

RESEARCH ARTICLE



Catalogue of fungi in China 3. New taxa of macrofungi from southern Xizang, China

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ABSTRACT

This is the third paper in the series *Catalogue of fungi in China* that aims to systematically and promptly publish Chinese fungal species. In this paper of the series, we focus on macrofungi from the southern border area of Xizang, a previously less concerned region. A total of 15 new species in six orders, 11 families, and 12 genera from *Agaricomycetes*, *Basidiomycota* are described. Both morphological and phylogenetic analyses support the identity of these new species and their taxonomic placements. In addition, one new combination *Trechispora cryptomerioides* is proposed. We hope that the third paper in the series *Catalogue of fungi in China* will draw more attention to reporting Chinese fungal diversity in the border areas of Xizang and other special geographic regions besides the aim of this series itself.

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1. Introduction

Fungi are of benefit to human beings in various ways, like as the sources of food and medicines (Zhou et al. 2022; Li et al. 2024). On the contrary, some fungi are human and crop pathogens that threaten the survival of human beings (Fones et al. 2020; Rokas 2022). China is expected to possess enumerable fungal species that exist in the highly diverse landscapes ranging from boreal to tropical zones (Zhou et al. 2011; Yuan et al. 2023). It is well accepted that the multidimensional recognition of fungal species diversity is the essential precondition for utilisation and conservation of these strategic biological resources from both positive and negative aspects (Bai et al. 2023; Zhou and May 2023; Liu et al. 2024a). Therefore, we initiated the series of *Catalogue of fungi in China* to publish Chinese fungal species systematically and promptly, and focused on the fungi in a special habit, viz. plants in the first paper (Liu et al. 2024c). Here, in the third paper of this series, we


moved our attention to macrofungi from the border areas of Xizang, a previously less concerned region, partially due to the inconvenience of transportation and extreme climate conditions.

The investigation of fungal resources in Xizang began in the late 19th century. Patouillard (1886) studied the fungal specimens collected from Xizang by some French priests and published several new species. It was followed by some foreign collectors sampling in the Himalayan region, including the border area of Nyingchi (Balfour-Browae 1955). The Comprehensive Scientific Expedition to Qinghai-Xizang Plateau, Academia Sinica (1983) carried out wide-ranging investigations in Xizang and reported 76 families, 271 genera, and 880 species of fungi resources. Zang (1979, 1980) described nine new species of macrofungi from southeast border area of Xizang. Mao et al. (1993) recorded 588 species of economic macrofungi in Xizang, including 415 edible fungi, 238 medicinal fungi, and 135 poisonous fungi. In the recent five years, Chinese scholars have

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published more than 15 new fungal species typified by the specimens from the border area of Xizang (Wu et al. 2020; Li et al. 2021; Zeng and Zhuang 2021; Zhao et al. 2021; Song et al. 2022; Wang et al. 2023b). However, the diversity of macrofungi in the border area of Xizang, especially the south Himalayan region might be less explored.

The Himalayas, located in the southern edge of Qinghai-Xizang Plateau and the border area of Xizang, are the highest (average alt. over 6,000 m) mountain range on the earth. The topography of the south and north Himalayas is asymmetrical. Unlike the wide plateau and valley basins on the north side, the terrain in south Himalayas drops sharply to below alt. 2,500–3,500 m, forming the landform of high mountains and deep valleys (Zhang 2005). Influenced by the warm and humid air currents from Indian Ocean, the south Himalayas has abundant rains in summer, which provides a suitable habitat for the growth of macrofungi.

During a field trip in July 2023, we collected 882 specimens in six counties from the border area of Xizang, China (Table 1). According to morphological examinations and phylogenetic analyses, the collections were identified as 339 species, belonging to two phyla, five classes, 16 orders, 40 families, and 169 genera. Of these species, 15 new macrofungal species were revealed and are described in this paper. In addition, one new combination is proposed. It should be noted that the border area of Xizang is huge, and thus much more efforts should be made to clarify the macrofungal diversity there. The current paper represents the preliminary systematic exploration of macrofungi in this region.

2. Materials and methods

Specimens were collected from Xizang Autonomous Region, China, and were deposited in the fungarium of Institute of Microbiology, Chinese Academy of Sciences (HMAS). Regarding the morphological examinations and phylogenetic analyses of various macrofungal groups, we generally took Wang et al. (2021, 2023c), Wang and Zhou (2024), and Shen et al. (2023) as references for corticioid fungi, Xie et al. (2021, 2022) and Wang et al. (2023a) for agarics, and Wu et al. (2023) for gasteroid fungi. The fresh basidiomata were photographed in situ, and the macro-morphological characters were recorded in detail before drying in an oven at 45 °C and also observed with a stereomicroscope at a magnification of up to 100×. Descriptions of the microscopical characters are from dried collections with a light microscope at a magnification of up to 1,000×. The newly generated ITS, nLSU, *tef1*, and *rpb2* sequences were deposited in the GenBank (<https://www.ncbi.nlm.nih.gov/genbank/>), and additional sequences used for phylogenetic analyses are also given in the supplementary materials (Tables S1–S12). Sequences for supporting the independence of new taxa in each genus were separately assembled and aligned in MAFFT v7.526 (Katoh et al. 2019). The matrix of dataset was manually adjusted with BioEdit v7.2.6. Multilocus datasets were concatenated using SequenceMatrix v1.9 (Vaidya et al. 2011). MrModeltest v2.3 was used to calculate the best model for BI analysis (Nylander 2004). Bayesian Inference (BI) and Maximum Likelihood (ML) methods were performed with MrBayes v3.2.6 (Ronquist and Huelsenbeck 2003) and MEGA v11 (Tamura et al. 2021), respectively.

Table 1. Information of the sampling sites in the border area of Xizang, China.

County	Location	Coordinate
Dingjie	Chentang Town, Chentanggou	27.87N, 87.42E
Dingri	Zhaxizong Town, the road to Everest Base Camp	28.34N, 86.96E
Jilong	Jilong Town, Jilonggou	28.37N, 85.33E
Kangma	Gala Town, along the road	28.26N, 89.38E
Nielamu	Zhangmu Town, Zhangmu Port	27.96N, 85.98E
Xietongmen	Tongmen Town, along the road	29.41N, 88.21E

3. Taxonomy

Basidiomycota

Agaricomycetes

Agaricales Underw., *Moulds, mildews and mushrooms. A guide to the systematic study of the Fungi and Mycetozoa and their literature* (New York): 97 (1899)

Bolbitiaceae Singer, *Pap. Mich. Acad. Sci.* 32: 147 (1948) [1946]

Notes: Bolbitiaceae, having the habitat preferences on leaf-litter and dung, is characterised by tiny fruiting bodies, balloon-shaped cells in pileus, and brown to rust colour basidiospores (Toth et al. 2013). This family includes the commonly encountered genera *Bolbitius* and *Conocybe* as well as several quite rare genera such as *Galerella*, *Pholiotina*, and *Pluteolus*. Some species in Bolbitiaceae are toxic due to containing hallucinogenic compounds, i.e. psilocybin, psilocin, phallotoxins, and amatoxins (Huang and Chen 2003).

Conocybe Fayod, *Annls Sci. Nat., Bot., sér. 7* 9: 357 (1889)

Notes: *Conocybe*, typified by *C. tenera*, is characterised by a conical pileus, brown to rusty lamellae, powdery or hairy stipe, and lageniform cheilocystidia (Song and Bau 2023). This genus is widely distributed and often grows on fertile soils and dung of herbivores.

Conocybe himalayana Ke Wang, T.Z. Wei & P. Hong, sp. nov. [Figure 1](#)

Fungal Names: FN 571986.

Etymology: *himalayana* (Latin), refers to its type locality, south Himalayas of Xizang, China.

Diagnosis: Differs from *C. ceracea* by the persistently pubescent pileus with faintly filiform striae at the margin.

Description: *Pileus* 5–20 mm diam., subglobose at first, hemispherical, campanulate to convex when mature, margin decurved; surface faintly pubescent, sometimes slightly hygrophanous when moist, finely striate at the margin; orange brown, sometimes darkening to chestnut brown at the centre, margin paler, grey brown to dull brown when dry. *Lamellae* up to 3 mm wide, adnate, close, with lamellulae, pale ochre to orange-brown with pale crenulate edge at first, brown when mature. *Stipe* 30–58 × 1–3 mm, cylindrical, slightly enlarged at base, sometimes forming a bulb; surface slightly longitudinally striate, with whitish powder; honey yellow to yellowish brown. *Context* thin, fleshy, pale brown to orange brown, odour indistinct, taste mild.

Basidiospores 10.4–12.8 (–13.4) × 6.3–8.0 µm, Quotient (short for Q) = 1.4–1.7 (av. = 1.6), ovoid to ellipsoid, with germ pore, slightly thick-walled, containing oil droplets, yellow-brown. *Basidia* 23–31 × 10–13 µm, clavate, 4- or 2-spored, with vacuolar contents and olivaceous intracellular pigment. *Cheilocystidia* 18–23 × 7–10 µm, lageniform, with 3.0–4.5 µm wide capitula. *Pileipellis* hymeniform, of subglobose, broad clavate to vesiculate elements, 28–50 × 16–30 µm, hyaline. *Clamp-connections* present in all tissues.

Materials examined: China. Xizang Autonomous Region, Dingri County, Zhaxizong Town, gregarious on soil in grassland, 28.35N, 86.96E, alt. 4,271 m,

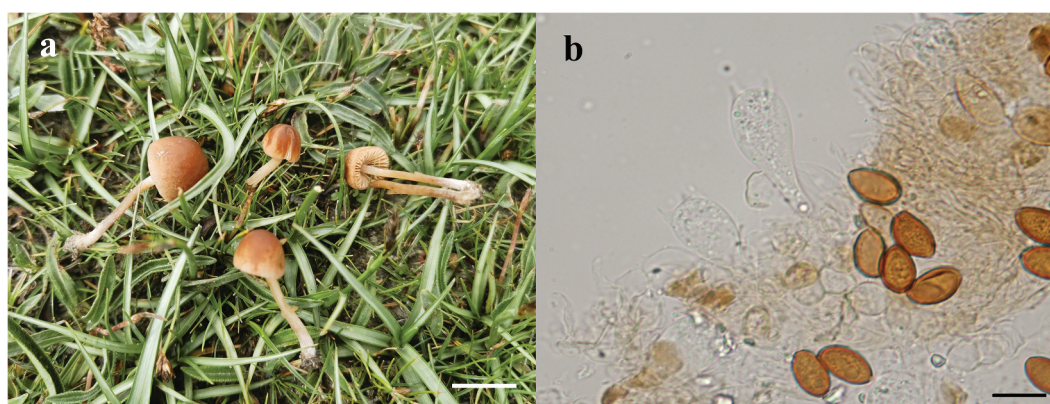


Figure 1. Morphological structures of *Conocybe himalayana* (HMAS 300535, holotype). (a) Basidiomes. (b) Basidia and basidiospores. Scale bars: a = 2 cm; b = 10 µm.

20 July 2023, Ke Wang, 2970 (HMAS 300535, holotype); 20 July 2023, Ke Wang, 2968 (HMAS 300534); 20 July 2023, Peng Hong, 153 (HMAS 300531); 20 July 2023, Peng Hong, 155 (HMAS 300532); Nielamu County, Zhangmu Town, 18 July 2023, Peng Hong, 149 (HMAS 300530).

Notes: *Conocybe himalayana* is characterised by its orange-tinged pileus with finely striate margin, honey-yellow stipe, and ovoid to ellipsoid basidiospores. Morphologically and phylogenetically, the new taxon is close to *C. ceracea* (Figure 2) (Song and Bau 2023), but *C. himalayana* differs from *C. ceracea* by its faintly filiform striae (like *Inocybe* species) at pileus margin. *Conocybe himalayana* is widely distributed in the alpine and subalpine areas of south Himalayas.

Entolomataceae Kotl. & Pouzar, Česká Mykol. 26: 218 (1972)

Notes: Entolomataceae is one of the three largest euagaric families and contains nearly 3,000 described species. This family is united by agarics with flesh-coloured or pinkish basidiospore prints and cyanophilic-walled basidiospores (Kluting et al. 2014).

Entoloma (Fr.) P. Kumm., Führ. Pilzk. (Zerbst): 23 (1871)

Notes: *Entoloma*, typified by *E. sinuatum*, with more than 2,300 species, has been described worldwide. Members of this genus are highly variable in morphological characters, comprising typical grassland species with a wide range of spore shapes (Noordeloos et al. 2022).

Entoloma zhangmuense Ke Wang, T.Z. Wei & P. Hong, sp. nov. Figure 3

Fungal Names: FN 571987.

Etymology: *zhangmuense* (Latin), refers to its type locality, Zhangmu Town in Nielamu County, Xizang Autonomous Region, China.

Diagnosis: Differs from *E. sororpratulense* and *E. pratulense* by the bigger basidiomata and crowded lamellae.

Description: *Pileus* 13–46 mm diam., hemispherical to campanulate at first, convex to convex-applanate when mature, usually with a faint umbo, margin straight to slightly crenulated; surface glabrous, hygrophanous and radically translucent-striate when moist; brownish grey at first, greyish to yellowish brown when mature, more or less darker at the

centre. *Lamellae* up to 2 mm wide, adnate to emarginate, close to moderately crowded, with lamellulae, pale grey to brownish grey when young, greyish pink when mature, edge concolorous. *Stipe* 11–45 × 1–3 mm, cylindrical with slightly thickened base, hollow; surface glabrous and polished, pallid, yellowish to greyish brown. *Context* thin, hygrophanous, concolorous to pileus, odour indistinct, taste mild.

Basidiospores (8.3–) 8.6–10.2 (–10.9) × (6.1–) 6.3–8.5 µm, $Q = 1.1–1.4$ (av. = 1.2), rather regularly quadrangular (rarely 5-angled) in side-view, hyaline, containing subhyaline oil droplets. *Basidia* 27–50 × 10–17 µm, clavate, 4-spored, rarely 2-spored, hyaline. *Cheilocystidia* 41–60 × 8.1–17.7 µm, clavate to narrowly lageniform, with long apical part, hyaline. *Hymenophoral trama* regular, of cylindrical hyphae, 3–15 µm diam., hyaline. *Pileipellis* a cutis of cylindrical hyphae, 3.5–9.9 µm diam., hyaline, sometimes with olivaceous intracellular granules. *Clamp-connections* present in all tissues.

Materials examined: China. Xizang Autonomous Region, Nielamu County, Zhangmu Town, gregarious on the soil in bamboo forest, 27.96N, 85.98E, alt. 2,595 m, 18 July 2023, Peng Hong, 143 (HMAS 300544, holotype); 18 July 2023, Peng Hong 141 (HMAS 300540); 18 July 2023, Peng Hong 144 (HMAS 300541); 18 July 2023, Ke Wang 2961 (HMAS 300542); 18 July 2023, Ke Wang 2963 (HMAS 300543).

Notes: *Entoloma zhangmuense* is characterised by greyish to yellowish brown basidiomata and rather regularly quadrangular basidiospores. In the phylogenetic tree, *E. zhangmuense*, *E. pratulense*, and *E. sororpratulense* make up a strongly supported clade (Figure 4). Morphologically, *E. zhangmuense* can be easily distinguished from *E. sororpratulense* and *E. pratulense*, by its slender basidiomata, longer stipe (up to 8 cm), and relatively more crowded lamellae. Furthermore, *E. zhangmuense* has regular quadrangular basidiospores as the members in the nearby clade such as *E. rhombisporum*, which differs from usually 5–6 angled spores of *E. pratulense* and *E. sororpratulense* (Noordeloos 1987; Noordeloos et al. 2022). *Entoloma zhangmuense* distributes in the subalpine regions of south Tibetan Plateau as current knowledge.

Hygrophoraceae Lotsy, Vortr. bot. Stammesgesch. 1: 705 (1907)

Notes: Hygrophoraceae is comprised of genera with different nutritional strategies, including

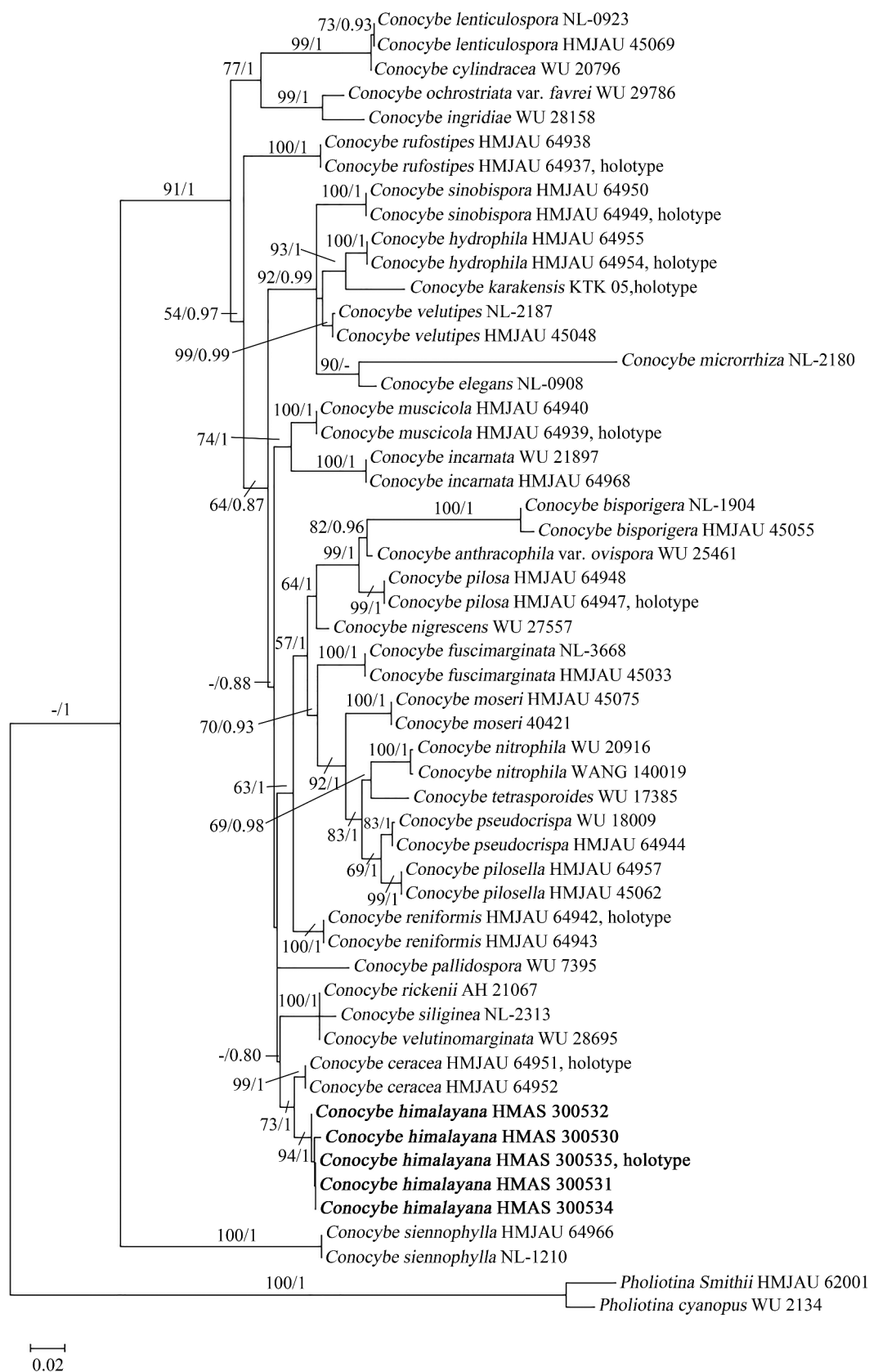


Figure 2. Phylogenetic relationship among species of *Conocybe* inferred from the combined dataset of ITS, nLSU, and *tef1* regions. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described species are in boldface.

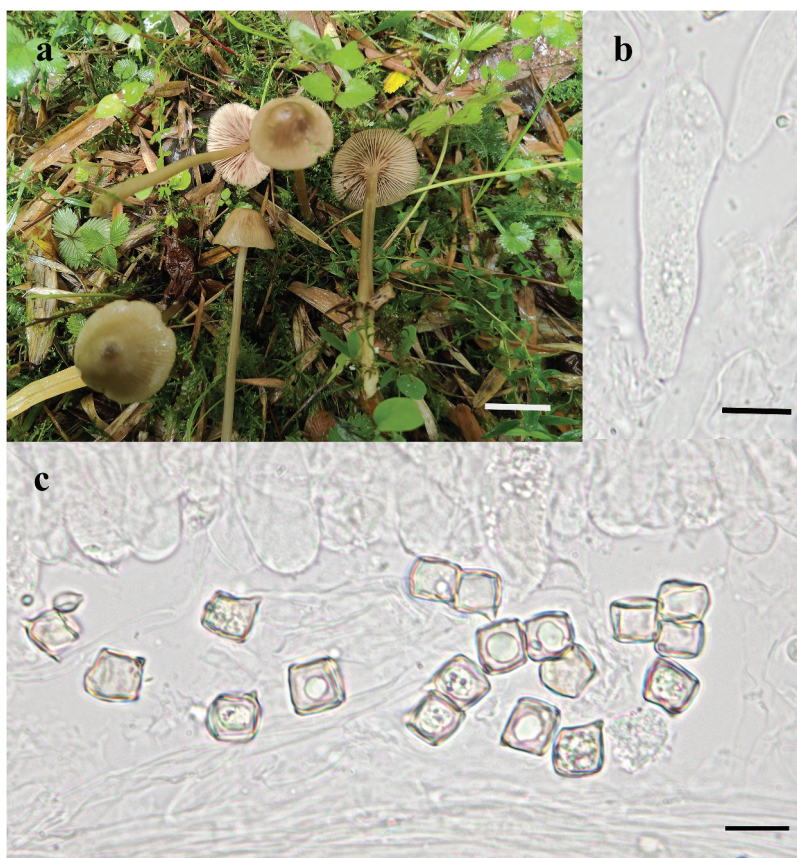


Figure 3. Morphological structures of *Entoloma zhangmuense* (HMAS 300544, holotype). (a) Basidiomes. (b) Basidia. (c) Basidiospores. Scale bars: a = 2 cm; b, c = 10 μ m.

saprotrophic and biotrophic associations with ectomycorrhizal plants, algae, cyanobacteria, and mosses (Lodge et al. 2014).

Cuphophyllus (Donk) Bon, Docums Mycol. 14(no. 56): 10 (1985) [1984]

Notes: *Cuphophyllus*, typified by *C. pratensis* (Schaeff.) Bon, is characterised by a mostly clitocyboid but rarely mycenoid pileus, decurrent lamellae, and smooth, hyaline, and inamyloid basidiospores (Voitk et al. 2020). It is a widely distributed genus occurring from the nemoral to the arctic-alpine zone (Boertmann 2010).

Cuphophyllus dingjieensis Ke Wang, T.Z. Wei & P. Hong, sp. nov. [Figure 5](#)

Fungal Names: FN 571988.

Etymology: *dingjieensis* (Latin), refers to its type locality, Dingjie County in Xizang Autonomous Region, China.

Diagnosis: Differs from *C. russocoriaceus* by its yellowish pileus and stipe. Not like *C. russocoriaceus* grows in hardwood/conifer wood forests, the new

species has only been found in the broad-leaved forest at high altitude (about alt. 3,000 m).

Description: *Pileus* 20–40 mm diam., convex, domed, margin crenulated; surface smooth, hygrophorous and faintly striate when moist; ivory white, yellowish to pale yellow, paling towards the margin. *Lamellae* up to 3 mm wide, decurrent, distant, unequal, with lamellulae, ivory white to pale yellow, nearly concolorous with pileus. *Stipe* 45–80 \times 4–6 mm, cylindrical or slightly enlarged at base, sometimes twisted, slender, hollow when mature; surface smooth, slightly longitudinally striated, cream-coloured. *Context* thin, fleshy, whitish to pallid, odour indistinct, taste mild.

Basidiospores (5.6–) 6.0–8.5 (–9.0) \times (4.0–) 4.4–6.6 μ m, $Q = 1.1$ –1.5 (av. = 1.3), ovoid to ellipsoid, smooth, subhyaline, containing oil droplets. *Basidia* (18–) 27–37 (–41) \times 5–7 (–8) μ m, clavate, hyaline, 4-spored, rarely 2-spored, sterigmata up to 7 μ m long, sometimes with vacuolar contents. *Cheilocystidia* 30–46 \times 4–6 μ m, clavate to lageniform, with long cylindrical necks, scattered, hyaline. *Pleurocystidia* absent.

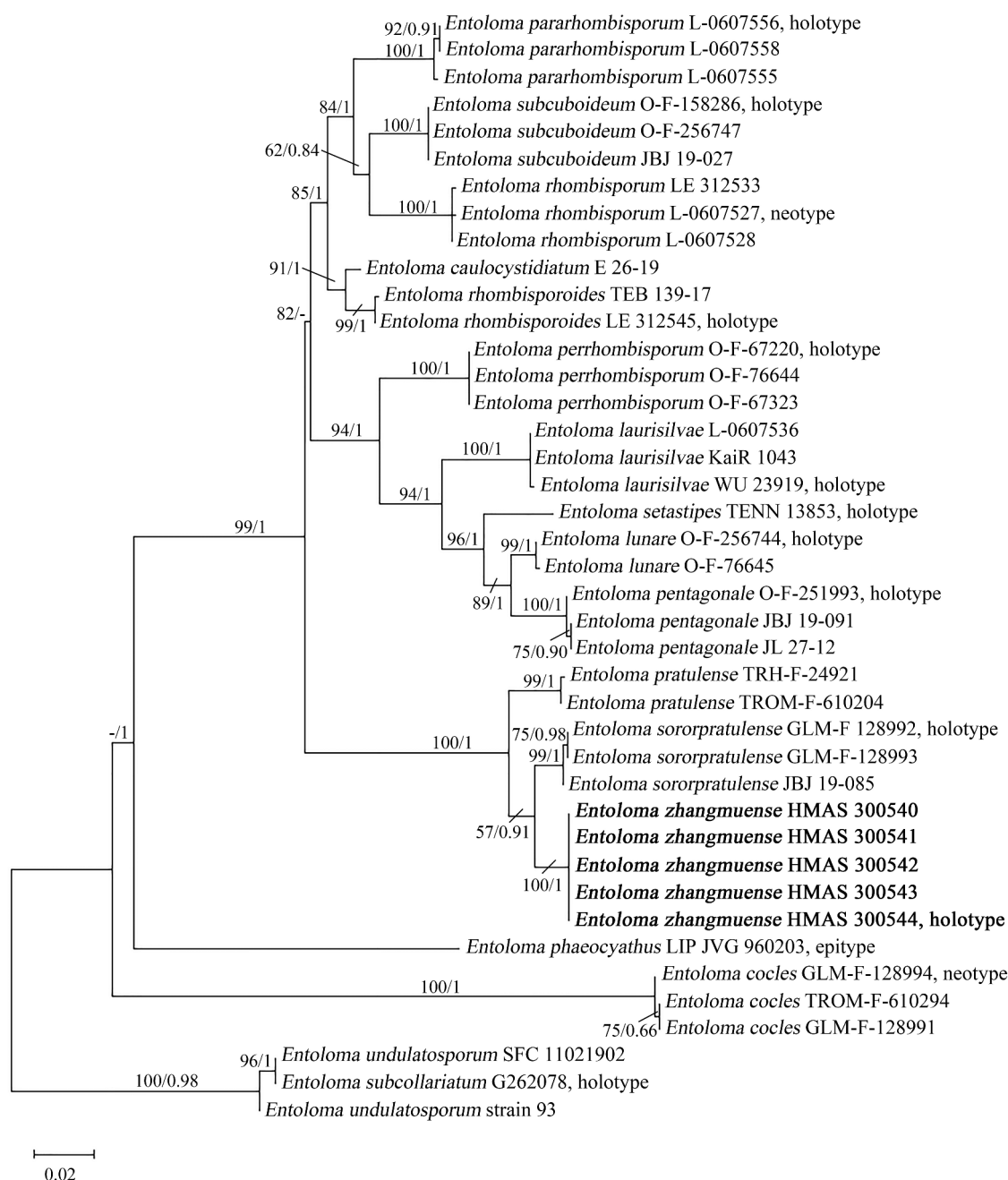


Figure 4. Phylogenetic relationship among species of *Entoloma* inferred from the dataset of ITS region. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described species are in boldface.

Pileipellis a cutis of repent hyphae, 3.0–8.5 µm in diam., hyaline. *Clamp-connections* present in all tissues.

Materials examined: China. Xizang Autonomous Region, Dingjie County, Chentang Town, in small groups of one to three separate basidiomata on soil in broad-leaved forest, 27.89N, 87.46E, alt. 3,019 m, 22 July 2023, Peng Hong, 214 (HMAS 300538, holotype).

Notes: *Cuphophyllus dingjieensis* is characterised by white to yellow pileus with faintly striate, pale, and hollow stipe, and oblong basidiospores. In the

phylogenetic tree, *C. dingjieensis* itself makes up a strongly supported clade near *C. russocoriaceus* (Figure 6). The new species is also similar to *C. russocoriaceus* in morphology but can be distinguished from the latter by its yellowish pileus and stipe (Desjardin et al. 2015). *Cuphophyllus dingjieensis* only distributes in the alpine area of south Himalayas from current sight, not like other phylogenetic-close species which are low altitude species mainly distributed in North America and Europe (Voitk et al. 2020).

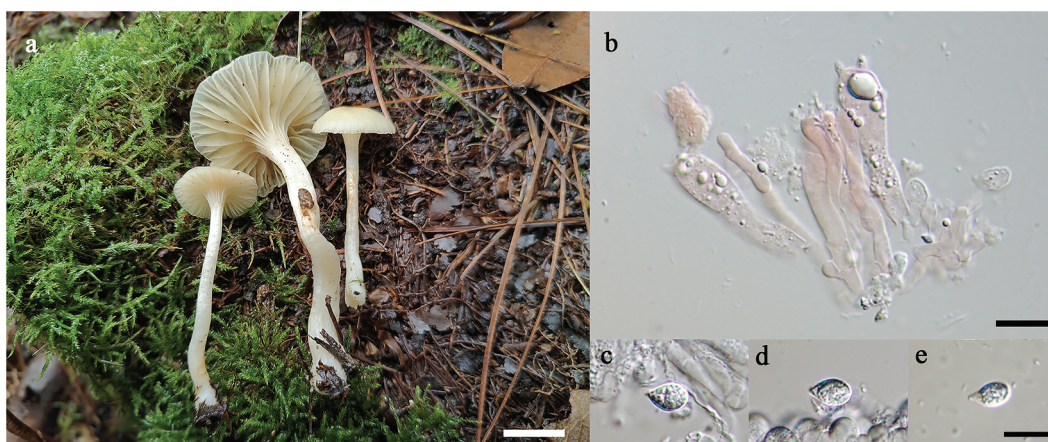


Figure 5. Morphological structures of *Cuphophyllus dingjieensis* (HMAS 300538, holotype). (a) Basidiomes. (b) Basidia. (c–e) Basidiospores. Scale bars: a = 2 cm, b–e = 10 μ m.

Cuphophyllus zhangmuensis Ke Wang, T.Z. Wei & P. Hong, sp. nov. [Figure 7](#)

Fungal Names: FN 571989.

Etymology: *zhangmuensis* (Latin), refers to its type locality, Zhangmu Town in Nielamu County, Xizang Autonomous Region, China.

Diagnosis: Differs from *C. aurantius* in orangish basidiomata and globose to subglobose basidiospores.

Description: *Pileus* 7–20 mm diam., convex to plano-convex, margin crenulated to incised; surface smooth, strongly hygrophanous when moist, faintly striate at the margin; orange to reddish orange, sometimes fading to yellowish orange at the margin. *Lamellae* up to 2 mm wide, decurrent or subdecurrent, subdistant, with lamellulae, pale orange to pinkish yellow, with entire and concolorous edge. *Stipe* 20–35 \times 2–5 mm, subcylindrical, occasionally compressed or twisted, hollow; surface smooth, hygrophanous, and glistening when moist, slightly longitudinally striate; orange to pale orange. *Context* thin, fleshy, hygrophanous, orange, odour indistinct, taste mild.

Basidiospores (4.6–) 5.4–6.0 (–6.3) \times (3.2–) 3.5–4.7 μ m, $Q = 1.2$ –1.5 (av. = 1.4), globose to subglobose, smooth, subhyaline, containing a single olivaceous or pale oil droplet. *Basidia* 20–27 \times 5.0–6.5 (–7) μ m, narrowly clavate, 4-spores, sterigmata up to 6 μ m long, sometimes with olivaceous vacuolar contents. *Cheilocystidia* and *pleurocystidia* unfound. *Pileipellis* a dense cutis of repent hyphae, 3–9 μ m diam., hyaline. *Clamp-connections* present in all tissues.

Materials examined: China. Xizang Autonomous Region, Nielamu County, Zhangmu Town, gregarious on soil in bamboo forest, 27.96N, 85.98E, alt. 2,576 m, 18 July 2023, Peng Hong, 148 (HMAS 300537, holotype); 18 July 2023, Peng Hong, 139 (HMAS 300536); 18 July 2023, Ke Wang, 2953 (HMAS 300539).

Notes: *Cuphophyllus zhangmuensis* can be easily distinguished from most other species of the genus by its small size, mycenoid, and totally orange basidiomata. Phylogenetically and morphologically, *C. dingjieensis* closely relates to *C. aurantius* ([Figure 6](#)). However, *C. aurantius* does not have distinct orange basidiomata (Leelavathy et al. 2006; Lodge et al. 2014). The new species is distributed in the alpine area of south Himalayas.

Spodocybe Z.M. He & Zhu L. Yang, MycoKeys 79: 139 (2021)

Notes: *Spodocybe*, typified by *S. rugosiceps*, is a newly proposed genus characterised by its clitocyboid and greyish pileus, decurrent lamellae, and ellipsoid and smooth basidiospores (He and Yang 2021). The genus is saprophytic and usually gregarious or caespitose in coniferous or mixed forests.

Spodocybe jilongensis Ke Wang, T.Z. Wei & P. Hong, sp. nov. [Figure 8](#)

Fungal Names: FN 571990.

Etymology: *jilongensis* (Latin), refers to its type locality, Jilong County in Xizang Autonomous Region, China.

Diagnosis: Differs from *S. tomentosum* and *S. rugosiceps* in the concave pileus with fibrous surface.

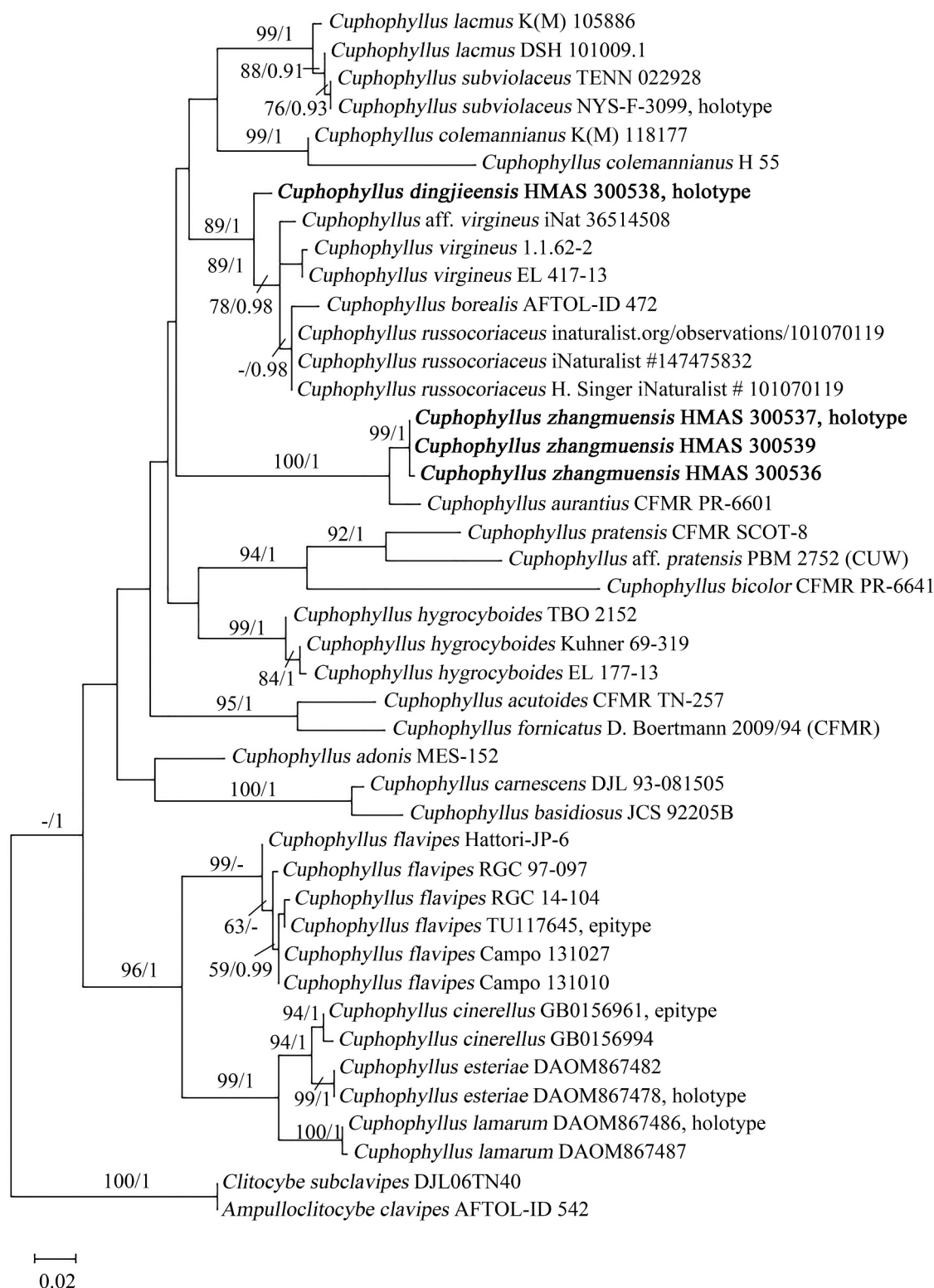


Figure 6. Phylogenetic relationship among species of *Cuphophyllus* inferred from the combined dataset of ITS, nLSU, and *rpb2* regions. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described species are in boldface.

Description: *Pileus* 20–59 mm diam., plano-convex with a depressed centre at first, concave when mature, margin straight and undulating; surface fibrous,

glabrescent when mature; greyish brown, dark greyish brown at the centre. *Lamellae* up to 3 mm wide, deeply decurrent, moderately crowded, with lamellulae,

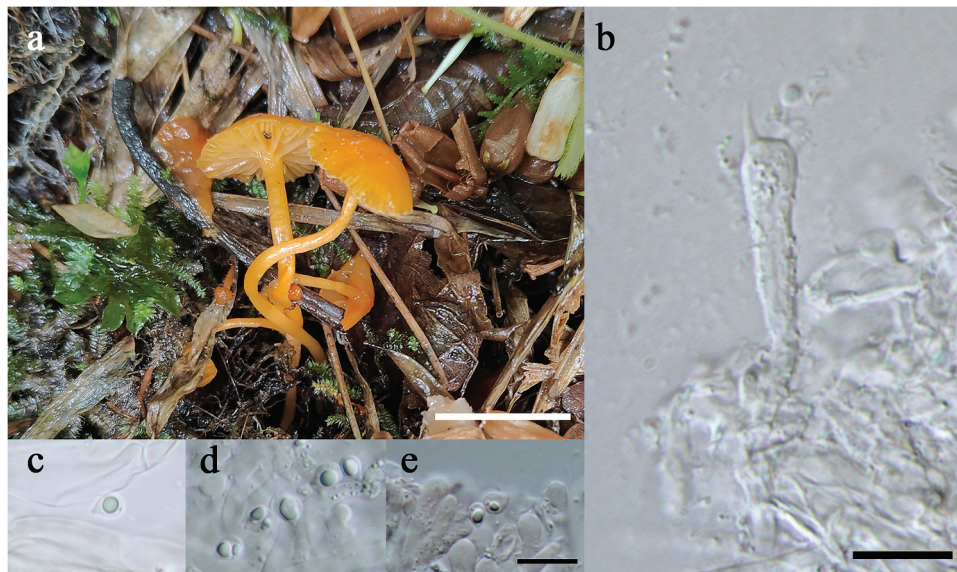


Figure 7. Morphological structures of *Cuphophyllus zhangmuensis* (HMAS 300537, holotype). (a) Basidiomes. (b) Basidia. (c–e) Basidiospores. Scale bars: a = 2 cm, b–e = 10 μ m.

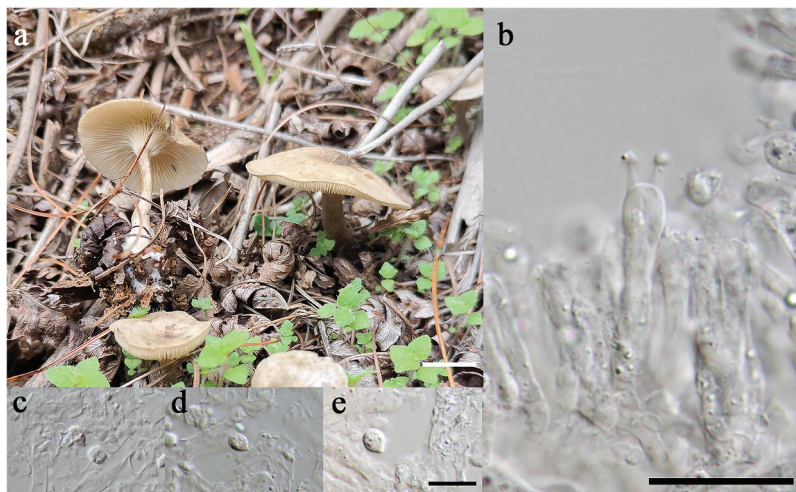


Figure 8. Morphological structures of *Spodocybe jilongensis* (holotype). (a) Basidiomes. (b) Basidia. (c–e) Basidiospores. Scale bars: a = 2 cm, b–e = 10 μ m.

whitish to creamy. *Stipe* 26–53 \times 2–5 mm, central, cylindrical, and slightly enlarged at base, sometimes flexuous, hollow; surface dry and nearly smooth, longitudinally striate; pale greyish brown to greyish brown. *Context* thin, up to 3 mm thick, fleshy, white, odour indistinct, taste mild.

Basidiospores (5.0–) 5.3–6.3 \times 2.7–4.0 (–4.3) μ m, $Q = 1.5–1.9$ (av. = 1.7), ellipsoid, smooth, hyaline, thin-walled. *Basidia* 16–20 \times 4.0–6.0 μ m, clavate, 4- or 2-spored, hyaline to subhyaline. *Cheilocystidia* and *pleurocystidia* unfound. *Lamellar trama* subregular, hyaline, of thin-walled cylindrical hyphae. *Pileipellis* a

cutis of thin-walled cylindrical hyphae, 3.0–7.0 μ m diam., subhyaline to with slightly brown pigment. *Clamp-connections* present in all tissue.

Materials examined: China. Xizang Autonomous Region, Jilong County, Jilong Town, scattered or solitary on soil in broad-leaved forest, 28.39N, 85.37E, alt. 3,291 m, 15 July 2023, Peng Hong, 106 (HMAS 300564, holotype); 15 July 2023, Peng Hong, 91 (HMAS 300563).

Notes: *Spodocybe jilongensis* is characterised by its concave and greyish brown pileus, concolorous stipe, and ellipsoid basidiospores. *Spodocybe jilongensis* is

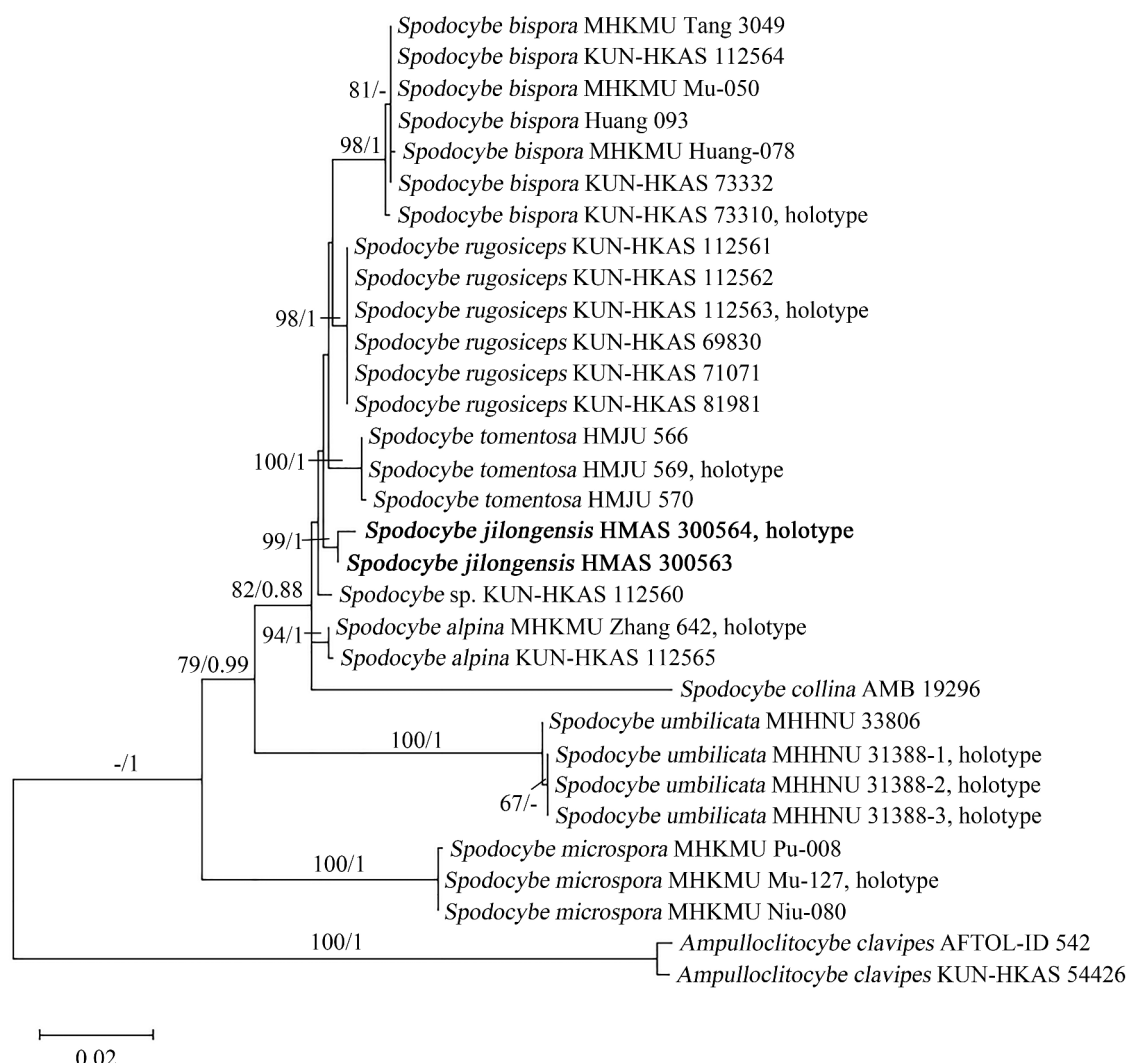


Figure 9. Phylogenetic relationship among species of *Spodocybe* inferred from the combined dataset of ITS, nLSU, and *rpb2* regions. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described species are in boldface.

close to *S. tomentosum* and *S. rugosiceps* in the phylogenetic tree (Figure 9), but *S. tomentosum* has white tomentum on the surface of pileus (Xu et al. 2023) and *S. rugosiceps* has a rugose pileus (He and Yang 2021). *Spodocybe jilongensis* is also morphologically similar to *S. bispora*, but differs from the latter by smaller fruitbodies and larger basidiospores [(7) 7.5–10.5 (11.5) × 3–4 μm] (He and Yang 2021). China has a rich species diversity of *Spodocybe*, as *S. bispora* and *S. rugosiceps* are distributed in Yunnan and *S. tomentosum* is found in Liaoning. *Spodocybe jilongensis* is the first record in south Himalayas of this genus.

Omphalotaceae Bresinsky, in Kämmerer, Besl & Bresinsky, Pl. Syst. Evol. 150(1–2): 113 (1985)

Notes: Omphalotaceae is a family including diverse marasmioid and gymnopoid agaric genera with wide distribution. The family has undergone many taxonomic changes based on phylogenetic studies recently (Matheny et al. 2006; Oliveira et al. 2019).

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

Notes: *Gymnopus*, typified by *G. fusipes*, is a widely distributed genus consisting of about 400 species. The genus is characterised by collybioid and marasmioid basidiomata, and commonly ellipsoid to oblong basidiospores (Antonín et al. 2013; Hu et al. 2022).

Gymnopus jilongensis Ke Wang, T.Z. Wei & P. Hong, sp. nov. Figure 10

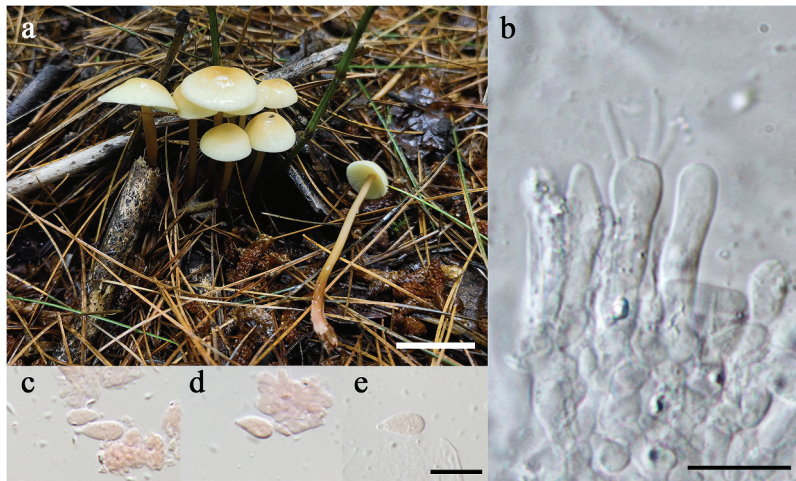


Figure 10. Morphological structures of *Gymnopus jilongensis* (HMAS 300549, holotype). (a) Basidiomes. (b) Basidia. (c–e) Basidiospores. Scale bars: a = 5 cm, b–e = 10 μ m.

Fungal Names: FN 571991.

Etymology: *jilongensis* (Latin), refers to its type locality, Jilong County in Xizang Autonomous Region, China.

Diagnosis: Differs from the closely related species *G. erythropus* in the more yellowish colour on pileus and stipes.

Description: *Pileus* 13–40 mm diam., convex to convex-applanate, margin sometimes uplifted; surface smooth, glabrous, slightly hygrophanous when moist; yellowish brown, orange brown to brown at the centre, margin whitish to yellowish. *Lamellae* up to 3 mm wide, adnate, crowded, with lamellulae, ivory white to creamy. *Stipe* 40–85 \times 3–6 mm, subcylindrical, slightly enlarged at the base, slender, hollow; surface fibrous, with white farinose, longitudinally striate; pale brown to orange brown, sometimes fading at the upper part and darker at the base. *Context* thin, fleshy, yellowish, odour indistinct, taste mild.

Basidiospores 5.1–8.6 (–9.6) \times 2.9–3.8 (–4.2) μ m, $Q = 1.6$ –2.4 (av. = 1.9), ovoid to ellipsoid, smooth, hyaline. *Basidia* 16–23 \times 5.0–6.6 μ m, clavate, 4- or 2-spored, sterigmata up to 7 μ m long. *Cheilocystidia* 19–26 \times 3.8–4.6 μ m, clavate, with obtuse on the top, thin-walled, hyaline. *Pileipellis* a cutis of irregularly repent hyphae with inflated and irregularly branched terminal elements, 4.0–8.7 μ m diam., hyaline. *Clamp-connections* present in all tissues.

Materials examined: China. Xizang Autonomous Region, Jilong County, Jilong Town, gregarious on the

deciduous layer or rotten branches in coniferous forest dominated by *Pinus* sp., 28.36N, 88.33E, alt. 2,708 m, 14 July 2023, Ke Wang, 2868 (HMAS 300549, holotype); 14 July 2023, Ke Wang, 2845 (HMAS 300547); 14 July 2023, Peng Hong, 27 (HMAS 300545); 14 July 2023, Peng Hong, 28 (HMAS 300546); 14 July 2023, Peng Hong, 44 (HMAS 300548).

Notes: *Gymnopus jilongensis* is characterised by its orange to brown pileus, brown and filiform stipe. Phylogenetically, the new species is close to *G. erythropus* (Figure 11), but they can be distinguished as the latter has a dark red-brown, shining stipe with typically red-brown coloured basal hairs (Antonín et al. 2013). Morphologically, *Gymnopus jilongensis* is quite similar to *G. longus* and *G. longisterigmaticus* (Hu et al. 2022). However, the two related species have basidium sterigmata up to 30 μ m long. The new species grows in broad-leaved forests in subalpine areas (about alt. 2,000–3,000 m).

Omphalinaceae Vizzini, Consiglio & M. Marchetti (2020)

Notes: Omphalinaceae is a newly proposed family in current thought, containing only two genera *Infundibulicybe* and *Omphalina* (Vizzini et al. 2024). Members of the family are usually saprotrophic growing on soil, litter, or associated with bryophytes. Zhang et al. (2022) described *Omphalina licheniformis* from China, which is the first example of a lichenised omphalinoid fungus except genus *Lichenomphalia* (Lichenomphaliaceae).



Figure 11. Phylogenetic relationship among species of *Gymnopus* inferred from the combined dataset of ITS and nLSU regions. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described species are in boldface.

Infundibulicybe Harmaja, Ann. bot. fenn. 40(3): 215 (2003)

Notes: *Infundibulicybe*, typified by *I. gibba*, is proposed to accommodate some species previously classified within *Clitocybe* mainly characterised by smooth and lacrymoid basidiospores with cyanophobic wall, and mycelia unable to reduce nitrate (Harmaja 2003). The genus used to be a family incertae sedis taxa, and just be classified within the new family Omphalinaceae (Vizzini et al. 2024).

Infundibulicybe jilongensis Ke Wang, T.Z. Wei & P. Hong, sp. nov. [Figure 12](#)

Fungal Names: FN 571992.

Etymology: *jilongensis* (Latin), refers to its type locality, Jilong County in Xizang Autonomous Region, China.

Diagnosis: Differs from the close species *I. ellipsospora* by subglobose to lacrymoid basidiospores. It also differs from the close species *I. trachyspora* and *I. mediterranea* in the pale yellowish-brown pileus.



Figure 12. Morphological structures of *Infundibulicybe jilongensis* (HMAS 282369, holotype). (a) Basidiomes. (b, c) Basidia. (d–f) Basidiospores. Scale bars: a = 2 cm, b–f = 10 µm.

Description: *Pileus* 38–90 mm diam., applanate with depressed centre at first, infundibuliform when mature, margin straight to slightly uplifted; surface dry, smooth, glabrous; orange brown at first, fading to pale yellow with orange tint when mature, darker at the centre, margin whitish, yellowish to pale orange brown. *Lamellae* up to 3 mm wide, long-decurrent, moderately crowded, with lamellulae, arcuate, white to creamy. *Stipe* 40–111 × 4–8 mm, central, cylindrical, hollow when mature; surface fibrous, longitudinally striate; pale yellowish brown to orange brown, base covered with white tomentum. *Context* thin, up to 4 mm thick, fleshy, whitish, odour fragrant, taste mild.

Basidiospores (4.9–) 5.2–5.6 (–6.0) × 3.9–4.6 µm, $Q = 1.2–1.4$ (av. = 1.3), subglobose to lacrymoid, smooth, hyaline. *Basidia* 22–28 × 6.0–7.2 (–8.2) µm, clavate, 4-spored, sterigmata up to 6 µm long, hyaline to subhyaline, thin-walled. *Cheilocystidia* and *pleurocystidia* unfound. *Lamellar trama* regular, of cylindrical hyaline hyphae. *Pileipellis* a cutis of repent and thin-walled hyphae, 3–8 µm diam., cylindrical to subclavate, with faint yellowish incrusting pigmentation. *Clamp-connections* present in all tissues.

Materials examined: China. Xizang Autonomous Region, Jilong County, Jilong Town, gregarious on the deciduous layer or rotten branches in coniferous forest dominated by *Pinus* sp., 28.38N, 85.36E, alt. 2,702 m, 15 July 2023, Peng Hong, 92 (HMAS 282369, holotype); 15 July 2023, Ke Wang, 2882

(HMAS 300552); 15 July 2023, Ke Wang, 2885 (HMAS 300553); 15 July 2023, Ke Wang, 2886 (HMAS 287927); 15 July 2023, Ke Wang, 2896 (HMAS 287928); 15 July 2023, Ke Wang, 2906 (HMAS 300554); 14 July 2023, Peng Hong, 61 (HMAS 300550); 14 July 2023, Ke Wang, 2873 (HMAS 300551).

Notes: *Infundibulicybe jilongensis* is characterised by its infundibuliform basidiomata, orange-tinged pileus and stipe, moderately crowded lamellae, and nearly globose basidiospores. The new species is close to *I. ellipsospora* in the phylogenetic tree (Figure 13), but the latter has ellipsoid or elongate basidiospores ($Q_m = 1.74 \pm 0.17$) (He and Yang 2023). Morphologically, *Infundibulicybe jilongensis* shares similarities with *I. trachyspora* in yellowish pileus, crowded lamellae, and lacrymoid to subglobose basidiospores. But *I. trachyspora* has brown to dark reddish-brown stipe (Xu et al. 2022). *Infundibulicybe jilongensis* grows on deciduous layers or rotten branches in coniferous forests dominated by *Pinus* sp. in subalpine areas, and shares similar habitat preferences with some other newly published species in China, i.e. *I. ellipsospora*, *I. bispora*, and *I. hongyinpan* (He and Yang 2023).

Strophariaceae Singer & A.H. Sm., Mycologia 38(5): 503 (1946)

Notes: Strophariaceae worldwide distributes in northern temperature zones (Zhang et al. 2014). Members of this family do not form ectomycorrhizae,

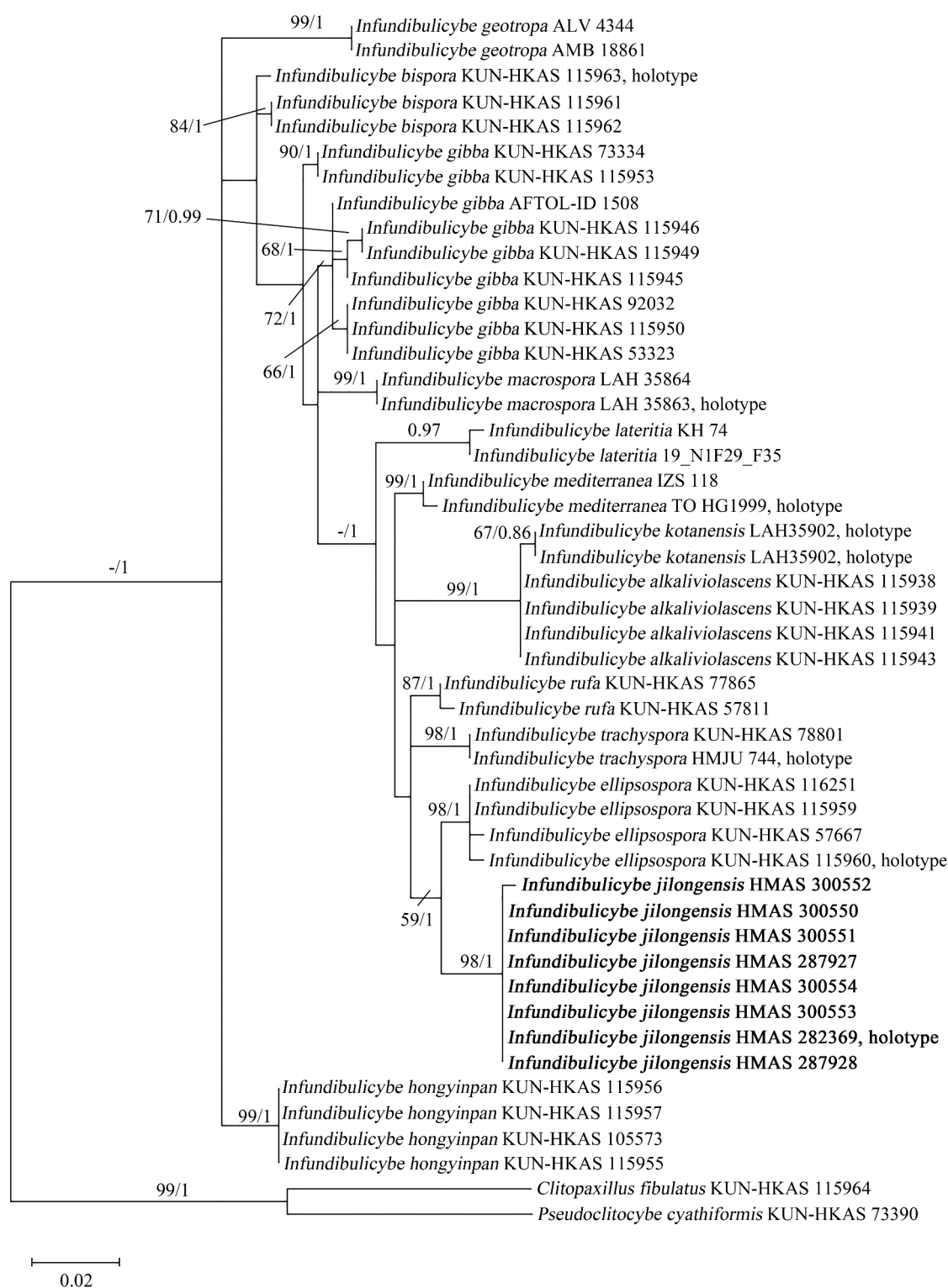


Figure 13. Phylogenetic relationship among species of *Infundibulicybe* inferred from the combined dataset of ITS, nLSU, and *rpb2* regions. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described species are in boldface.

occurring on a variety of substrates, such as living or decomposing wood, soil, litter, exposed roots, manure, and mosses.

Pholiota (Fr.) P. Kumm., Führ. Pilzk. (Zerbst): 22 (1871)

Notes: *Pholiota* is made up of wood-rotting saprotrophic agarics characterised by yellow or brown pileus with scales, and brownish smooth basidiospores with germ pore. Some members of *Pholiota* can produce a variety of bioactive compounds with antitumor and antioxidant effects (He et al. 2012).

Pholiota alpina Ke Wang, T.Z. Wei & P. Hong, sp. nov.
Figure 14

Fungal Names: FN 571993

Etymology: *alpina* (Latin), refers to the mountain environment of high altitude where the type was collected.

Diagnosis: Differs from *P. terrestris* in the brownish and moderately close lamellae. The new species grows on the grassland in alpine forest (alt. 3,500–4,500 m) of Qinghai-Xizang Plateau.

Description: *Pileus* 9–33 mm diam., hemispheric at first, then convex to plano-convex, convex-applanate when mature; surface viscid when moist, slightly fibrillose, margin with scattered whitish veil remnants at first; ochraceous orange at first, brownish yellow to pale brown when mature, yellowish brown at the centre, paler at the margin. *Lamellae* adnexed to adnate, moderately close, with lamellulae, pale brown to yellowish brown in youth, yellowish brown to brown when mature, edges pale. *Stipe* 22–40 × 2–5 mm, central, cylindrical, sometimes tapering towards base; surface dry, with pale fibrils, longitudinally striate; whitish to yellowish at the apex, brownish yellow to pale brown elsewhere. Partial veil



Figure 14. Morphological structures of *Pholiota alpina* (HMAS 300558, holotype). (a) Basidiomes. (b) Basidia. (c) Basidiospores. Scale bars: a = 2 cm, b, c = 10 μ m.

present when young, whitish to pale, evanescent. *Context* thin, fleshy, pale to brownish, odour indistinct, taste mild.

Basidiospores 6.4–8.2 (–9.4) × (3.4–) 3.8–4.5 µm, Q = 1.5–2.1 (av. = 1.8), ellipsoid to oblong-ellipsoid, smooth, often containing several oil droplets, yellowish brown. *Basidia* 15–27 × 5.5–6.8 µm, clavate, 4-spores, rarely 2-spored, often with finely granular brownish pigment. *Cheilocystidia* 20–35 × 5.0–7.5 µm, bottle-shaped, with long cylindrical necks, thin-walled, apices obtuse, hyaline. *Pleurocystidia* similar to cheilocystidia but longer. *Pileipellis* of two distinct layers: epicutis an ixocutis of cylindrical hyphae, 3–7 µm diam., subhyaline, sometimes slightly yellowish brown; hypodermium of parallel cylindrical hyphae, 6–15 µm diam., tawny to dark brown. *Clamp-connections* present in all tissues.

Materials examined: China. Xizang Autonomous Region, Xietongmen County, Tongmen Town, solitary or gregarious on soil of grassland, 29.41N, 88.21E, alt. 3,882 m, 12 July 2023, Ke Wang, 2838 (HMAS 300558, holotype); 12 July 2023, Ke Wang, 2839 (HMAS 300557); Dingri County, 20 July 2023, Ke Wang, 2967 (HMAS 300559); 20 July 2023, Ke Wang, 2969 (HMAS 300560); 20 July 2023, Peng Hong, 151 (HMAS 300555); 20 July 2023, Peng Hong, 156 (HMAS 300556).

Notes: *Pholiota alpina* is characterised by its orange to brownish yellow, slightly fibrillose pileus, and light-coloured stipe. In the phylogenetic tree, the new species itself makes up a strongly supported clade near *P. adiposa* complex (Figure 15). The species is similar to *P. terrestris*, but the lamellae of *P. terrestris* are yellowish and more crowded (Lee et al. 2020). *Pholiota alpina* has a habitat preference on grassland of subalpine to alpine area (alt. 3,500–4,500 m) in south Himalayas as current sight.

Boletales E.-J. Gilbert, *Les Livres du Mycologue* Tome I-IV, Tom. III: Les Bolets: 83 (1931)

Sclerodermataceae Corda [as “*Sclerodermaceae*”], *Icon. fung.* (Prague) 5: 23 (1842)

Notes: Sclerodermataceae distributes worldwide on soil and rotting wood, characterised by a puff-ball-like fruiting body, a firm peridium, and a dark-coloured gleba when mature.

Scloderma Pers., *Syn. meth. fung.* (Göttingen) 1: xiv, 150 (1801)

Notes: *Scloderma*, typified by *S. verrucosum*, is an easily recognisable genus of gasteroid fungi, it is characterised by subglobose to pyriform, or subturbinate basidiomata, a firm peridium, and globose, coloured and ornamented basidiospores (Guzmán 1970). Members of the genus play a vital role in maintaining plant diversity, ecosystem stability, and afforestation (Sanon et al. 2009).

Scloderma dingjieense Ke Wang, T.Z. Wei & P. Hong, sp. nov. Figure 16

Fungal Names: FN 571994.

Etymology: *dingjieensis* (Latin), refers to its type locality, Dingjie County in Xizang Autonomous Region, China.

Diagnosis: Differs from its similar species *S. erubescens* by its warty to furfuraceous squamules on the surface of peridium.

Description: *Basidiomata* 1.7–4.5 × 1.2–3.3 cm, epigeous, upper part globose to subglobose, irregularly oblate when mature. *Peridium* leathery, thin, 0.5–1.5 mm thick, intact when young, apex rupturing, and irregular opening when mature. Surface rough, cracking into warty to furfuraceous brown squamules; pale brown to yellowish brown. *Gleba* greyish white at first, compact, turning dark brown, powdery when mature. *Stipe* 3–5 × 3–5 mm, subcylindric, concolorous to peridium, with whitish rhizomorphs at the base.

Basidiospores (9.1–) 9.3–11.7 (–12.2) µm diam., 10.5 µm on average; globose, occasionally subglobose, with spinose ornamentation (up to 1.0–2.2 µm high), pale brown to yellowish brown. *Peridium* of subcylindric hyphae, 3–7.5 µm diam., evenly to tightly arranged, yellowish to light yellowish brown; inner layer of cylindric and hyaline hyphae, loosely arranged. *Gleba* compact, of hyaline hyphae, 2.2–4.7 µm diam. *Clamp-connections* present on the rhizomorphic hyphae.

Materials examined: China. Xizang Autonomous Region, Dingjie County, Chentang Town, solitary on soil by roadside, 27.85N, 87.43E, alt. 2,184 m, 20 July 2023, Peng Hong, 162 (HMAS 282370, holotype); 20 July 2023, Ke Wang, 2998 (HMAS 300562).

Notes: *Scloderma dingjieensis* is characterised by its yellowish brown and warty basidiomata, short stipe, and globose and warty basidiospores. Phylogenetically, *Scloderma dingjieensis* is a sister group of *S. squamulosum* (Figure 17), but the latter

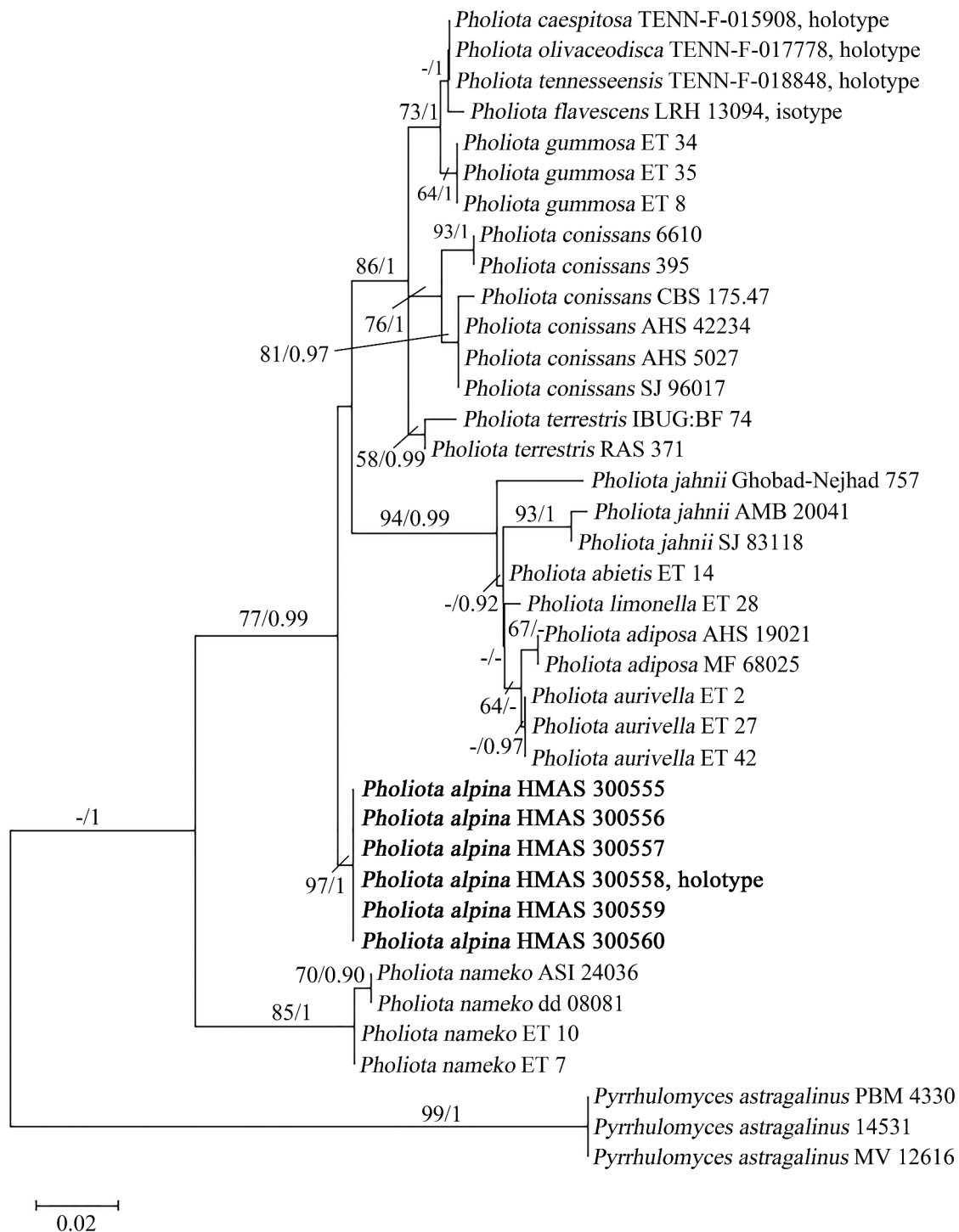


Figure 15. Phylogenetic relationship among species of *Pholiota* inferred from the combined dataset of ITS, nLSU, and *rpb2* regions. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described species are in boldface.

has a well-developed stipe with abundant attachments. Morphologically, the new species is similar to some other members of *Scleroderma* in southwest China, such as *S. separatum* and *S. erubescens* (Wu et al. 2023). However, *S. erubescens* has smaller

basidiomata and turns purple to blackish red after injury. Compared with squamules of *S. dingjieensis*, the squamules of *S. separatum* are easily detachable. The new species grows in subalpine areas of south Himalayas.

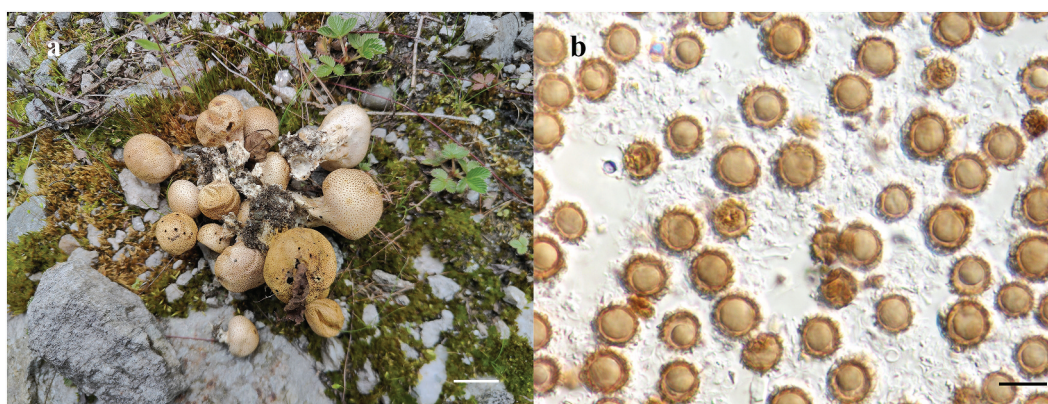


Figure 16. Morphological structures of *Scleroderma dingjieensis* (HMAS 282370, holotype). (a) Basidiomes. (b) Basidiospores. Scale bars: a = 2 cm, b = 10 μ m.

Scleroderma griseobrunneum Ke Wang, T.Z. Wei & P. Hong, sp. nov. [Figure 18](#)

Fungal Names: FN 571995.

Etymology: *griseobrunneum* (Latin), refers to the greyish brown colour of the basidiomata.

Diagnosis: Differs from the closely species *S. bovista* in having a stipe and no colour changes when rubbed.

Description: *Basidiomata* 25–45 \times 17–23 mm, epigeous, upper part globose to subglobose at first, irregularly oblate when mature. *Peridium* leathery, thin, 0.4–1.2 mm thick, intact when young, apex rupturing and irregular opening when mature; surface rough, cracking into furfuraceous brown squamules; greyish brown. *Gleba* greyish white at first, compact, turning dark brown, powdery when mature. *Stipe* 2–7 \times 3–7 mm, subcylindric, concolorous to peridium, with numerous white rhizomorphs at the base.

Basidiospores (12.4–) 12.9–15.1 \times 11.5–14.2 μ m, $Q = 1.0$ –1.2 (av. = 1.0); subglobose, surface prominently reticulate, with spinose ornamentation (up to 1.3–2.5 μ m high), brown. *Peridium* of subcylindric hyphae, 3.5–5.5 μ m diam., evenly to tightly arranged, yellow to light yellowish brown; inner layer of loosely arranged hyphae, irregular, hyaline. *Gleba* compact, of thin-walled hyphae, 3.5–6.6 μ m diam. *Clamp-connections* present on the rhizomorphic hyphae.

Materials examined: China. Xizang Autonomous Region, Dingjie County, Chentang Town, solitary on the soil of broad-leaved forest, 27.87N, 87.42E, alt. 2,615 m, 20 July 2023, Peng Hong, 195 (HMAS 300561, holotype).

Notes: *Scleroderma griseobrunneum* is characterised by greyish brown colour basidiomata and distinctly

large and warty basidiospores. The new species is a sister group of *S. bovista* in phylogeny ([Figure 17](#)), but the latter has a smoother peridium, no stipes, and its peridium surface turns purplish red or pinkish when rubbed. *Scleroderma citrinum* is also similar to *S. griseobrunneum* in morphology, but the former has a thick, coarsely scaly peridium. The new species is only found growing in the subalpine area of south Himalayas.

Cantharellales Gäum., Vergleichende Morphologie der Pilze: 495 (1926)

Botryobasidiaceae (Parmasto) Jülich, Bibliotheca Mycologica 85: 357 (1982)

Notes: Botryobasidiaceae was originally erected by Jülich (1981) with *Botryobasidium* as the type genus. Two additional genera *Candelabrochaete* and *Suillosporium* were originally included in Botryobasidiaceae, but were subsequently transferred to Polyporales and Trechisporales, respectively (Binder et al. 2005; Larsson 2007; de Meiras-Otoni et al. 2021). The species of Botryobasidiaceae cause white-rot decay of wood.

Botryobasidium Donk, Meded. Ned. Mycol. Ver. 18–20: 116 (1931)

Notes: *Botryobasidium*, typified by *B. subcoronatum*, is morphologically well defined by its not continuous, arachnoid basidiomes, broad sized hyphae branched at right angles, and short, subcylindrical basidia usually with six to eight sterigmata (Bernicchia and Gorjón 2010). Some species of this genus produce asexual morphs.

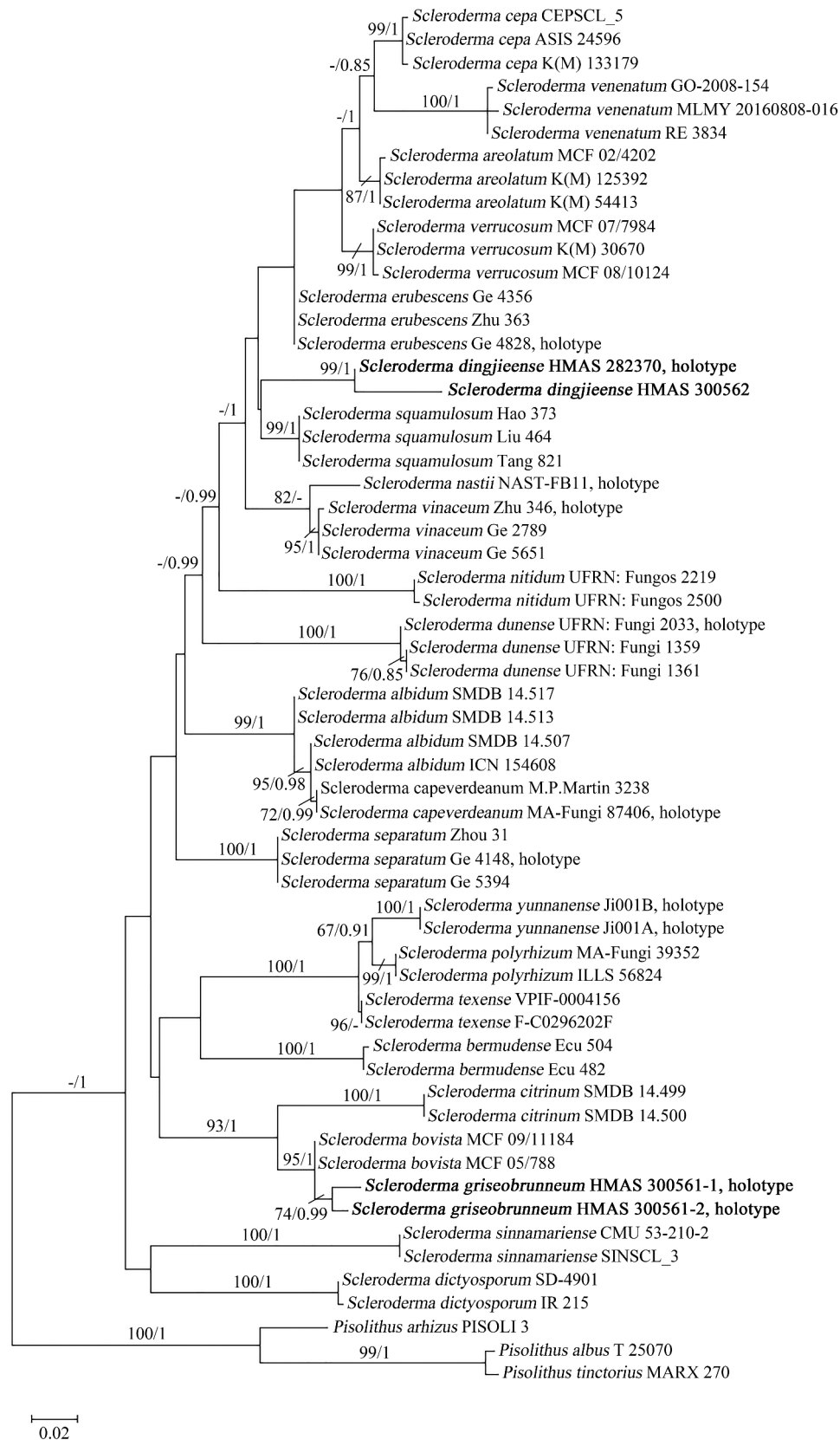


Figure 17. Phylogenetic relationship among species of *Scleroderma* inferred from the dataset of ITS region. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described species are in boldface.

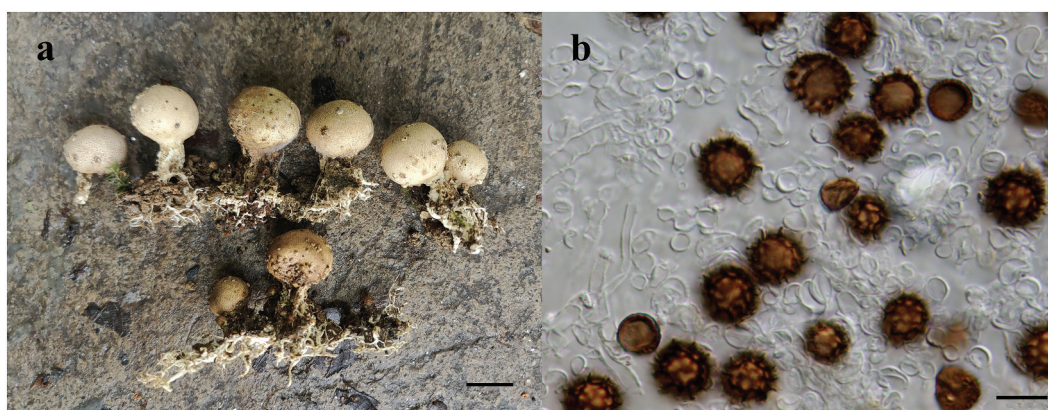


Figure 18. Morphological structures of *Scleroderma griseobrunneum* (HMAS 300561, holotype). (a) Basidiomes. (b) Basidiospores. Scale bars: a = 2 cm, b = 10 μ m.

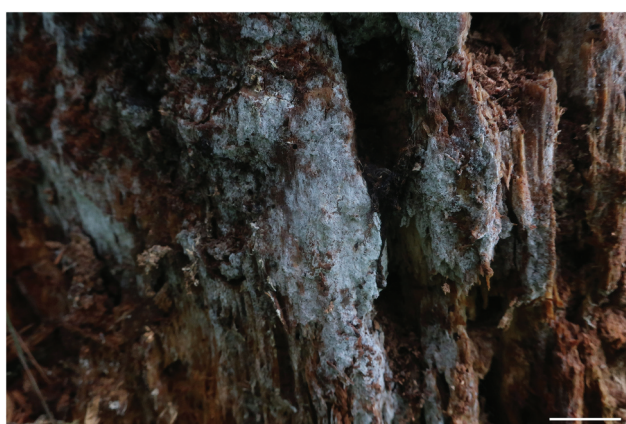


Figure 19. Basidiomes of *Botryobasidium subincanum* (HMAS 259458, holotype). Scale bar: 1 cm.

Botryobasidium subincanum S.L. Liu & L.W. Zhou, sp. nov. **Figures 19–20**

Fungal Names: FN 572034.

Etymology: *subincanum* (Latin), refers to the similarity to *B. incanum*.

Diagnosis: Differing from *B. incanum* in the longer basidiospores (6.5–8.5 μ m in length, $L = 7.48 \mu$ m in *B. incanum*; Zhou et al. 2024).

Description: *Basidiomes* annual, resupinate, effused, very thin, separable, up to 8 cm long, 4 cm wide, and 100 μ m thick. *Hymenophore* smooth, arachnoid, whitish to ash-grey when fresh, pale olivaceous buff when dry, not cracked. *Margin* indistinct and not differentiated, white, up to 0.5 mm wide.

Hyphal system monomitic; generative hyphae simple-septate; subhymenial hyphae hyaline, thin-walled, 8–10 μ m in diam.; basal hyphae hyaline, slightly thick-walled, frequently branched at right angles, 8–11 μ m in diam. *Cystidia* absent. *Basidia* subcylindrical, 18–23 \times 8–11 μ m, with six sterigmata, simple-septate at the base; basidioles in shape similar to basidia but

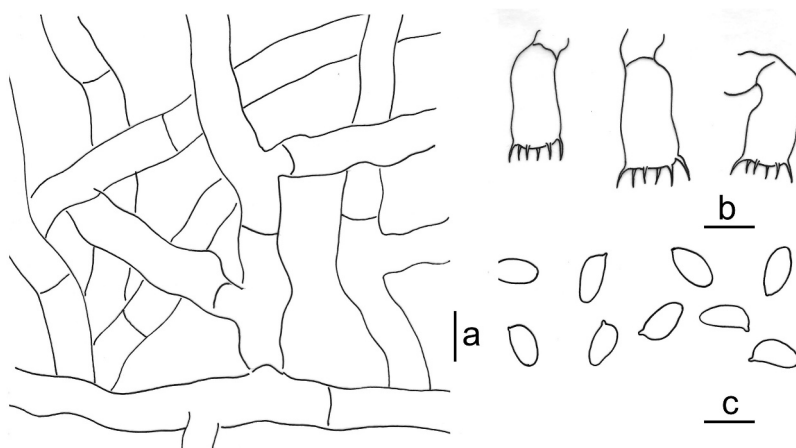


Figure 20. Microscopic structures of *Botryobasidium subincanum* (HMAS 259458, holotype). (a) Hyphae in subiculum. (b) Basidia. (c) Basidiospores. Scale bars: a–c = 10 μ m.

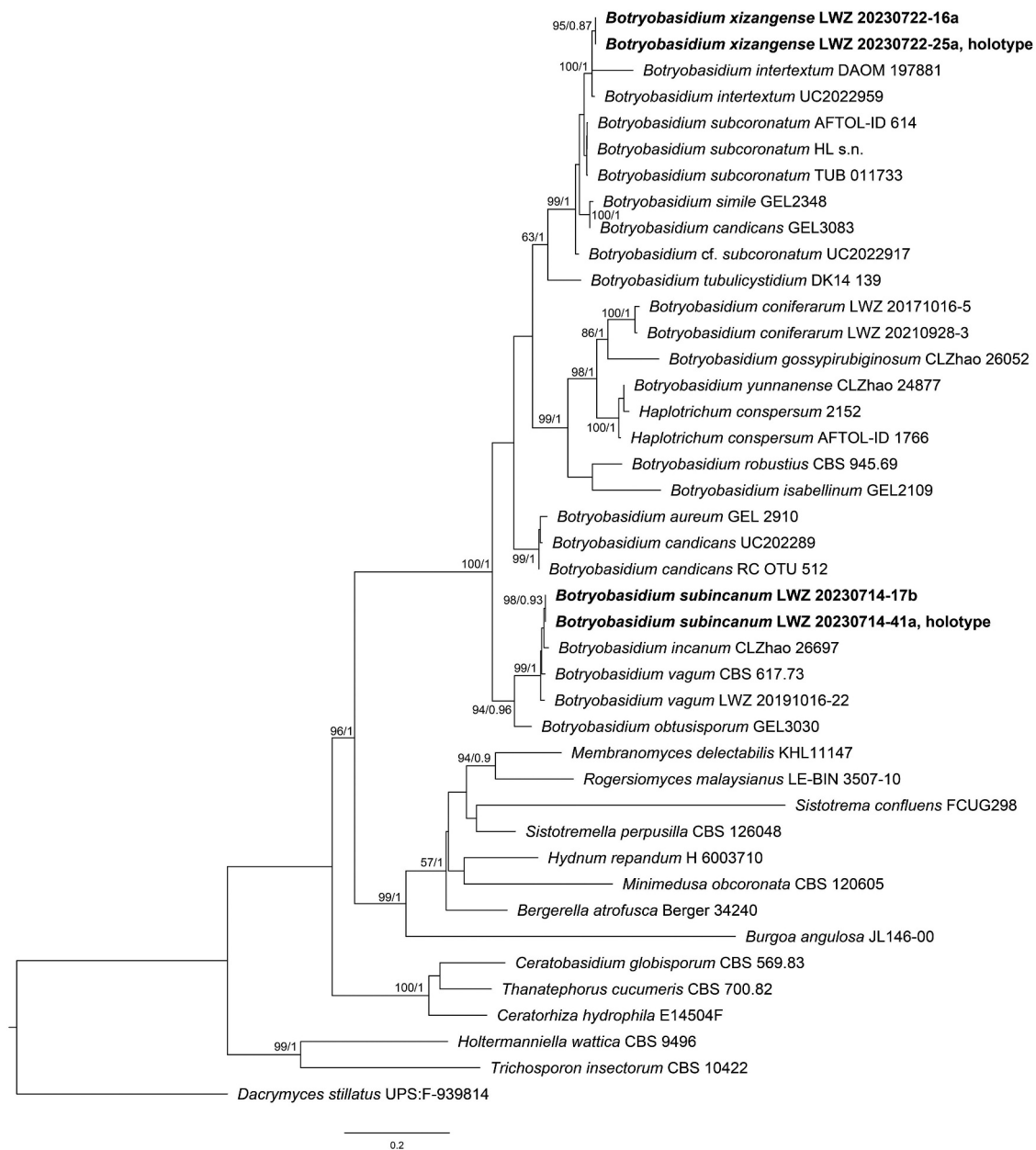


Figure 21. Phylogenetic relationship among species of *Botryobasidium* inferred from the combined dataset of ITS and nLSU regions. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described species are in boldface.

slightly smaller. *Basidiospores* navicular, hyaline, slightly thick-walled, smooth, inamyloid, indextrinoid, acyanophilous, (7.5–) 7.8–10 × (3.8–) 4–5 (–5.5) μm , $L = 9.0 \mu\text{m}$, $W = 4.5 \mu\text{m}$, $Q = 2.0$ ($n = 60/2$).

Anamorph not observed.

Materials examined: China. Xizang Autonomous Region, Jilong County, Jilong Town, Jilonggou, on rotten *Pinus* trunk, 14 July 2023, L.W. Zhou, LWZ 20230714-41a (HMAS 259458, holotype); on fallen branch of angiosperm, 14 July 2023, L.W. Zhou, LWZ 20230714-17b (HMAS 259459).

Notes: In the current phylogeny, *Botryobasidium subincanum* has a close relationship with *B. incanum* (Figure 21). However, there are 13 nucleotide differences in the ITS regions between *Botryobasidium subincanum* and *B. incanum*, accounting for approximately 2.3% of the total nucleotide length. In conjunction with discernible morphological disparities, the two specimens LWZ 20230714-41a and LWZ 20230714-17b collected from Xizang Autonomous Region, China, are proposed to be a new species.



Figure 22. Basidiomes of *Botryobasidium xizangense* (HMAS 259460, holotype). Scale bar: 1 cm.

Botryobasidium xizangense S.L. Liu & L.W. Zhou, sp. nov. **Figures 22–23**

Fungal Names: FN 572035.

Etymology: *xizangense* (Latin), refers to the type locality in Xizang Autonomous Region, China.

Diagnosis: Differing from *B. intertextum* in the wider basidiospores on average ($W = 2.3 \mu\text{m}$ in *B. intertextum*; Kotiranta and Saarenoksa 1990).

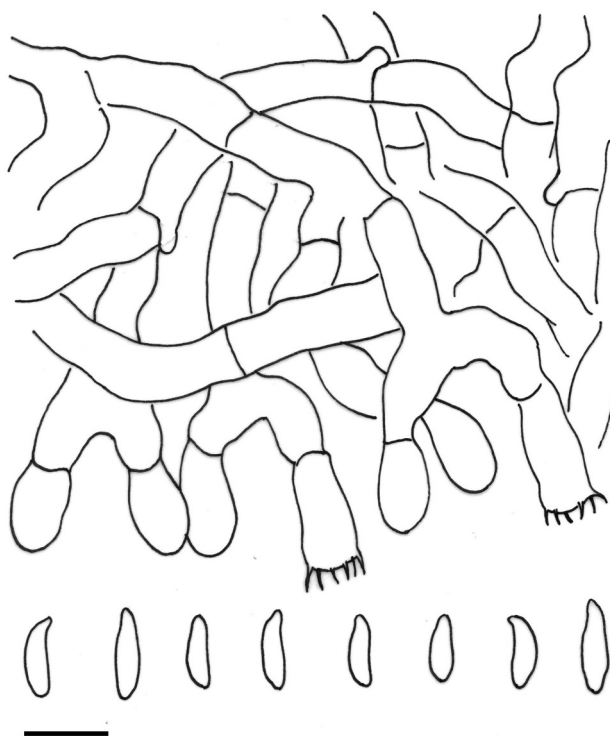


Figure 23. Vertical section of basidiomes of *Botryobasidium xizangense* (HMAS 259460, holotype). Scale bar: 10 μm .

Description: *Basidiomes* annual, resupinate, effused, very thin, separable, up to 6 cm long, 4 cm wide, and 100 μm thick. *Hymenophore* smooth, arachnoid, white when fresh, unchanged after drying, not cracked. *Margin* white, thinning out as byssoid, finely fibrillose, 0.5 mm wide.

Hyphal system monomitic; generative hyphae with or without clamp connections; subhymenial hyphae hyaline, thin-walled, 5.5–7.5 μm in diam.; basal hyphae hyaline, slightly thick-walled, frequently branched at right angles, 6–8 μm in diam. *Cystidia* absent. *Basidia* subcylindrical, 12–16 \times 6–7 μm , with six sterigmata, simple-septate at the base; basidioles in shape similar to basidia but slightly smaller. *Basidiospores* navicular, hyaline, thin-walled, smooth, inamyloid, indextrinoid, cyanophilous, (7–) 7.5–10 \times (2.3–) 2.5–3 (–3.1) μm , $L = 8.4 \mu\text{m}$, $W = 2.7 \mu\text{m}$, $Q = 3.1$ ($n = 60/2$).

Anamorph not observed.

Materials: China. Xizang Autonomous Region, Dingjie County, Chentang Town, Chentanggou, on fallen branch of angiosperm, 22 July 2023, L.W. Zhou, LWZ 20230722-25a (HMAS 259460, holotype); *ibid.* on fallen branch of *Pinus*, 22 July 2023, L.W. Zhou, LWZ 20230722-16a (HMAS 259461).

Notes: *Botryobasidium xizangense* is characterised by whitish basidiomes, both clamped and non-clamped generative hyphae, and navicular basidiospores. *Botryobasidium subcoronatum* is similar to *B. xizangense*, but differs by having yellowish to ochraceous hymenophore and shorter basidiospores (6–8 μm in length; Bernicchia and Gorjón 2010).

Polyporales Gäum., Vergleichende Morphologie der Pilze: 503 (1926)

Phanerochaetaceae Jülich, Bibliotheca Mycologica 85: 384 (1982)

Notes: Phanerochaetaceae, typified by *Phanerochaete*, is a globally widespread group of wood-inhibiting fungi with 24 genera (Chen et al. 2021; Liu et al. 2024c). Phylogenetically, the family is highly supported as monophyletic in the phlebioid clade within *Polyporales* (Chen et al. 2021).

Phanerochaete P. Karst., Bidrag Kännedom Finlands Natur Folk 48: 426 (1889)

Notes: *Phanerochaete* is a large group of corticioid fungi, characterised by the membranaceous

basidiomes, a monomitic hyphal system, simple-septate generative hyphae, clavate basidia, and smooth, thin-walled, inamyloid basidiospores (Bernicchia and Gorjón 2010; Wu et al. 2010). Recent studies revealed that species of *Phanerochaete* s.l. group together with other genera from various families (Justo et al. 2017; Chen et al. 2021).

Phanerochaete xizangensis S.L. Liu & L.W. Zhou, sp. nov. Figures 24–25

Fungal Names: FN 572036.

Etymology: *xizangensis* (Latin), refers to the type locality in Xizang Autonomous Region, China.

Diagnosis: Characterized by cream to buff basidiomes with smooth hymenophore surface becoming deep olive in KOH, the presence of leptocystidia, and narrowly ellipsoid basidiospores.

Description: *Basidiomes* annual, resupinate, effused, easily separable from substrate, membranaceous, up to 12 cm long, 3 cm wide, and up to 300 μm thick. Hymenophore smooth, cream to pale buff when fresh, olivaceous buff when dry, becoming deep olive



Figure 24. Basidiomes of *Phanerochaete xizangensis* (HMAS 259462, holotype). Scale bar: 1 cm.

in KOH, not cracked or slightly cracked with age. Margin thinning out, fimbriate, white.

Hyphal system monomitic; generative hyphae simple-septate. Subicular hyphae hyaline, thin to slightly thick-walled, frequently branched and septate, loosely interwoven, more or less parallel to substrate, 5–8 μm in diam., encrusted with hyaline to yellowish crystals.

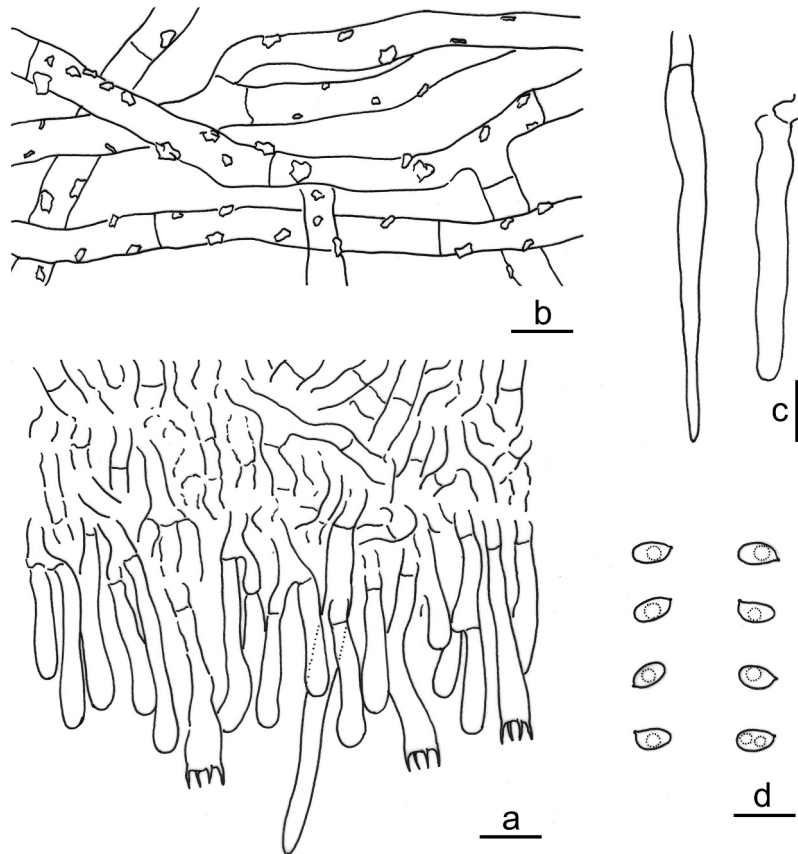


Figure 25. Microscopic structures of *Phanerochaete xizangensis* (HMAS 259462, holotype). (a) Vertical section of basidiomes. (b) Hyphae in subiculum. (c) Leptocystidia. (d) Basidiospores. Scale bars: a–d = 10 μm .

Leptocystidia subcylindrical, slightly tapering towards apex, hyaline, thin-walled, smooth, $40\text{--}60 \times 5\text{--}7\text{ }\mu\text{m}$. *Basidia* clavate to subcylindrical, hyaline, thin-walled, smooth, with four sterigmata and a basal simple septum, $25\text{--}35 \times 4.5\text{--}5.5\text{ }\mu\text{m}$; basidioles in shape similar to basidia but slightly smaller. *Basidiospores* ellipsoid to narrowly ellipsoid, with an apiculus, hyaline, thin-walled, smooth, inamyloid, acyanophilous, $5\text{--}6.3(6.5) \times 2.8\text{--}3.2(3.5)\text{ }\mu\text{m}$, $L = 5.6\text{ }\mu\text{m}$, $W = 3.0\text{ }\mu\text{m}$, $Q = 1.9$ ($n = 60/2$).

Materials examined: China. Xizang Autonomous Region, Jilong County, Jilong Town, Jilonggou, on fallen branch of angiosperm, 14 July 2023, L.W. Zhou, LWZ 20230714-22b (HMAS 259462, holotype); 16 July 2023, L.W. Zhou, LWZ 20230716-6b (HMAS 259463); 16 July 2023, L.W. Zhou, LWZ 20230716-8b (HMAS 259464).

Notes: *Phanerochaete burtii*, *P. leptocystidiata*, *P. sinensis*, and *P. xizangensis* formed a strongly supported clade in the current phylogeny (Figure 26). The

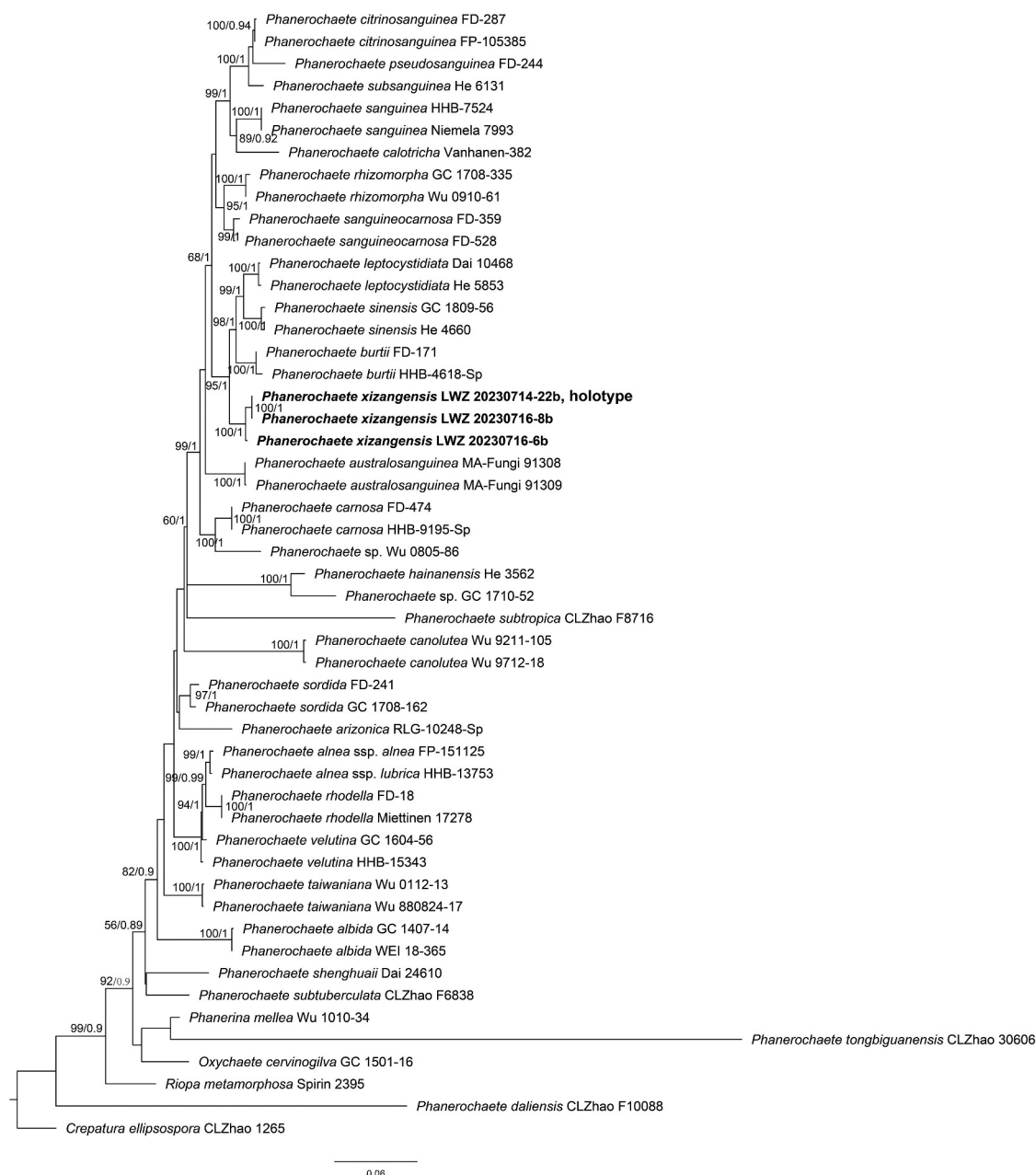


Figure 26. Phylogenetic relationship among species of *Phanerochaete* inferred from the combined dataset of ITS and nLSU regions. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described species is in boldface.

four species are also quite similar in morphology and exhibit only slight variations in leptocystidia and basidiospores (Xu et al. 2020). The most distinct characteristic of *P. xizangensis* from another three species is its hymenophores becoming deep olive colour in KOH solution.

Trechisporales K.H. Larss., in Hibbett et al., Mycol. Res. 111(5): 541 (2007)

Hydnodontaceae Jülich, Biblthca Mycol. 85: 372 (1982) [1981]

Notes: Hydnodontaceae is the only family of *Trechisporales*, with the type genus *Hydnodon*. While *Sertulicium* and *Sistotremastrum* were moved to a new family Sistotremastraceae within the new order Sistotremastrales, Hydnodontaceae accommodates 12 genera now (Liu et al. 2022).

Trechispora P. Karst., Hedwigia 29: 147 (1890)

Notes: *Trechispora*, established by Karsten (1890) with *T. onusta* as the type species, exhibits various kinds of hymenophoral configurations. Over 100 species have been described worldwide (Lin et al. 2022; Liu et al. 2022, 2024b, 2024c; Deng et al. 2023; Sommai et al. 2023; Luo et al. 2024).

Trechispora cryptomerioides (W.R. Lin & P.H. Wang) S.L. Liu & L.W. Zhou, comb. nov.

Fungal Names: FN 572033.

Basionym: *Scytinopogon cryptomerioides* W.R. Lin & P.H. Wang, Phytotaxa 552 (1): 78 (2022).

Notes: *Scytinopogon cryptomerioides* was originally reported in Taiwan of China together with *Trechispora copiosa* and *T. khokpasiensis*, and is characterised by having coralloid basidiomes, ampullate septa of subicular hyphae, short cylindrical basidia and ornamented spores (Lin et al. 2022). In terms of microstructural characteristics, *S. cryptomerioides* exhibits traits consistent with *Trechispora*. Despite its coralloid basidiomes, these structures are now also recognised as characteristic of *Trechispora* (Liu et al. 2022). Recent multilocus-based phylogenetic analyses provide robust evidence for supporting *Scytinopogon* as a synonym of *Trechispora* (Liu et al. 2022). Therefore, *S. cryptomerioides* is transferred to the genus *Trechispora*.



Figure 27. Basidiomes of *Trechispora subconfinis* (HMAS 259465, holotype). Scale bar: 1 cm.

Trechispora subconfinis S.L. Liu & L.W. Zhou, sp. nov. Figures 27–28

Fungal Names: FN 572037.

Etymology: *subconfinis* (Latin), refers to the similarity to *T. confinis*.

Diagnosis: Characterized by easily separable basidiomes with cords, grandinioid hymenophores, a monomitic hyphal system, small crystals, and smooth basidiospores.

Description: *Basidiomes* annual, resupinate, effused, soft and fragile, thin, easily separated from substrates, up to 12 cm long and 5 cm wide. *Hymenophore* smooth to grandinioid, continuous, greyish white to pale olivaceous buff when fresh, olivaceous buff when dry. *Margin* thinning out, arachnoid, concolorous, about 5 mm wide. *Cords* frequent in subiculum, concolorous.

Hyphal system monomitic; generative hyphae with clamp connections. Subicular hyphae distinct, hyaline, slightly thick-walled, frequently branched, loosely interwoven, 2.5–3.5 μm in diam. with ampullate septa up to 5 μm wide. *Cystidia* absent. Crystals usually small, single or in aggregates. *Basidia* cylindrical with a slight median constriction, hyaline, thin-walled, with four sterigmata and a basal clamp connection, 10–14 \times 4–5 μm ; basidioles in shape similar to basidia, but slightly smaller. *Basidiospores* subglobose to ovoid, hyaline, thin to slightly thick-walled, smooth, inamyloid, acyanophilous, 3–3.5 (–3.8) \times (2.5–) 2.7–3.2 μm , L = 3.3 μm , W = 2.9 μm , Q = 1.1 ($n = 60/2$).

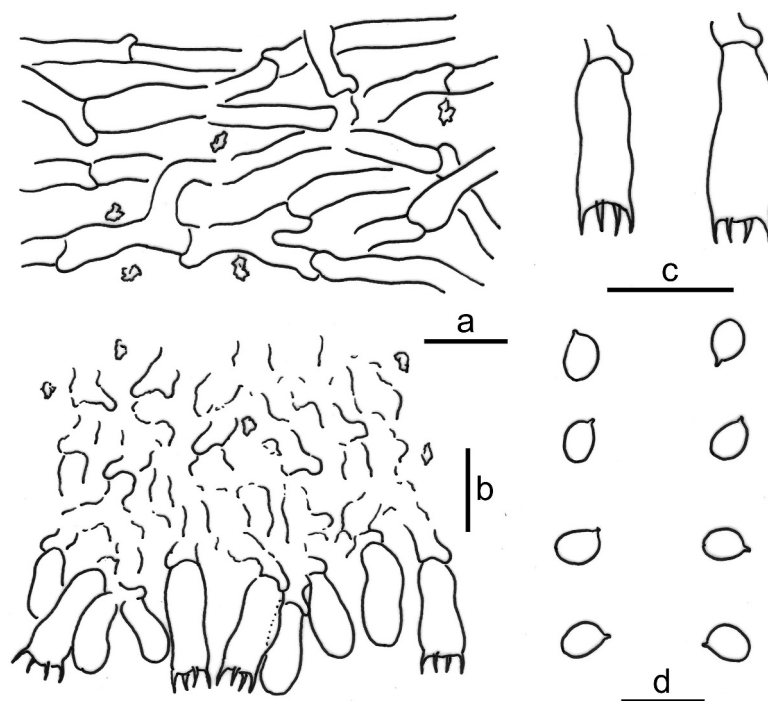


Figure 28. Microscopic structures of *Trechispora subconfinis* (HMAS 259465, holotype). (a) Vertical section of basidiomes. (b) Hyphae in subiculum. (c) Basidia. (d) Basidiospores. Scale bars: a–c = 10 µm, d = 5 µm.

Materials examined: China. Xizang Autonomous Region, Jilong County, Jilong Town, Jilonggou, on rotten *Pinus* trunk, 15 July 2023, L.W. Zhou, LWZ 20230715-12a (HMAS 259465, holotype); 15 July 2023, L.W. Zhou, LWZ 20230715-10a (HMAS 259466); 15 July 2023, L.W. Zhou, LWZ 20230715-33a (HMAS 259467); Dingjie County, Chentang Town, Chentanggou, on rotten *Pinus* trunk, 22 July 2023, L.W. Zhou, LWZ 20230722-18a (HMAS 259468).

Notes: During a large-scale survey of wood-inhabiting fungi in the Xizang Autonomous Region, four specimens were identified in a distinct position, sister to *T. confinis*, in the phylogenetic tree (Figure 29), and they are newly described as *T. subconfinis*. Differing from *T. confinis*, *T. subconfinis* exhibits typically *Trechispora*-like basidiomes, and has wider basidiospores (2.2–3 µm in *T. confinis*; Larsson 1992). *Trechispora mellina* resembles *T. subconfinis* by continuous basidiomes with cords and similar basidiospores, but differs in somewhat isodiametric, wider subhymenial hyphae (4–6 µm in *T. mellina*; Chikowski et al. 2020).

Xenasmatellales L.W. Zhou & S.L. Liu, in Liu, Wei & Zhou, Mycology: 7 (2023)

Xenasmatellaceae L.W. Zhou & S.L. Liu, in Liu, Wei & Zhou, Mycology: 6 (2023)

Notes: Xenasmatellaceae is a newly identified family within the new order Xenasmatellales, consisting of a single genus *Xenasmatella*, although the distinct phylogenetic position of this lineage has long been recognised (Liu et al. 2023).

Xenasmatella Oberw., Sydowia 19 (1–3): 28 (1966)

Notes: *Xenasmatella*, typified by *X. subflavidogrisea*, was erected by Oberwinkler (1966). *Xenasmatella* is a small corticioid genus with 29 species, and is characterised by a combination of smooth to grandinioid hymenophores, pleural basidia, aculeate basidiospores, and growth on wood (Liu et al. 2023). *Phlebiella* was previously considered to be a synonym of *Xenasmatella*.

Xenasmatella jilongensis S.L. Liu & L.W. Zhou, sp. nov. Figures 30–31

Fungal Names: FN 572038.

Etymology: *jilongensis* (Latin), refers to the type locality Jilong County in Xizang Autonomous Region, China.

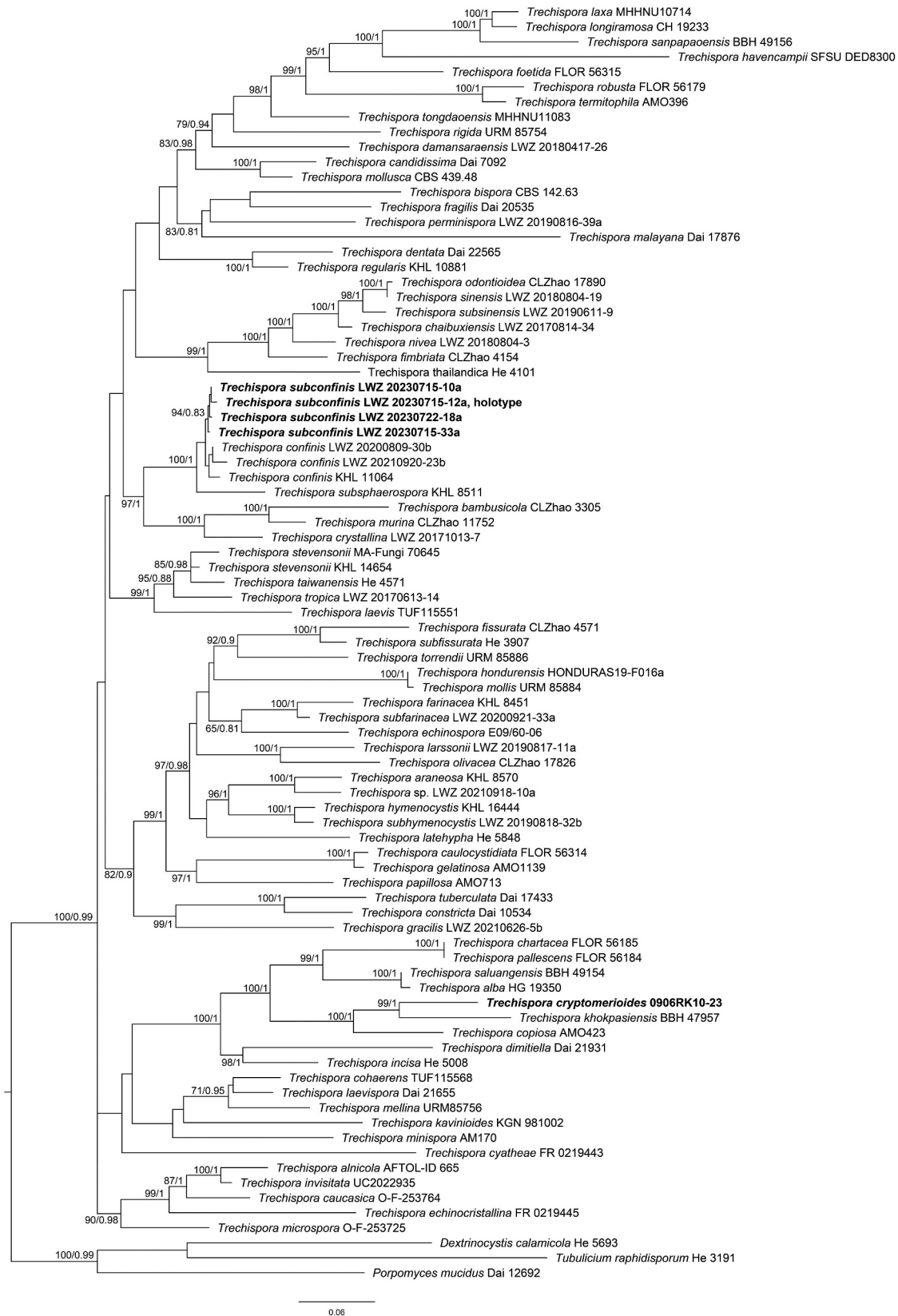


Figure 29. Phylogenetic relationship among species of *Trechispora* inferred from the combined dataset of ITS and nLSU regions. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described and combined species are in boldface.



Figure 30. Basidiomes of *Xenasmatella jilongensis* (HMAS 259469, holotype). Scale bar: 1 cm.

Diagnosis: Differs from other species of *Xenasmatella* in the grandinioid basidiomes, and pale mouse-grey hymenophore surface becomes brownish-black in KOH.

Description: *Basidiomes* annual, resupinate, soft membranous when fresh, smooth to grandinioid, fragile when dry, up to 6 cm long, 3 cm wide, 200 μm thick. *Hymenophore* pale mouse-grey to olivaceo-bubalinus when fresh, greyish brown upon drying. Margin

sterile, thinning out, fimbriate, concolorous to hymenophore surface, brownish black in KOH, sometimes fibrillose.

Hyphal system monomitic; generative hyphae with clamp connections, thin-walled, hyaline to yellowish, unbranched or rarely branched, normally 2.5–4 μm in diam., inamyloid, indextrinoid, acyanophilous. *Cystidia* and *cystidioles* absent. *Basidia* pleural or broadly clavate, with 4 sterigmata and a basal clamp connection, 15–20 \times 6–9 μm ; basidioles dominant, in shape similar to basidia, but slightly smaller. *Basidiospores* ellipsoid, hyaline to yellowish, thin-walled, aculeate, inamyloid, indextrinoid, acyanophilous, (4.8–) 5–6 \times (3.2–) 3.5–4.3 (–4.5) μm , L = 5.7 μm , W = 3.9 μm , Q = 1.5 ($n = 60/2$).

Materials examined: China. Xizang Autonomous Region, Jilong County, Jilong Town, Jilonggou, on rotten *Pinus* trunk, 14 July 2023, L.W. Zhou, LWZ 20230714-40b (HMAS 259469, holotype); 14 July 2023, L.W. Zhou, LWZ 20230714-46a (HMAS 259470).

Notes: The similarity between *Xenasmatella jilongensis* and *X. hjortstamii* is their hymenophore surfaces both becoming brownish-black in KOH; however, the latter species has an exclusively smooth hymenophore surface and growth on bamboo (Liu et al. 2023).

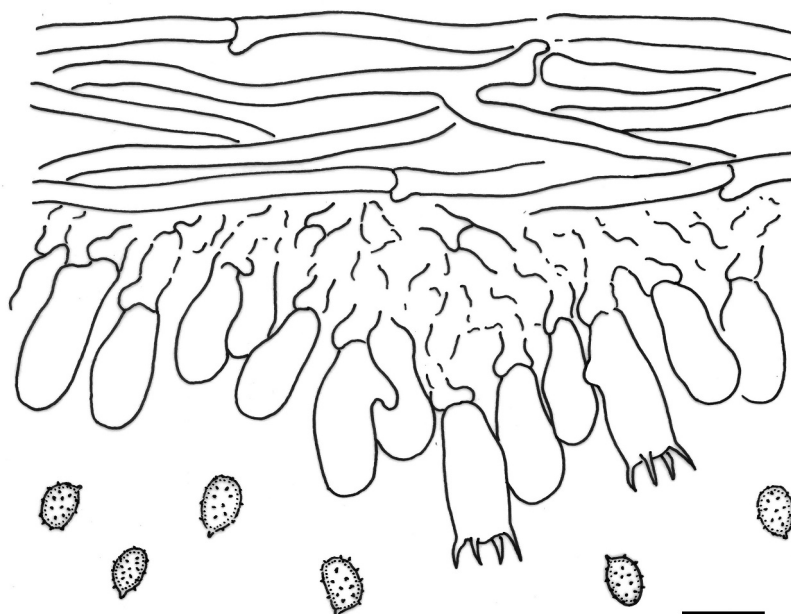


Figure 31. Vertical section of basidiomes of *Xenasmatella jilongensis* (HMAS 259469, holotype). Scale bar: 10 μm .

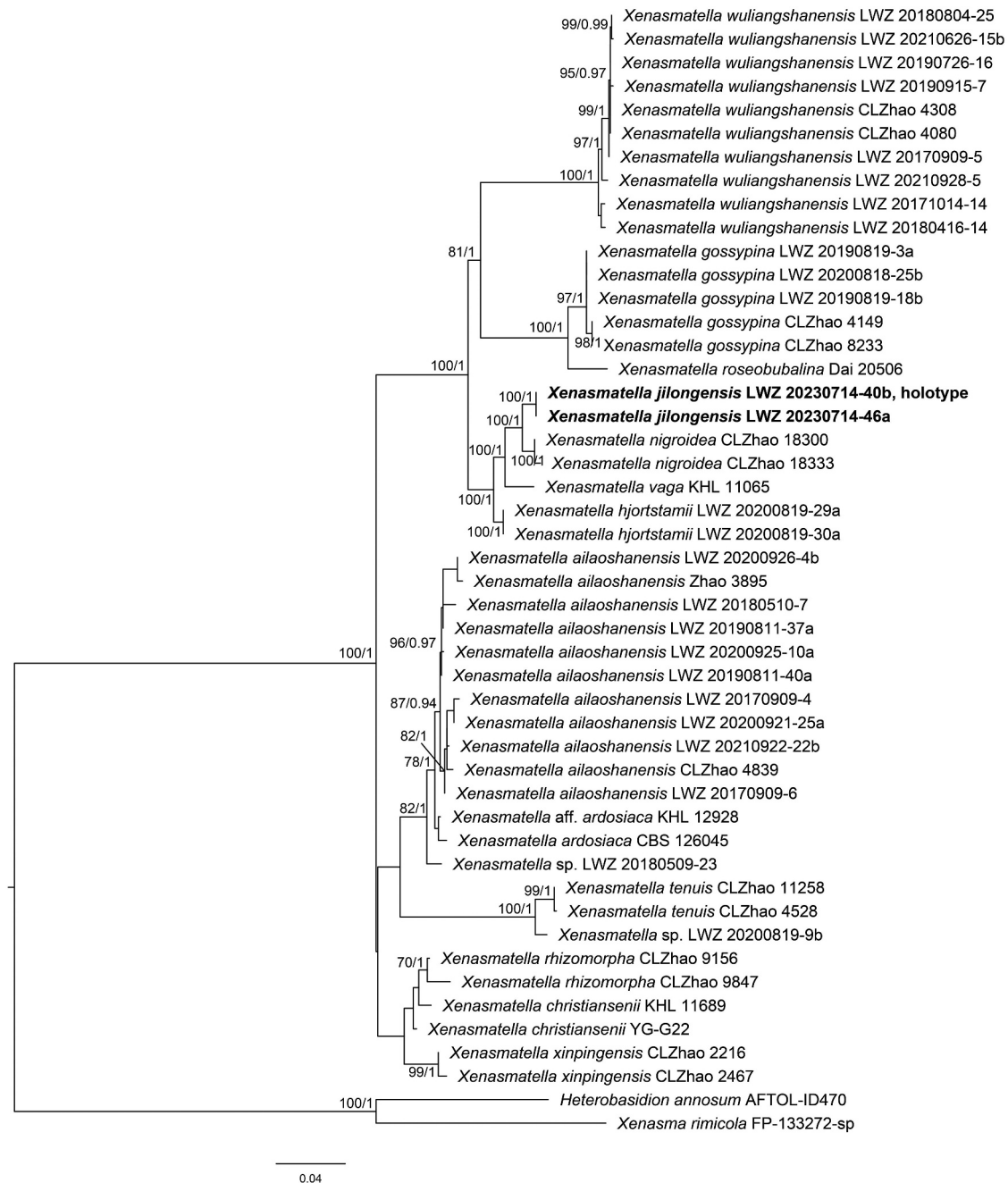


Figure 32. Phylogenetic relationship among species of *Xenasmatella* inferred from the combined dataset of ITS and nLSU regions. The topology is generated by the maximum likelihood algorithm. Bootstrap values and Bayesian posterior probabilities, when simultaneously above 50% and 0.8, respectively, are labelled at the nodes. The newly described species is in boldface.

Phylogenetically, this species was sister to *X. nigroidea* (Figure 32), but morphologically differs by having smooth hymenophores and smaller basidiospores ($3.5\text{--}4.5 \times 2.5\text{--}3.5 \mu\text{m}$; Luo and Zhao 2022).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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References

- Antonín V, Sedláč P, Tomšovský M. 2013. Taxonomy and phylogeny of European *Gymnopus* subsection *Levipedes* (Basidiomycota, Omphalotaceae). *Persoonia*. 31(1):179–187. doi: [10.3767/003158513X674043](https://doi.org/10.3767/003158513X674043).
- Bai M, Zhou LW, Tong YJ, Yin F. 2023. Risk assessment and warning system for strategic biological resources in China. *Innov Life*. 1:100004. doi: [10.59717/j.xinn-life.2023.100004](https://doi.org/10.59717/j.xinn-life.2023.100004).
- Balfour-Browae FL. 1955. Some Himalayan fungi. *Bull Brit Mus (Nat Hist)*. 1(7):189–218.
- Bernicchia A, Gorjón SP. 2010. *Fungi Europaei* 12. Corticiaceae s.l. 1–1008. Alassio: Edizioni Candusso.
- Binder M, Hibbett DS, Larsson KH, Larsson E, Langer E, Langer G. 2005. The phylogenetic distribution of resupinate forms across the major clades of mushroom-forming fungi (Homobasidiomycetes). *Syst Biodivers*. 3(2):113–157. doi: [10.1017/S1477200005001623](https://doi.org/10.1017/S1477200005001623).
- Boertmann D. 2010. The genus *Hygrocybe*. 2nd revised ed. Fungi of Northern Europe. Vol 1. Copenhagen: Svampetryk.
- Chen CC, Chen CY, Sh WU. 2021. Species diversity, taxonomy and multi-gene phylogeny of phlebioid clade (Phanerochaetaceae, Irpicaceae, Meruliaceae) of polyporales. *Fungal Divers*. 111(1):337–442. doi: [10.1007/s13225-021-00490-w](https://doi.org/10.1007/s13225-021-00490-w).
- Chikowski RS, Larsson KH, Gibertoni TB. 2020. Taxonomic novelties in *Trechispora* (Trechisporales, Basidiomycota) from Brazil. *Mycol Prog*. 19(12):1403–1414. doi: [10.1007/s11557-020-01635-y](https://doi.org/10.1007/s11557-020-01635-y).
- de Meiras-Ottoni A, Larsson KH, Gibertoni TB. 2021. Additions to *Trechispora* and the status of *Scytinopogon* (Trechisporales, Basidiomycota). *Mycol Prog*. 20:203–222. doi: [10.1007/s11557-021-01667-y](https://doi.org/10.1007/s11557-021-01667-y).
- Deng PT, Yan J, Liu XF, He ZM, Lin Y, Lu MX, Zhang P. 2023. Three coralloid species of the genus *Trechispora* (Trechisporales, Basidiomycota) in China: two newly discovered taxa and one reported for the first time. *Mycosphaer*. 99:153–170. doi: [10.3897/mycokeys.99.109375](https://doi.org/10.3897/mycokeys.99.109375).
- Desjardin DE, Wood MG, Stevens FA. 2015. California mushrooms: the comprehensive identification guide 1–560. Portland (OR): Timber Press.
- Fones HN, Bebb DP, Chaloner TM, Kay WT, Steinberg G, Gurr SJ. 2020. Threats to global food security from emerging fungal and oomycete crop pathogens. *Nat Food*. 1:332–342. doi: [10.1038/s43016-020-0075-0](https://doi.org/10.1038/s43016-020-0075-0).
- Guzmán G. 1970. Monografía del género *Scleroderma* Pers. emend. Fr. *Darwiniana*. 16:233–407.
- Katoh K, Rozewicki J, Yamada KD. 2019. MAFFT online service: multiple sequence alignment, interactive sequence choice and visualization. *Brief Bioinform*. 20(4):1160–1166. doi: [10.1093/bib/bbx108](https://doi.org/10.1093/bib/bbx108).
- Harmaja H. 2003. Notes on *Clitocybe* s. lato (Agaricales). *Ann Bot Fenn*. 40:213–218.
- He XL, Li TH, Jiang ZD, Shen YH. 2012. Four new species of *Entoloma* s.l. (Agaricales) from southern China. *Mycol Prog*. 11(4):915–925. doi: [10.1007/s11557-012-0807-0](https://doi.org/10.1007/s11557-012-0807-0).
- He ZM, Yang ZL. 2021. A new clitocyboid genus *Spodocybe* and a new subfamily Cuphophylloideae in the family Hygrophoraceae (Agaricales). *Mycosphaer*. 79:129–148. doi: [10.3897/mycokeys.79.66302](https://doi.org/10.3897/mycokeys.79.66302).
- He ZM, Yang ZL. 2023. A contribution to the knowledge of the genus *Infundibulicybe* (Tricholomatineae, Agaricales) in China: two new species and five redescribed taxa. *Mycologia*. 115(5):693–713. doi: [10.1080/00275514.2023.2226893](https://doi.org/10.1080/00275514.2023.2226893).
- Hu JJ, Zhao GP, Tuo YL, Rao G, Zhang ZH, Qi ZX, Yue L, Liu YJ, Zhang T, Li Y, et al. 2022. Morphological and molecular evidence reveal eight new species of *Gymnopus* from Northeast China. *J Fungi*. 8(4):349. doi: [10.3390/jof8040349](https://doi.org/10.3390/jof8040349).
- Huang HY, Chen ZH. 2003. Mushroom toxin and toxic treatment (III)-Psilocybin. *Practical Preventative Med*. 10(4):620–622.
- Jülich W. 1981. Higher taxa of Basidiomycetes. *Bibl Mycol*. 85:1–485.
- Justo A, Miettinen O, Floudas D, Ortiz-Santana B, Sjökvist E, Lindner D, Nakasone K, Niemelä T, Larsson KH, Ryvarden L, et al. 2017. A revised family-level classification of the Polyporales (Basidiomycota). *Fungal Biol*. 121(9):798–824. doi: [10.1016/j.funbio.2017.05.010](https://doi.org/10.1016/j.funbio.2017.05.010).
- Kluting KL, Baroni TJ, Bergemann SE. 2014. Toward a stable classification of genera within the Entolomataceae: a phylogenetic re-evaluation of the *Rhodocybe-Clitopilus* clade. *Mycologia*. 106(6):1127–1142. doi: [10.3852/13-270](https://doi.org/10.3852/13-270).
- Kotiranta H, Saarenoksa R. 1990. Reports of Finnish corticolous Aphyllophorales (Basidiomycetes). *Karstenia*. 30(2):43–69. doi: [10.29203/ka.1990.280](https://doi.org/10.29203/ka.1990.280).
- Tamura K, Stecher G, Kumar S, Battistuzzi FU. 2021. MEGA11: molecular evolutionary genetics analysis version 11. *Mol Biol Evol*. 38(7):3022–3027. doi: [10.1093/molbev/msab120](https://doi.org/10.1093/molbev/msab120).
- Larsson KH. 1992. The genus *Trechispora* (Corticiaceae, Basidiomycetes) [Ph.D. dissertation]. Sweden: University of Gothenburg.
- Larsson KH. 2007. Re-thinking the classification of corticioid fungi. *Mycol Res*. 111(9):1040–1063. doi: [10.1016/j.mycres.2007.08.001](https://doi.org/10.1016/j.mycres.2007.08.001).
- Lee JW, Park MS, Park JH, Cho YH, Kim CM, Kim CS, Jo JW, Lim YW. 2020. Taxonomic study of the genus *Pholiota* (Strophariaceae, Basidiomycota) in Korea. *Mycobiology*. 48(6):476–483. doi: [10.1080/12298093.2020.1831427](https://doi.org/10.1080/12298093.2020.1831427).
- Leelavathy KM, Manimohan P, Arnolds EJM. 2006. *Hygrocybe* in Kerala State, India. *Persoonia*. 19(1):101–151.
- Li JX, He MQ, Zhao RL. 2021. A review of *Cystoderma* (Agaricales/Basidiomycota) from China with four new species and two new records. *Mycologia*. 13(3):163–176. doi: [10.1080/21501203.2021.2013969](https://doi.org/10.1080/21501203.2021.2013969).
- Li QZ, Xiong C, Wong WC, Zhou LW. 2024. Medium composition optimization and characterization of polysaccharides extracted from *Ganoderma boninense* along with antioxidant activity. *Int J Biol Macromol*. 260:129528. doi: [10.1016/j.ijbiomac.2024.129528](https://doi.org/10.1016/j.ijbiomac.2024.129528).
- Lin WR, Wang PH, Hsieh SY. 2022. *Scytinopogon cryptomerioides* (Hydnodontaceae), a new species from Taiwan. *Phytotaxa*. 552(1):73–83. doi: [10.11646/phytotaxa.552.1.6](https://doi.org/10.11646/phytotaxa.552.1.6).
- Liu SL, He SH, Wang XW, May TW, He G, Chen SL, Zhou LW. 2022. Trechisporales emended with a segregation of Sistotremastrales ord. nov. (Basidiomycota). *Mycosphere*. 13(1):862–954. doi: [10.5943/mycosphere/13/1/11](https://doi.org/10.5943/mycosphere/13/1/11).

- Liu SL, Wei HW, Zhou LW. 2023. *Xenasmatellales* ord. nov. and *Xenasmatellaceae* fam. nov. for *Xenasmatella* (Agaricomycetes, Basidiomycota). *Mycology*. 14(3):175–189. doi: [10.1080/21501203.2023.2216213](https://doi.org/10.1080/21501203.2023.2216213).
- Liu SL, Liu DM, Zhou LW. 2024a. The future is now: How to conserve fungi. *Biol Divers*. 1(1):6–8. doi: [10.1002/bod2.12003](https://doi.org/10.1002/bod2.12003).
- Liu SL, Wang XW, Li GJ, Deng CY, Rossi W, Leonardi M, Liimatainen K, Kekki T, Niskanen T, Smith ME, et al. 2024b. Fungal diversity notes 1717–1817: taxonomic and phylogenetic contributions on genera and species of fungal taxa. *Fungal Divers*. 124(1):1–216. doi: [10.1007/s13225-023-00529-0](https://doi.org/10.1007/s13225-023-00529-0).
- Liu SL, Zhao P, Cai L, Shen S, Wei HW, Na Q, Han M, Wei R, Ge Y, Ma H, et al. 2024c. Catalogue of fungi in China 1. New taxa of plant-inhabiting fungi. *Mycology*. 83:1–58. doi: [10.1080/21501203.2024.2316066](https://doi.org/10.1080/21501203.2024.2316066).
- Lodge DJ, Padamsee M, Matheny PB, Aime MC, Cantrell SA, Boertmann D, Kovalenko A, Vizzini A, Dentinger BTM, Kirk PM, et al. 2014. Molecular phylogeny, morphology, pigment chemistry and ecology in Hygrophoraceae (Agaricales). *Fungal Divers*. 64(1):1–99. doi: [10.1007/s13225-013-0259-0](https://doi.org/10.1007/s13225-013-0259-0).
- Luo KY, Su JQ, Zhao CL. 2024. Morphological and molecular identification for four new wood-inhabiting species of *Trechispora* (Basidiomycota) from China. *MycKeys*. 105:155–178. doi: [10.3897/mycokeys.105.120438](https://doi.org/10.3897/mycokeys.105.120438).
- Luo KY, Zhao CL. 2022. Morphology and multigene phylogeny reveal a new order and a new species of wood-inhabiting basidiomycete fungi (Agaricomycetes). *Front Microbiol*. 13:970731. doi: [10.3389/fmicb.2022.970731](https://doi.org/10.3389/fmicb.2022.970731).
- Mao XL, Jiang CP, Ouzhu CW. 1993. *Economic macrofungi of Tibet*. Beijing: Beijing Science and Technology Press.
- Matheny PB, Curtis JM, Hofstetter V, Aime MC, Moncalvo JM, Ge ZW, Yang ZL, Slot JC, Ammirati JF, Baroni TJ, et al. 2006. Major clades of Agaricales: a multilocus phylogenetic overview. *Mycologia*. 98(6):982–995. doi: [10.1080/15572536.2006.11832627](https://doi.org/10.1080/15572536.2006.11832627).
- Noordeloos ME, Jansen GM, Jordal JB, Morozova O, Weholt Ø, Brandrud TE, Vila J, Karich A, Reschke K, Lorås J, et al. 2022. Molecular and morphological diversity in the *Rhombisporum* clade of the genus *Entoloma* with a note on *E. cocles*. *Mycol Prog*. 21:48. doi: [10.1007/s11557-022-01779-z](https://doi.org/10.1007/s11557-022-01779-z).
- Noordeloos ME. 1987. *Entoloma* (Agaricales) in Europe. *Beih Nova Hedwigia*. 91:1–419.
- Nylander JAA. 2004. MrModeltest v2. Program distributed by the author. Evolutionary Biology Centre, Uppsala University.
- ampignons de l'Équateur (Pugillus IV). *Bull l'Herbier Boissier*. 3:53–74.
- Oberwinkler F. 1966. Primitive basidiomyceten. Revision einiger formenkreise von basidienpilzen mit plastischer basidie. *Sydowia*. 19(1–3):1–72.
- Oliveira JJ, Vargas-Isla R, Cabral TS, Rodrigues DP, Ishikawa NK. 2019. Progress on the phylogeny of the Omphalotaceae: *Gymnopus* s. str., *Marasmiellus* s. str., *Paragymnopus* gen. nov. and *Pusillomyces* gen. nov. *Mycol Prog*. 18(5):713–739. doi: [10.1007/s11557-019-01483-5](https://doi.org/10.1007/s11557-019-01483-5).
- Patouillard. 1886. Champignons parasites des Phanerogames exotiques. *Rev Mycol*. 8:80–84.
- Rokas A. 2022. Evolution of the human pathogenic lifestyle in fungi. *Nat Microbiol*. 7(5):607–619. doi: [10.1038/s41564-022-01112-0](https://doi.org/10.1038/s41564-022-01112-0).
- Ronquist F, Huelsenbeck JP. 2003. MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics*. 19(12):1572–1574. doi: [10.1093/bioinformatics/btg180](https://doi.org/10.1093/bioinformatics/btg180).
- Sanon KB, Am B, Delaruelle C, Duponnois R, Martin F. 2009. Morphological and molecular analyses in *Scleroderma* species associated with some Caesalpinoid legumes, Dipterocarpaceae and Phyllanthaceae trees in southern Burkina Faso. *Mycorrhiza*. 19(8):571–584. doi: [10.1007/s00572-009-0272-z](https://doi.org/10.1007/s00572-009-0272-z).
- Shen S, Liu SL, Zhou LW. 2023. Taxonomy of *Hyphodermella*: a case study to show that simple phylogenies cannot always accurately place species in appropriate genera. *IMA Fungus*. 14(1):11. doi: [10.1186/s43008-023-00116-7](https://doi.org/10.1186/s43008-023-00116-7).
- Sommai S, Pinruan U, Khamsuntorn P, Lueangjaroenkit P, Somrithipol S, Luangsa-Ard J. 2023. Three new species of *Trechispora* from Northern and Northeastern Thailand. *Mycol Prog*. 22(6):95. doi: [10.1007/s11557-023-01886-5](https://doi.org/10.1007/s11557-023-01886-5).
- Song HB, Bau T. 2023. *Conocybe* section *Pilosellae* in China: reconciliation of taxonomy and phylogeny reveals seven new species and a new record. *J Fungi*. 9(9):924. doi: [10.3390/jof9090924](https://doi.org/10.3390/jof9090924).
- Song ZK, Zhu AH, Liu ZD, Qu Z, Li Y, Ma HX. 2022. Three new species of *Hypoxylon* (Xylariales, Ascomycota) on a multi-gene phylogeny from Medog in Southwest China. *J Fungi*. 8(5):1–16. doi: [10.3390/jof8050500](https://doi.org/10.3390/jof8050500).
- The Comprehensive Scientific Expedition to Qinghai-Tibet Plateau, Academia Sinica. 1983. *Fungi of Xizang* 1–226. Beijing: Science Press.
- Toth A, Hausknecht A, Krisai-Greilhuber I, Papp T, Vágvolgyi C, Nagy LG, Joly S. 2013. Iteratively refined guide trees help improving alignment and phylogenetic inference in the mushroom family Bolbitiaceae. *PLoS One*. 8(2):e56143. doi: [10.1371/journal.pone.0056143](https://doi.org/10.1371/journal.pone.0056143).
- Vaidya G, Lohman DJ, Meier R. 2011. SequenceMatrix: concatenation software for the fast assembly of multi-gene datasets with character set and codon information. *Cladistics*. 27(2):171–180. doi: [10.1111/j.1096-0031.2010.00329.x](https://doi.org/10.1111/j.1096-0031.2010.00329.x).
- Vizzini A, Alvarado P, Consiglio G, Marchetti M, Xu J. 2024. Family matters inside the order Agaricales: systematic reorganization and classification of incertae sedis clitocyboid, pleurotoid and tricholomatoid taxa based on an updated 6-gene phylogeny. *Stud Mycol*. 107(1):67–148. doi: [10.3114/sim.2024.107.02](https://doi.org/10.3114/sim.2024.107.02).
- Voitk A, Saar I, Lodge DJ, Boertmann D, Berch SM, Larsson E. 2020. New species and reports of *Cuphophyllus* from northern North America compared with related Eurasian species. *Mycologia*. 112(2):438–452. doi: [10.1080/00275514.2019.1703476](https://doi.org/10.1080/00275514.2019.1703476).
- Wang GS, Cai Q, Hao YJ, Bau T, Chen ZH, Li MX, David N, Kraisitdomsook N, Yang ZL. 2023a. Phylogenetic and taxonomic updates of Agaricales, with an emphasis on *Tricholomopsis*. *Mycology*. 15(2):180–209. doi: [10.1080/21501203.2023.2263031](https://doi.org/10.1080/21501203.2023.2263031).

- Wang SH, Li GJ, Phurbu D, He MQ, Zhang MZ, Zhu XY, Li JX, Zhao RL, Cao B. 2023b. Four new species of *Russula* from the Xizang Autonomous Region and other provinces of China. *Mycology*. 15(2):210–237. doi: [10.1080/21501203.2023.2265667](https://doi.org/10.1080/21501203.2023.2265667).
- Wang XW, Liu SL, Zhou LW. 2023c. An updated taxonomic framework of Hymenochaetales (Agaricomycetes, Basidiomycota). *Mycosphere*. 14(1):452–496. doi: [10.5943/mycosphere/14/1/6](https://doi.org/10.5943/mycosphere/14/1/6).
- Wang XW, May TW, Liu SL, Zhou LW. 2021. Towards a natural classification of *Hyphodontia* sensu lato and the trait evolution of basidiocarps within Hymenochaetales (Basidiomycota). *J Fungi*. 7(6):478. doi: [10.3390/jof7060478](https://doi.org/10.3390/jof7060478).
- Wang XW, Zhou LW. 2024. Umbellaceae fam. nov. (Hymenochaetales, Basidiomycota) for *Umbellus sinensis* gen. et sp. nov. and three new combinations. *J Fungi*. 10(1):22. doi: [10.3390/jof10010022](https://doi.org/10.3390/jof10010022).
- Wu F, Zhao Q, Yang ZL, Ye SY, Rivoire B, Dai YC. 2020. *Exidia yadongensis*, a new edible species from East Asia. *Mycosystema*. 39(7):1–12. doi: [10.13346/j.mycosystema.200205](https://doi.org/10.13346/j.mycosystema.200205).
- Wu R, Zhou L, Qu H, Ge ZW. 2023. Updates on *Scleroderma*: four new species of section *Scleroderma* from Southwestern China. *Diversity*. 15(6):775. doi: [10.3390/d15060775](https://doi.org/10.3390/d15060775).
- Wu SH, Nilsson HR, Chen CT, Yu SY, Hallenberg N. 2010. The white-rotting genus *Phanerochaete* is polyphyletic and distributed throughout the phleboid clade of the Polyporales (Basidiomycota). *Fungal Divers*. 42(1):107–118. doi: [10.1007/s13225-010-0031-7](https://doi.org/10.1007/s13225-010-0031-7).
- Xie M, Chen J, Phukhamsakda C, Dima B, Fu Y, Ji R, Wang K, Wei T, Li Y. 2021. *Cortinarius subsalor* and *C. tibeticisalor* spp. nov., two new species from the section *Delibuti* from China. *Peer J*. 9:e11982. doi: [10.7717/peerj.11982](https://doi.org/10.7717/peerj.11982).
- Xie ML, Phukhamsakda C, Wei TZ, Li JP, Wang K, Wang Y, Ji RQ, Li Y. 2022. Morphological and phylogenetic evidence reveal five new *Telamonoid* species of *Cortinarius* (Agaricales) from East Asia. *J Fungi*. 8(3):257. doi: [10.3390/jof8030257](https://doi.org/10.3390/jof8030257).
- Xu JZ, Jiang Y, Wang TT, Zhang D, Li XB, Hosen MI. 2023. Morphological characteristics and phylogenetic analyses revealed four new species of Agaricales from China. *Front Microbiol*. 14:1118525. doi: [10.3389/fmicb.2023.1118525](https://doi.org/10.3389/fmicb.2023.1118525).
- Xu JZ, Zhao W, Yu XD, Idrees M, Li Y, Qin JC. 2022. *Infundibulicybe trachyspora*, a new species from Northeastern China based on morphology and molecular phylogeny. *Curr Microbiol*. 79(5):130. doi: [10.1007/s00284-022-02808-6](https://doi.org/10.1007/s00284-022-02808-6).
- Xu YL, Cao YF, Nakasone KK, Chen CC, He SH. 2020. Taxonomy and phylogeny of *Phanerochaete* sensu stricto (Polyporales, Basidiomycota) with emphasis on Chinese collections and descriptions of nine new species. *Mycosphere*. 11(1):1527–1552. doi: [10.5943/mycosphere/11/1/12](https://doi.org/10.5943/mycosphere/11/1/12).
- Yuan Y, Bian LS, Wu YD, Chen JJ, Wu F, Liu HG, Zeng GY, Dai YC. 2023. Species diversity of pathogenic wood-rotting fungi (Agaricomycetes, Basidiomycota) in China. *Mycology*. 14(3):204–226. doi: [10.1080/21501203.2023.2238779](https://doi.org/10.1080/21501203.2023.2238779).
- Zang M. 1979. Some new species of higher fungi from Xizang (Tibet) of China. *Acta Botanica Yunnanica*. 1(2):101–105.
- Zang M. 1980. Some new species of basidiomycetes from the Xizang Autonomous Region of China. *Acta Microbiol Sin*. 20(1):29–34.
- Zeng ZQ, Zhuang WY. 2021. A new species of *Sarcopodium* (Hypocreales, Nectriaceae) from China. *Phytotaxa*. 491(1):65–71. doi: [10.11646/phytotaxa.491.1.7](https://doi.org/10.11646/phytotaxa.491.1.7).
- Zhang LH. 2005. Chinese mountains and rivers. Qingdao: Qingdao Publishing House.
- Zhang TT, Zhu XY, Vizzini A, Li BT, Cao ZH, Guo WQ, Qi S, Wei XL, Zhao RL. 2022. New insights into lichenization in agaricomycetes based on an unusual new basidiolichen species of *Omphalina* s. str. *J Fungi*. 8(10):1033. doi: [10.3390/jof8101033](https://doi.org/10.3390/jof8101033).
- Zhang WW, Tian GT, Geng XR, Zhao YC, Ng TB, Zhao LY, Wang HX. 2014. Isolation and characterization of a novel lectin from the edible mushroom *Stropharia rugosoannulata*. *Molecules*. 19(12):19880–19891. doi: [10.3390/molecules191219880](https://doi.org/10.3390/molecules191219880).
- Zhao P, Zhang ZF, Hu DM, Tsui KM, Qi XH, Phurbu D, Gafforov Y, Cai L. 2021. Contribution to rust flora in China I, tremendous diversity from natural reserves and parks. *Fungal Divers*. 110(1):1–58. doi: [10.1007/s13225-021-00482-w](https://doi.org/10.1007/s13225-021-00482-w).
- Zhou LW, Ghobad-Nejhad M, Tian XM, Wang YF, Wu F. 2022. Current status of ‘Sanghuang’ as a group of medicinal mushrooms and their perspective in industry development. *Food Rev Int*. 38(4):589–607. doi: [10.1080/87559129.2020.1740245](https://doi.org/10.1080/87559129.2020.1740245).
- Zhou LW, Hao ZQ, Wang Z, Wang B, Dai YC. 2011. Comparison of ecological patterns of polypores in three forest zones in China. *Mycology*. 2(4):260–275. doi: [10.1080/21501203.2011.602726](https://doi.org/10.1080/21501203.2011.602726).
- Zhou LW, May TW. 2023. Fungal taxonomy: Current status and research agendas for the interdisciplinary and globalisation era. *Mycology*. 14(1):52–59. doi: [10.1080/21501203.2022.2103194](https://doi.org/10.1080/21501203.2022.2103194).
- Zhou Q, Jiang Q, Yang X, Yang J, Zhao C, Zhao J. 2024. Phylogenetic and taxonomic analyses of five new wood-inhabiting fungi of *Botryobasidium*, *Coltricia* and *Coltriciella* (Basidiomycota) from China. *J Fungi*. 10(3):205. doi: [10.3390/jof10030205](https://doi.org/10.3390/jof10030205).