (1983). The genus has been reported from five continents: Africa, Asia, North America, Oceania, and South America (Menolli et al. 2022); these regions encompass at least six floristic realms, namely the African, Australian, Holarctic, Indo-Malesian, Neotropical, and Novozealandic (Liu et al. 2023). The famous edible fungus, *L. edodes* (Berk.) Pegler, is the only species of the genus distributed in China.

Neonothopanus R.H. Petersen & Krisai, Persoonia 17(2): 210 (1999)

Type species – *Neonothopanus nambi* (Speg.) R.H. Petersen & Krisai

Spectrum of reported species in China – *Neonothopanus nambi* (Speg.) R.H. Petersen & Krisai (Yan et al. 2015).

Notes – Only one species within the genus was reported in China.

Omphalotus Fayod, Annls Sci. Nat., Bot., sér. 7 9: 338 (1889)

Type species – *Omphalotus olearius* (DC.) Singer

Spectrum of reported species in China – *Omphalotus flagelliformis* Zhu L. Yang & B. Feng, *O. guepiniiformis* (Berk.) Neda, *O. mangensis* (Jian Z. Li & X.W. Hu) Kirchm. & O.K. Mill., *O. olearius* (DC.) Singer (Liu & Hu 1993, Li & Bau 2014, Mao 2000, Yang & Feng 2013).

Notes – Four species within the genus were reported in China, but most of them lack molecular evidence.

Paramycetinis R.H. Petersen, in Petersen & Hughes, Mycotaxon 135: 9 (2020)

Type species – *Paramycetinis austrobrevipes* R.H. Petersen

Spectrum of reported species in China – No records have been found regarding reports of this genus in China.

Notes – The genus is monotypic, associated with *Arthrotaxis* and *Nothofagus*, and known only from Tasmania in Australia and the North Island of New Zealand, both of which are part of the Novozealandic floristic realms (Petersen & Hughes 2020, Liu et al. 2023).

DISCUSSION

The phylogram presented in this study is congruent with the findings of Looney et al. (2021), Oliveira et al. (2019), Petersen & Hughes (2020), and Sandoval–Leiva et al. (2016) at its core. The genera in the robust clade D in this study, which includes *Collybiopsis* (*Marasmiellus* in other research), *Connopus*, *Lentinula*, *Pseudomarasmius*, *Pusillomyces*, and *Rhodocollybia*, are in agreement with the unsupported clade formed by clade A and clade B in Looney et al. (2021) and Oliveira et al. (2019). The evolutionary relationships in clade D are similar in Petersen & Hughes (2020) and Sandoval–Leiva et al. (2016); the only difference is that *Pseudomarasmius* or *Pusillomyces* was excluded from their analyses. The clade C in this study, comprising *Gymnopus*, *Paragymnopus*, and *Marasmius* sp. 1, corresponds to the clade formed by clades G and H in Oliveira et al. (2019), both of which are unsupported. The strongly supported clade A (*Anthracophyllum*, *G. contrarius*, *Neonothopanus*, and *Omphalotus*) and clade B (*Gymnopanella*,

Mycetinis, and *Paramycetinis*) in this study differ slightly from previous studies. In one case, they are not confined to a single clade; in another, a specific genus is excluded from the analysis, but they are closely related in phylogeny (Looney et al. 2021, Oliveira et al. 2019, Petersen & Hughes 2020, Sandoval–Leiva et al. 2016). In Oliveira et al. (2019), the morphology and phylogeny of genera in Omphalotaceae were more elucidated with the delimitation of *Gymnopus* in the family, which led them to argue that *G. contrarius* would represent a distinct genus. Agreeing with Oliveira et al. (2019), the lineage now has twelve *G. contrarius* specimens from China, Pakistan, Russia and USA including the type specimen, the lineage along with *Anthracophyllum*, *Neonothopanus*, and *Omphalotus* collectively form a well–supported clade (clade A) as basal (80% / 0.99, Fig. 1d–e), reflecting the earlier emergence. This result provides enough support for the proposal of a new genus, *Peckorumyces* gen. nov., since it did not branch within the *Gymnopus* clade nor even have a close relationship. According to the phylogenetic tree (ITS and LSU combined, Fig. 1d–e), the type specimen of *M. contrarius* from the USA is clearly conspecific with the specimens from China morphologically evaluated here. This indicates that the new genus is monotypic, distributed from North America to temperate Asia and Nearctic to Palearctic biogeographic realms until new species, if extent, are discovered. As indicated by phylogeny, they are very similar in morphology and can be distinguished from *G. contrarius*. *Anthracophyllum* exhibits decurrent lamellae, a context encrusted with conspicuous pigment granules, and lacks a garlic odour (Pegler & Young 1989). *Neonothopanus* possesses decurrent lamellae, typically has an eccentric stipe, and lacks a garlic odour (Capelari et al. 2011, Petersen &Krisai-Greilhuber 1999, Desjardin et al. 2008, Ndong et al. 2011). *Omphalotus*, famed for bioluminescence, features decurrent lamellae (Berkeley 1944, Bigelow et al. 1976, Liu & Hu 1993, Mora & Guzman 1983, Murrill 1945, Neda 2004, Raithelhuber 1988, Schweinitz 1822, Singer 1986, Spooner 1977, Yang & Feng 2013). In terms of evolutionary history, *G. contrarius* along with *Anthracophyllum*, *Neonothopanus* and *Omphalotus* within the basal clade, can be traced back to the most recent common ancestor of Omphalotaceae at the earliest point. This suggests that the trait of garlic-like odour diverged into some other genera, such as the species within the *G.* sect. *Impudicae* (except for *G. barbipes* R.H. Petersen & K.W. Hughes, which lacks a description of garlic), the majority of *Mycetinis* species, certain species of *Paragymnopus*, and some species of *Paramycetinis* (Antonín & Noordeloos 2010, Oliveira et al. 2019, Petersen & Hughes 2017, 2020). The chemical reaction that turns green in KOH existing in *Anthracophyllum*, was diverged into at least *Gymnopus* and *Mycetinis* (Petersen & Hughes 2017, Antonín & Noordeloos 2010).

In clade B, which includes *Gymnopanella*, *Mycetinis*, and *Paramycetinis*, their morphology is distinct from that of the new genus. Contrary to Petersen & Hughes (2020), this study reveals that *Paramycetinis* pairs as a sister group with *Gymnopanella*, rather than with *Mycetinis*. In relative terms, these three genera can be more readily circumscribed in distinction from *G. contrarius*. Both Petersen & Hughes (2020) and this study implied that these three genera and *G. contrarius* are not congeneric in phylogeny. Morphologically, *Paramycetinis* is characterised by its minute to small basidiomata, fusiform pleurocystidia, and a pileipellis with slime or gelatinised features (Petersen & Hughes 2020). *Gymnopanella*, on the other hand, is distinguished by its reticulate–lamellate structure, lateral stipe, and a pileipellis composed of thick-walled hyphae (Sandoval–Leiva et al. 2016). *Mycetinis* features the pileipellis with inflated hyphal termini that can be subglobose, obpyriform, or deeply lobed (Petersen & Hughes 2017 and this study).

In clade C, which includes *Gymnopus*, *Paragymnopus*, and an unassigned species, their morphology tends to converge with that of the new genus, particularly in the *G.* sect. *Impudicae*. Halling's studies on the combination of *M. contrarius* (as *G. contrarius*) sufficiently demonstrate the difficulty of distinguishing them based solely on morphology (Antonín et al. 1997). However, recent studies have sufficiently aided in excluding this species from *Gymnopus*, but leaving *G.* sect. *Impudicae*. *Gymnopus* sect. *Gymnopus* is distinctly distinguishable from *G. contrarius* due to its basidiomata with a non–garlic odour, a stipe that is either glabrous or finely pruinose and roots in the substrate, and a pileipellis that predominantly consists of inflated cells mixed with some structures resembling the *Dryophila*-type (Antonín & Noordeloos 2010, Li et al. 2022a). *Gymnopus*

sect. *Androsacei* stands apart from *G. contrarius* with its small and non–garlic odour basidiomata, filiform stipe, cheilocystidia featuring *Siccus*-type broom cells or coralloid elements, and the pileipellis that showcases both *Siccus*-type broom cells and coralloid elements (Antonín & Noordeloos 2010, Oliveira et al. 2019). *Gymnopus* sect. *Levipedes* differs from *G. contrarius* in its polished or pubescent stipe and the presence of *Dryophila*-type structures in the pileipellis (Antonín & Noordeloos 2010). The distinction between *G.* sect. *Impudicae* and *G. contrarius* is subtle, primarily marked by the absence of numerous thick-walled caulocystidia exceeding 100 µm in length (Antonín & Noordeloos 2010). However, the significant differences in the three presented DNA fragments and their distinctive phylogenetic relationships strongly suggest they cannot be congeneric. For the genus *Paragymnopus*, sect. *Paragymnopus* typically either lacks cheilocystidia or possesses them in clavate to utriform shapes with its pileipellis consisting of a gelatinized layer, while sect. *Pinophili* features a glabrous–shining stipe, cheilocystidia in the form of *Siccus*-type broom cells, and a pileipellis with a well–developed *Rameales* structure (Oliveira et al. 2019, Petersen & Hughes 2016). The morphological features of *Marasmius* sp. 1 (TENN–F–050116) are unknown, and it would represent a new genus if it helps to separate *Gymnopus* and *Paragymnopus*.

In clade D, which includes *Collybiopsis*, *Connopus*, *Lentinula*, *Pseudomarasmius*, *Pusillomyces*, and *Rhodocollybia*, their morphological boundaries are very clear except for the genus *Collybiopsis*. Species within *Collybiopsis* are morphologically similar to *G. contrarius*, a genus to which *G. contrarius* could more adequately be assigned rather than *Gymnopus* s. str. based on morphology alone. The limit between some *Collybiopsis* species and *G. contrarius* based on basidiomata morphology is not obvious, indicating a strong convergence that mislead taxonomy. The strict combination of macro and microstructures, along with the distinct garlic odour and the substrate preference in *G. contrarius* finds no pair in *Collybiopsis* (Antonín & Noordeloos 2010, Oliveira et al. 2019, Petersen & Hughes 2021). The cheilocystidia with highly irregular apical projections in *G. contrarius* seem unique, although some *Collybiopsis* species may present similar structures. Another important characteristic of *G. contrarius* is its substrate preference for Pinaceae leafy elements (Peck 1911, Halling 1983, Desjardin 1989, present paper) and the stipe having basal mycelia. *Collybiopsis* include a multitude of small and thin to large and fleshy basidiomata habit: marasmioid, marasmielloid, gymnopoid, omphalioid to tricholomatoid (Antonín & Noordeloos 2010, Oliveira et al. 2019, Petersen & Hughes 2021). Basidiomata in *G. contrarius* are only gymnopoid and thin. Additionally, some sequences from type or non–type specimens of *Gymnopus* or *Marasmiellus* were placed within the *Collybiopsis* clade in this study. The evidence is sufficient to reclassify them into *Collybiopsis* if the sequences are from type specimens. For the remaining non–*Collybiopsis* species within this clade, it would be better to examine their morphology or generate new sequences based on the type material before making a final decision. *Connopus* exhibits a connate habit, basidiomata devoid of a garlic odour, and a pileipellis of lax trichoderm, as described by Hughes et al. (2010). The genus *Lentinula* is distinctly characterized by its typically fleshy basidiomata, close to very crowded lamellae, often accompanied by veil remnants, a squamulose or scaled stipe, and inflated clavate to spheropedunculate cheilocystidia (Looney et al. 2021, Mata & Petersen 2000, Menolli et al. 2022, Oliveira et al. 2022, Pegler 1983). *Pseudomarasmius*, as outlined by Petersen & Hughes (2020), is marked by its non–garlic odour basidiomata, the general absence of clamp connections or their rarity, and a pileipellis that either gelatinizes or showcases a *Rameales* structure. *Pusillomyces* is a clampless genus notable for its diminutive basidiomata, filiform stipe, and pileipellis containing elements akin to *Siccus*-type broom cells or *Rameales* structures (Cesar et al. 2020, Oliveira et al. 2019, and this study). Moreover, combining the morphological comparison and phylogenetic results, the sample identified as *S. afibulatus* by Desjardin & Perry (2017) is possibly representative of a species within *Pusillomyces*. However, because the sequence from the type specimen is lacking and not all relevant samples were examined in this study, the combination has not been proposed here. Lastly, *Rhodocollybia*, as characterized by Antonín & Noordeloos (2010), displays cyanophilous and at least partly distinctly dextrinoid basidiospores, complemented by a pinkish spore print.

Perhaps due to the presence of only LSU sequences, most phylogenetic analyses of Omphalotaceae, including this study, have not incorporated *Hymenoporus*. However, its true tubular hymenophore, dendriform cheilocystidia, and pileipellis hyphae mixed with dendriform cells sufficiently distinguish it from the new genus (Tkalčec et al. 2015). Neither morphology nor molecular phylogeny support *G. contrarius* belonging to *Gymnopus* sensu stricto. Therefore, a new genus, *Peckorumyces* gen. nov., was proposed here to reconcile the conflict between morphology and phylogeny.

Conclusions

A total of 29 taxonomic units from eight genera within Omphalotaceae were involved in this study. Two historical type specimens were examined, and one of them was successfully sequenced, enabling the bridging of morphology and molecular phylogeny. Thereby, a robust and well–sampled phylogenetic analysis of Omphalotaceae was presented here to help improve the knowledge of species diversity in China, and understand the relationships among the genera. This study further discusses the morphological circumscription between each clade and, therefore, contributes to the evolutionary study of the family. As a result: the polyphyletic nature of *Gymnopus* has been resolved; the taxonomic spectrum of Omphalotaceae has been significantly expanded, particularly in China, by the proposal of one new genus, *Peckorumyces* gen. nov, the introduction of 15 new species, the detailed descriptions of five known species and the proposal of nine new combinations according to the analysis based on sequences from type material. Among the known taxa, one known genus and three known species are new to China, marking a substantial update in our understanding of the fungal diversity in this region.

Combinations

Collybiopsis billbowesii (Desjardin & B.A. Perry) J.P. Li & Chang–Tian Li, comb. nov.
Fungal names: FN571931
Basionym: *Gymnopus billbowesii* Desjardin & B.A. Perry, Mycosphere 8(9): 1385 (2017)
Collybiopsis cylindrica (J.L. Mata) J.P. Li, J.S. Oliveira, Antonín & Chang–Tian Li, comb. nov.
Fungal names: FN571839
Basionym: *Gymnopus cylindricus* J.L. Mata, in Mata, Halling & Petersen, Fungal Diversity 16: 118 (2004)
≡ *Marasmiellus cylindricus* (J.L. Mata) J.S. Oliveira, in Oliveira, Vargas–Isla, Cabral, Rodrigues & Ishikawa, Mycol. Progr. 18(5): 734 (2019)
Collybiopsis diaphana (César, Bandala & Montoya) J.P. Li, Antonín, J.S. Oliveira & Chang–Tian Li, comb. nov.
Fungal names: FN571840
Basionym: *Marasmiellus diaphanus* César, Bandala & Montoya, in César, Montoya, Bandala & Ramos, Mycol. Progr. 19(10): 1022 (2020)
Collybiopsis hirtelloides (Desjardin & B.A. Perry) J.P. Li, Antonín, J.S. Oliveira & Chang–Tian Li, comb. nov.
Fungal names: FN571841
Basionym: *Gymnopus hirtelloides* Desjardin & B.A. Perry, Mycosphere 8(9): 1361 (2017)
Collybiopsis mustachia (Desjardin & B.A. Perry) J.P. Li & Chang–Tian Li, comb. nov.
Fungal names: FN571932
Basionym: *Gymnopus mustachius* Desjardin & B.A. Perry, Mycosphere 8(9): 1382 (2017)
Collybiopsis ocella (Desjardin & B.A. Perry) J.P. Li, Antonín, J.S. Oliveira & Chang–Tian Li, comb. nov.
Fungal names: FN571842
Basionym: *Gymnopus ocellus* Desjardin & B.A. Perry, Mycosphere 8(9): 1363 (2017)
Collybiopsis pseudolodgeae (J.L. Mata) J.P. Li & Chang–Tian Li, comb. nov.
Fungal names: FN571933

Basionym: *Gymnopus pseudolodgeae* J.L. Mata, in Mata, Halling & Petersen, Fungal Diversity 16: 120 (2004)
Collybiopsis trogioides (A.W. Wilson, Desjardin & E. Horak) J.P. Li, J.S. Oliveira, Antonín & Chang–Tian Li, comb. nov.
Fungal names: FN571843
Basionym: *Gymnopus trogioides* A.W. Wilson, Desjardin & E. Horak, Sydowia 56(1): 195 (2004)
≡ *Marasmiellus trogioides* (A.W. Wilson, Desjardin & E. Horak) J.S. Oliveira, in Oliveira, Vargas–Isla, Cabral, Rodrigues & Ishikawa, Mycol. Progr. 18(5): 736 (2019)

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