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ARTICLE

Species diversity, taxonomy, distribution and multi-gene phylogeny of chanterelles in China

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Abstract

The Chinese Chanterelles, or the members of *Cantharellus* and *Craterellus* are studied in the paper. They are widely distributed and have significant ecological and economic values. Although there have been several studies especially in recent years focusing on the chanterelle mushrooms in China, the research on their species diversity and phylogenetic relationships is still far from sufficient. In this study, taxonomic and phylogenetic analyses on the species diversity, distribution patterns, and interspecific relationships of *Cantharellus* and *Craterellus* in China were conducted through morphological examination and molecular phylogenetic analyses of multiple loci, including the internal transcribed spacer regions (ITS), the large subunit of nuclear ribosomal RNA gene (nrLSU), the second largest subunit of RNA polymerase II (*rpb*2), the translation elongation factor 1 gene (*tef1*), and the small subunit of mitochondrial ribosomal RNA gene (mtSSU). The results demonstrated that the species of *Cantharellus* formed seven subgenera level clades, and species of *Craterellus* formed six main clades. In total, 68 chanterelle species are recognized in China, including 42 species of *Cantharellus* and 26 species of *Craterellus.* Among them, there are 8 new species of *Cantharellus*: namely *C. albidohymenius* sp. nov., *C. chrysantyemoides* sp. nov., *C. danxiashanensis* sp. nov., *C. pseudoaustrosinensis* sp. nov., *C. pseudohainanensis* sp. nov., *C. roseocastaneus* sp. nov., *C. sinolateritius* sp. nov., and *C. subtilis* sp. nov.; and *C. subvaginatus* is a new recorded species for China. There are also 12 new species of *Craterellus*: namely *Cr. aprilis* sp. nov., *Cr. brunneus* sp. nov., *Cr. guizhouensis* sp. nov., *Cr. gypseus* sp. nov., *Cr. parvofuscus* sp. nov., *Cr. sinensis* sp. nov., *Cr. Sinocornucopioides* sp. nov., *Cr. subalpinus* sp. nov., *Cr. sublutescens* sp. nov., *Cr. tengii* sp. nov., *Cr. tropicus* sp. nov. and *Cr. viridifuscus* sp. nov.; and *Cr. parvogriseus* and *Cr. sordidus* are two newly recorded species for China. Besides, 5 new combination names are proposed. In addition, one ambiguous taxon was tentatively named as *Craterellus* sp., and five synonyms, *Cr. connatus*, *Cr. fulviceps*, *C. laevigatus, Cr. longitipes* and *Cr. striatus* were redefined. Among the accepted species, 36 known species were described in detail based on observations, and the other 9 species were reviewed. Furthermore, two new species, *Cr. grisellonigricans* sp. nov. and *Cr. murinus* sp. nov., from Vietnam were also described and introduced in the present study. Keys to the accepted species of *Cantharellus* and *Craterellus* in China were provided.

Keywords – Cantharellales – edible fungi – Hydnaceae – novel taxa – phylogenetics

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INTRODUCTION

Chanterelles in this paper refer to members of the genera *Cantharellus* Adans. ex Fr. (abbreviated as "*C.*") and *Craterellus* Pers. (abbreviated as "*Cr.*"), which belong to family Hydnaceae Chevall. (Cantharellaceae s. str.), including numerous highly appreciated wild edible species (such as *C. cibarius* Fr.). Chanterelles are characterized by their blunt and interconnected hymenophore, commonly referred to as "false gills", which extend down the stipe and cannot be removed or separated easily from the pileus. In some species there are even no false gills or ridges, featuring a completely smooth underside of the pileus, and distinguishing them from other mushrooms with blade-like "true gills". Chanterelles are ectomycorrhizal and form symbiotic associations with trees, such as members of Betulaceae, Dipterocarpaceae, Fabaceae, Fagaceae, Juglandaceae, Leguminosae, Pinaceae, and Salicaceae (Corner 1966, Buyck et al. 2014, Cao et al. 2021a). They are widely distributed around the world and play vital roles in forest ecosystems.

Traditionally, identifying chanterelle mushrooms was mainly based on a limited range of morphological characters, such as the colour of the pileus, hymenophore characters, presence or absence of clamp connections, and shape and size of basidiospores (Corner 1966). The genus *Cantharellus*, with the type species *C. cibarius* Fr., is mainly characterized by its fleshy, funnel-shaped basidiomata often with bright colours such as yellow, orange, pink or cream, nearly smooth to obvious veined hymenophore, solid stipe, long and stichic basidia with 4–8-spores, and cylindrical pileipellis hyphal terminals (Corner 1966, Cairney & Chambers 1999, Pine et al. 1999, Buyck et al. 2014). *Craterellus*, with the type species *Cr. cornucopioides* (L.) Pers. (Persoon 1825), exhibits notable similarities to *Cantharellus*, including trumpet-shaped basidiomata, poorly developed hymenophore with transverse veins, stichic basidia, and smooth basidiospores. However, members of *Craterellus* can be distinguished by the trumpet-shaped, thinner and more fragile basidiomata usually with perforation in the pileus center, the broader colour range of pileus (from black, deep brown to pale yellow) usually covered with fine scales on surface, hollow stipe, and poorly developed hymenophore mostly without any transverse veins. These features are uncommon in *Cantharellus*. Additionally, the pileipellis of *Craterellus* is typically a cutis, composed of a relatively regular arrangement of thin-walled hyphae, while the hyphae of the pileipellis in *Cantharellus* are more interwoven, and in some species, the terminal hyphae exhibit their thick-walled characteristics.

It is not difficult to recognize and identify chanterelle mushrooms at the genus level in the field, but it is challenging to identify the chanterelle species solely based on morphology due to the high morphological similarities among species and the limited distinguishing morphological features. Taxonomic research on chanterelles, which previously mainly relied on morphological characteristics, resulted in widespread misidentification of some species globally. In Asia, the taxonomic confusion of *Cantharellus* is particularly severe, most species were mislabelled as the names of European and American species since Corner′s work in 1960 (Wang et al. 2004, Shao et al. 2012, Zhang et al. 2021a). The most common misconception relates to *C. cibarius*, where nearly every medium-sized, yellow *Cantharellus* was erroneously identified as the European species *C. cibarius*, irrespective of its geographical origin (Wang et al. 2023a). The misidentification led to substantial gaps in comprehension of the actual species diversity and distribution of *Cantharellus*. However, in the last decade, advancement of molecular biological techniques has posed a challenge to traditional morphology-based taxonomy, significantly advancing the progress of fungal classification research and showing the traditional generic delimitation of the two genera to be somewhat questionable. Feibelman et al. (1997) first confirmed that *Cantharellus* and *Craterellus* are two distinct groups, and that *Cantharellus tubaeformis* Fr. and *Pseudocraterellus sinuosus* (Fr.) Corner should be placed in *Craterellus* based on phylogenetic analysis using 28S sequences. Subsequent studies such as Hibbett et al. (1997), Pine et al. (1999) and Dahlman et al. (2000), further confirmed that they are two distinct but closely related genera, closely related to *Hydnum*, *Sistotrema* and *Clavulina*. Therefore, Hibbett et al. (2014) merged the previously morphology-based classification group of family Cantharellaceae s.l. (containing the genera *Afrocantharellus*, *Cantharellus*, *Craterellus*, *Goossensia*, *Parastereopsis*, *Pseudocraterellus*

and *Pterygellus*) into family Hydnaceae which was established earlier, and established the current taxonomic framework.

Within the genus *Cantharellus*, Buyck & Hofstetter (2011) firstly demonstrated that the tef-1 sequences can effectively separate species, and reported several new species (Buyck and Hofstetter 2011, Buyck et al. 2011). Then, Buyck et al. (2014) established the multigene phylogenetic framework of *Cantharellus* using nucLSU, mitSSU, rpb2, and tef-1 sequences, and divided the genus into six subgenera and ten sections. Cao et al. (2021a) proposed a new subgenus within *Cantharellus*, i. e. *C.* subg. *Magni*.

Feibelman et al. (1997) and Dahlman et al. (2000) conducted molecular phylogenetic analyses of *Craterellus,* and proved *Craterellus* as a distinct group from *Cantharellus*. The hollow stipe appeared to be a synapomorphy for *Craterellus* species. Later, *Craterellus* was proved to be monophyletic, and some new species were reported (Wilson et al. 2012, Henkel et al. 2014, Zhao et al. 2022, Jiang et al. 2025). Cao et al. (2021a) divided the genus into six subgenera based on multigene analyses.

Molecular analyses utilizing nucleotide sequence data have accelerated discovery of new chanterelles species, and resulted in publication of numerous new taxa over the past decade (Das et al. 2015, 2017, De Kesel et al. 2016, Leacock et al. 2016, Shao et al. 2016a, b, Buyck et al. 2016a, b, c, 2018, 2020, 2021, An et al. 2017, Antonín et al. 2017, Bijeesh et al. 2018, Herrera et al. 2018, Zhong et al. 2018, Jian et al. 2020, Cao et al. 2021a, Montoya et al. 2021, Zhang et al. 2020, 2021a, b, 2022a, b, c, 2023, Zhao et al. 2022, Swenie & Matheny 2023, Jiang et al. 2025). Simultaneously, some synonyms have also been identified. In Europe, for example, thirteen species names referring to *Cantharellus* s. str. have been reported, but only eight species were recognized based on molecular phylogenetic analyses (Olariaga et al. 2016). The species *C. henrici* Eyssart. & Buyck, *C. lilacinopruinatus* Hermitte, Eyssart. & Poumarat, and *C. ilicis* Olariaga & Salcedo are now all considered synonyms of *C. alborufescens* (Malençon) Papetti & S. Alberti; and *C. parviluteus* Fern. Sas., Pérez-De-Greg. & Eyssart. is a synonym of *C. cibarius* (Olariaga et al. 2016). In Asia, *C. cibarius* has been widely reported, but recent research has demonstrated that its distribution is relatively limited and it is not as common as previously recorded. The "*C. cibarius*" previously reported in various parts of Asia encompassed several species that were morphologically similar but distinct from each other (Wang et al. 2023a, Zhang et al. 2021a, 2022a, b, 2023). The reported subalpine species *C. sikkimensis* K. Das et al. is actually a synonym of *C. zangii* X.F. Tian, P.G. Liu & Buyck; and the widely distributed species in southern China *C. albovenosus* Buyck, Antonín & Ryoo is a later synonym of *C. phloginus* S.C. Shao & P.G. Liu based on phylogenetic analyses (Zhang et al. 2021a, Wang et al. 2023a). Molecular analyses have also unveiled some species complex, such as the black trumpet mushrooms (*Cr. cornucopioides* complex). The species has been widely reported in the Northern Hemisphere (Pilz et al. 2003); however, phylogenetic studies have proven the existence of multiple morphologically similar species, and reported several independent species such as *Cr. fallax* A.H. Sm., *Cr. involutus* N.K. Zeng & T. Jiang, *Cr. macrosporus* T. Cao & H.S. Yuan and *Cr. squamatus* T. Cao & H.S. Yuan (Matheny et al. 2010, Cao et al. 2021a, Zhang et al. 2022c, Jiang et al. 2025).

In terms of the geographical distribution, chanterelle mushrooms are widely distributed in both the northern and southern hemispheres, with a particularly rich presence in paleotropical regions (Wilson et al. 2012, Buyck 2016, Olariaga et al. 2016). Recent studies have indicated that chanterelles demonstrate a broad regional endemism, with very few species showing intercontinental distribution. For example, in the genus *Cantharellus*, approximately 31 species have been originally reported in North America, none of which occur in Europe (Buyck et al. 2016a, 2016c, Thorn et al. 2017, Hall et al. 2023). In tropical Africa, including Madagascar, approximately 75 species have been reported, displaying distinctive tropical regional distribution characteristics (Buyck et al. 2013, Buyck 2016, Kesel et al. 2016). In Asia, approximately 52 species have been reported, with most taxa being described in recent years through phylogenetic analyses, and all the species differ from the known species on other continents, except *C. cibarius* (Buyck 2016, Zhang et al. 2021a, Wang et al. 2023a). In Europe, only eight species have been identified. Apart from *C.*

cibarius which can also be seen in Asia, all the others are endemic to Europe (Buyck 2016, Olariaga et al. 2016). Therefore, the global distribution pattern of chanterelle species exhibits strong continental regional endemism, featuring morphologically similar yet genetically distinct species across the globe (Buyck et al. 2014, Thorn et al. 2017). To date, approximately 300 species of *Cantharellus* and 70 species of *Craterellus* have been recognized worldwide (Buyck et al. 2014, Cao et al. 2021a, http://indexfungorum.org/, accessed 09/06/2025).

Chanterelle mushrooms are economically valuable, especially those belonging to the genus *Cantharellus*. About 150 000~200 000 tons of chanterelles are consumed annually worldwide (Watling 1997). In China, over 5 000 tons of *Cantharellus* mushrooms are sold in Yunnan free markets annually. The primary species traded is *C. applanatus*, but others, including *C. cibarius*, *C. elongatipes*, *C. phloginus* and *C. versicolor*, *C. phloginus* and *C. elongatipes*, are also available. All these species are collectively known in the market as "ji you jun (鸡油菌)" or "huang si jun (黄丝菌)" in China, but the taxonomic study on them is still inadequate. Historically, approximately 100 species names of chanterelles have been reported in China based on morphology, and most of these names were originally from North America or Europe. Consequently, the true species diversity of chanterelles in China remained unclear. Over the past decade, China has emerged as a hotspot for studying chanterelle species diversity and phylogenetics, and some native species have been discovered from China (or Asia), which all differ from North American and European species, significantly expanding the catalog of known Chinese chanterelles (Shao et al. 2014, 2016a, 2016b, An et al. 2017, Jian et al. 2020, Zhang et al. 2020, 2021a, 2021b, 2022a, 2022b, 2022c, 2023, Cao et al. 2021a, 2021b, Wang et al. 2023a, Jiang et al. 2025).

Despite the recent advances in taxonomy and systematics of *Cantharellus* and *Craterellus*, the exact number of existing chanterelle species in China remains unclear, and many more taxa are still to be described. A comprehensive reassessment is necessary on the classification of the Chinese chanterelles, emphasizing genetic analysis alongside morphological traits to accurately delineate the species boundaries and understand their diversity and distribution. In this study, morphological features and DNA-based molecular analyses were conducted on over 610 collections from China over the past ten years, aiming to elucidate species diversity, phylogenetic relationships, endemism and geographic distribution of the chanterelle species in China, and to provide some foundational information to their identification. Additionally, two keys to the species of *Cantharellus* and *Craterellus* in China are provided in this study.

MATERIALS AND METHODS

Sample collections

A total of 610 samples were collected from most provinces, municipalities and autonomous regions of China, with the exception of the northwest areas of Qinghai, Xinjiang, Ningxia, Gansu, and Shaanxi Provinces, and the southern areas of Hong Kong, Macao, and Taiwan. Observations of morphological characteristics were obtained from fresh specimens. Colour codes and names were based on Kornerup and Wanscher (1981).

Morphological observation

Macro-morphological characters of specimens were noted from the field records and photographs. Microscopic measurements were carried out on dried tissue sections rehydrated in 5% KOH and stained with 1% aqueous Congo red. Measurements and photographs were taken using a light microscope (Olympus BX51, Tokyo) with magnification up to 1000×. For basidiospore descriptions, a notation (a)b–c(d) describes basidiospore dimensions, where the range "b–c" represents 90% or more of the measured values and "a" and "d" are the extreme values; L_m and W_m indicate the average length and width (± standard deviation) of the measured basidiospores, respectively; Q value refer to the length/width ratio of an individual basidiospore; and Q_m refers to the average Q value of all measured basidiospores ± standard deviation. All line-drawings of microstructures were made by free hand based on rehydrated materials. The studied specimens

were deposited in the Fungarium of Institute of Microbiology, Guangdong Academy of Sciences (GDGM). Registration numbers were obtained from Fungal Names (https://nmdc.cn/fungalnames/) (Wang et al. 2023b), and Facesoffungi numbers were obtained from Faces of Fungi (https://facesoffungi.org/).

DNA extraction and amplification

Genomic DNA was extracted from the voucher specimens using the Sangon Fungus Genomic DNA Extraction kit (Sangon Biotech Co., Shanghai, China) according to the manufacturer's instructions. Five loci, including the 5.8S nuclear ribosomal RNA gene with the two flanking internal transcribed spacer (ITS) regions, the partial the nuclear large subunit (LSU), the partial translation elongation factor (*tef1*), the partial RNA polymerase second largest subunit (*rpb*2) and the partial mitochondrial small subunit (mitSSU) were amplified and sequenced. Primer pairs ITS1/ITS4, LR0R/LR7, tef1F/tef1R or tef-1Fcanth/tef-1Rcanth, RPB2-5FCanth/RPB2-7cRCanth and MS1/MS2 were used to amplify ITS, LSU, *tef1*, *rpb*2 and SSU gene, respectively (Vilgalys & Hester 1990, White et al. 1990, Gardes & Bruns 1993, Buyck et al. 2014). PCR reactions were performed in a total volume of 25 µL containing 0.5 µL template DNA, 11 µL distilled water, 0.5 µL of each primer and 12.5 µL PCR mix [DreamTaqtm Green PCR Master Mix (2×), Fermentas]. Amplification reactions were performed in a Tprofessional Standard thermocycler (Biometra, Göttingen, Germany) under the following conditions: at 95°C for 4 min, then 35 cycles of denaturation at 94°C for 60 s, annealing at 53°C (ITS, LSU and SSU) /50°C (*tef1*) /52°C (*rpb*2) for 60 s and extension at 72°C for 60 s, with a final extension at 72°C for 8 min. The PCR products were electrophoresed on 1% agarose gels with known standard DNA markers and sequencing were performed on an ABI Prism® 3730 Genetic Analyzer (PE Applied Biosystems, Foster, CA, USA) at Beijing Genomic Institute (BGI) using the same primers. The raw sequences were assembled with SeqMan implemented in Lasergene v7.1 (DNASTAR, USA). The newly assembled sequences were submitted to GenBank.

Molecular phylogenetics

Data on the newly generated sequences and homologous sequences downloaded from GenBank were used to reconstruct the phylogenetic trees, including all described species of *Cantharellus* and *Craterellus* with available sequences. Detailed sample information, including species names, voucher specimens, localities, GenBank accession numbers and references, have been listed in Table 1. Sequences of five loci (ITS, nrLSU, *tef1* and rpb2, mtSSU) were aligned with MAFFT (Katoh et al. 2019) using '--auto' strategy and normal alignment mode, separately, and were examined and manually edited in MEGA version 6 (Tamura et al. 2013). Ambiguously aligned bases and introns of protein-coding genes were retained in the final analyses. To prevent highly divergent sequences between the two genera *Cantharellus* and *Craterellus*, and to address the issue of long branch attraction, phylogenetic analyses of the two genera were conducted separately.

Phylogenetic analyses were conducted using the software PhyloSuite (Zhang et al. 2020a), following the methods described by Zhang et al. (2022d). Maximum likelihood phylogenies were inferred using IQ-TREE (Nguyen et al. 2015) and Bayesian inference (BI) was performed using MrBayes 3.2.6 (Ronquist et al. 2012). For both ML and BI analyses, the most suitable substitution model for each gene partition was determined using ModelFinder (Kalyaanamoorthy et al. 2017). Default parameters were included for the ML analysis, except for selecting the most suitable model, and statistical data were obtained by performing rapid non-parametric bootstrapping with 1000 replicates. Bayesian inference (BI) analysis using four chains and the stoprul command with stopval set to 0.01. Trees were sampled every 100 generations, the first 25% generations were discarded as a burn-in, and Bayesian posterior probabilities (BPP) were calculated from the posterior distribution of the retained Bayesian trees. Bootstrap support (BS) in the ML tree ≥ 75% and BPP ≥ 0.95 indicated statistical significance. Phylogenetic trees were visualized using FigTree v1.4.23.

Table 1 List of species, specimens, country, and GenBank accession numbers of sequences used in present study. * refers to holotype, isotype, epitype and paratype specimens, – refers to data unavailability.

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cantharellus addaiensis	1630/EDC14.414	Togo	–	KX857101	KX857074	KX857005	KX857127	Buyck 2016
C. addaiensis	ADK 3983	Kenya	–	–	KX834362	KX834417	–	De Kesel et al. (2016)
C. addaiensis	ADK 4371	Togo	–	–	–	KX834442	–	De Kesel et al. (2016)
C. addaiensis	ADK 5377	RD Congo	–	–	KX834363	KX834418	–	De Kesel et al. (2016)
C. addaiensis	BB 96.010	Zambia	–	KM484680	–	–	–	Unpublished
C. addaiensis	BB 98.033	Tanzania	–	KF294667	JX192992	KF294745	KF294592	Buyck et al. (2014)
C. addaiensis	BB 98.057	Tanzania	–	KF294621	JX192976	KF294695	KF294550	Buyck et al. (2014)
C. addaiensis	JD 1093	RD Congo	–	–	KX834364	–	–	De Kesel et al. (2016)
C. addaiensis	LAG-0148	Benin	MW829787	MK908840	–	–	–	Unpublished
C. afrocibarius	ADK 5389	RD Congo	–	–	KX834409	KX834420	–	De Kesel et al. (2016)
C. afrocibarius	ADK 5418	RD Congo	–	–	KX834365	KX834421	–	De Kesel et al. (2016)
C. afrocibarius	BB 96. 235	Zambia	–	KF294668	JX192993	KF294746	KF294593	Buyck et al. (2014)
C. afrocibarius	BB 96. 236	Zambia	–	KF294669	JX192994	KF294747	KF294594	Buyck et al. (2014)
C. afrocibarius	JD 937	RD Congo	–	–	KX834366	KX834422	–	De Kesel et al.(2016)
C. albidolutescens	BB 08. 057	Madagascar	–	KF294645	KF294752	KF294722	KF294576	Buyck et al. (2014)
C. albidolutescens	BB 08. 070	Madagascar	KF981365	KF294646	–	KF294723	–	Buyck et al. (2014)
C. albidosquamosus	1595/T.W. Henkel 10005 *	Cameroon	–	MT002284	MT002269	MT004805	MT002296	Unpublished
C. albidosquamosus	1617/T.W. Henkel 10314	Cameroon	–	MT002285	MT002270	MT004806	MT002297	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. albidosquamosus	1618/T.W. Henkel 10375	Cameroon	–	MT002286	MT002271	MT004807	MT002298	Unpublished
C. albidosquamosus	1619/T.W. Henkel 10705	Cameroon	–	MT002287	MT002272	MT004808	MT002299	Unpublished
C. albopileatus	**GDGM80787**	**China**	**PX658637**	**PX523958**	**PX704887**	**–**	**–**	**Present study**
C. albopileatus	**GDGM80789**	**China**	**PX658638**	**PX523959**	**PX704888**	**–**	**–**	**Present study**
C. albopileatus	**GDGM85935**	**China**	**PX658639**	**PX523960**	**PX704889**	**PX516699**	**PX590135**	**Present study**
C. albopileatus	**GDGM97430**	**China**	**–**	**PX664346**	**PX704890**	**PX657138**	**PX657479**	**Present study**
C. albopileatus	FHMU6850	China	–	OM691481	OM811322	–	–	Zhang et al. (2022b)
C. albopileatus	FHMU1987 *	China	OM835804	OM691480	OM811321	–	–	Zhang et al. (2022b)
C. alboroseus	1650/BB 16.016	Central African Republic	–	–	–	MT004812	MT002302	Unpublished
C. alboroseus	1659/BB16.086	Central African Republic	–	KX857103	KX857076	KX857007	KX857129	Buyck (2016)
C. alboroseus	1668/BB 16.106	Central African Republic	–	–	–	MT004813	MT002303	Unpublished
C. alboroseus	1670/BB16.108	Central African Republic	–	KX857104	KX857077	KX857008	KX857130	Buyck (2016)
C. alborufescens	1006/EC 09.91	Italy	–	KX907221	KX907242	KX907231	–	Olariaga et al. (2016)
C. alborufescens	1108/BB 12.075	Italy	KX907209	KX929161	KX907243	KX907232	–	Olariaga et al. (2016)
C. alborufescens	1109/BB 12.076	Italy	–	KX907222	KX907244	KX907233	–	Olariaga et al. (2016)
C. alborufescens	1121/BB.12.088	Italy	–	KX907223	KX907245	KX907234	–	Olariaga et al. (2016)
C. alborufescens	AH44783	France	–	KR677492	KX828817	KX828736	–	Olariaga et al. (2016)
C. alborufescens	BIO-Fungi 11687	Spain	KX828765	KX828793	KX828818	KX828737	–	Olariaga et al. (2016)
C. alborufescens	BIO-Fungi 11691	Spain	KX828766	KX828794	–	–	–	Olariaga et al. (2016)
C. alborufescens	ICH431F	Iran	MH463257	MH463258	MH463260	MH463259	–	Parad et al. (2018)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. alborufescens	ICH432F	Iran	MH463265	MH463266	MH463268	MH463267	–	Parad et al. (2018)
C. alborufescens	ICH434F	Iran	MH463280	MH463281	MH463283	MH463282	–	Parad et al. (2018)
C. alborufescens	ICH437F	Iran	MH463290	MH463291	MH463293	MH463292	–	Parad et al. (2018)
C. alborufescens	ICH438F	Iran	MH463261	MH463262	MH463264	MH463263	–	Parad et al. (2018)
C. alborufescens	ICH439F	Iran	MH463272	MH463273	MH463275	MH463274	–	Parad et al. (2018)
C. alborufescens	ICH440F	Iran	MH463276	MH463277	MH463279	MH463278	–	Parad et al. (2018)
C. albus	**GDGM44800**	**China**	**PX658640**	**–**	**–**	**–**	**–**	**Present study**
C. albus	GDGM56646	China	–	MZ605071	MZ613974	MZ614019	**PX657391**	Zhang et al. (2021a) Present study
C. albus	GDGM77819	China	**PX658641**	MZ605072	MZ613975	MZ614020	**PX657395**	Zhang et al. (2021a) Present study
C. albus	GDGM81064	China	**–**	MZ605073	MZ613976	MZ614021	**PX590137**	Zhang et al. (2021a) Present study
C. albus	GDGM81399	China	**–**	MZ605074	MZ613977	MZ614022	–	Zhang et al. (2021a) Present study
C. albus	GDGM84809	China	**–**	MZ605075	MZ613978	MZ614038	**PX657464**	Zhang et al. (2021a) Present study
C. albus	GDGM84814	China	**PX658642**	MZ605076	MZ613979	MZ614039	**PX590138**	Zhang et al. (2021a) Present study
C. albus	**GDGM85726**	**China**	**PX658643**	**PX523961**	**PX704891**		**PX590136**	**Present study**
C. albus	**GDGM85729**	**China**	**PX658644**	**–**	**PX704892**			**Present study**
C. albus	**GDGM93449**	**China**	**–**	**PX664347**	**PX704893**	**PX657124**	**–**	**Present study**
C. albus	**GDGM93722**	**China**	**–**	**–**	**PX704894**	**PX657125**	**–**	**Present study**
C. albus	HKAS 107045*	China	–	MT782540	MT776015	MT776012	–	Jian et al. (2020)
C. albus	HKAS 107047	China	–	MT782542	MT776017	MT776014	–	Jian et al. (2020)
C. albus	HKAS 107048	China	–	MT782541	MT776016	MT776013	–	Jian et al. (2020)
C. altipes	BB 07.005	USA	–	KR349275	–	–	–	Unpublished
C. altipes	BB 07.019	USA	–	KF294627	–	KF294702	KF294556	Buyck et al. 2014
C. altipes	BB 07.055	USA	–	–	GQ914940	–	–	Buyck et al. (2011)
C. altipes	BB 07.112	USA	–	–	GQ914941	–	–	Buyck et al. (2011)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. altipes	BB 07.114	USA	–	–	GQ914942	–	–	Buyck et al. (2011)
C. altipes	BB 07.115	USA	JN944018	JN940599	GQ914943	–	–	Buyck et al. (2011)
C. altipes	BB 07.116	USA	–	–	GQ914944	–	–	Buyck et al. (2011)
C. altipes	BB 07.162	USA	–	KF294636	–	KF294713	KF294567	Buyck et al. 2014
C. altipes	BB 14.032	USA	KX896770	–	–	–	–	Buyck et al. (2016b)
C. altipes	JJ NC-cant-6	USA	KX896772	KX896787	–	–	–	Buyck et al. (2016b)
C. altipes	RAS639	USA	–	–	OM751854	OM687955	OR470852	Unpublished
C. ambohitantelyensis	BB 08.336	Madagascar	KF981366	KF294656	JX192989	KF294733	KF294582	Buyck et al. 2014
C. amethysteus	09.08.24.av04	Canada	MN206942	KX592684	MN181459	–	–	Thorn et al. (2017) Unpublished
C. amethysteus	1003/EC 09.29	Italy	–	KX907220	KX907241	KX907230	–	Olariaga et al. (2016)
C. amethysteus	349/BB 07.284	Slovakia	JN944020	JN940589	–	KF294716	–	Unpublished
C. amethysteus	993/Estades 10.453	France	–	KX907213	KX907236	KX907225	–	Olariaga et al. (2016)
C. amethysteus	994/Estades 10.454	France	KX907205	KX907214	KX907237	KX907226	–	Olariaga et al. (2016)
C. amethysteus	AH44796	Spain	KR677512	KR677550	KX828819	KX828738	–	Olariaga et al. (2015, 2016)
C. amethysteus	BB 07.284	Slovakia	–	KF294639	GQ914953	–	KF294570	Buyck et al. (2011, 2014)
C. amethysteus	BB 07.309	Slovakia	–	KF294642	GQ914954	KF294719	KF294573	Buyck et al. (2011, 2014)
C. amethysteus	BIO-Fungi 12923	Spain	KR677514	KR677552	–	–	–	Olariaga et al. (2015)
C. appalachiensis	AG191_FLAS-F-60204	USA	–	–	MK045364	–	–	Unpublished
C. appalachiensis	BB 07.123	USA	–	KF294635	GQ914979	KF294711	KF294565	Buyck et al. (2011, 2014)
C. appalachiensis	FLAS-F-61022	USA	MH281862	–	MK045365	–	–	Unpublished
C. appalachiensis	FLAS-F-61050	USA	–	–	MK045366	–	–	Unpublished
C. appalachiensis	GRSM 77088	USA	–	DQ898668	–	DQ898748	DQ898646	Moncalvo et al. (2007)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. appalachiensis	JJ MO-cant-3	USA	–	KX857090	KX857032	KX856994	KX857116	Buyck 2016
C. applanatus	121	India	HQ270118	HM750918	–	–	–	Deepika et al. (2013)
C. applanatus	C-84	Japan	LC085359	–	–	–	–	Unpublished
C. applanatus	**GDGM79335**	**China**	**PX658648**	**PX664348**	**PX704895**	**PX657076**	**PX657401**	**Present study**
C. applanatus	**GDGM80785**	**China**	**PX658649**	**PX664349**	**PX704896**	**–**	**–**	**Present study**
C. applanatus	**GDGM80786**	**China**	**PX658650**	**PX664350**	**PX704897**	**–**	**–**	**Present study**
C. applanatus	**GDGM80814**	**China**	**–**	**PX664351**	**PX704898**	**PX657072**	**PX657407**	**Present study**
C. applanatus	**GDGM80816**	**China**	**PX658651**	**PX664352**	**PX704899**	**–**	**–**	**Present study**
C. applanatus	**GDGM80866**	**China**	**PX658653**	**PX664353**	**PX704900**	**PX657073**	**PX657409**	**Present study**
C. applanatus	**GDGM80871**	**China**	**PX658654**	**PX523962**	**PX704901**	**PX516700**	**PX590139**	**Present study**
C. applanatus	**GDGM80874**	**China**	**PX658655**	**PX664354**	**PX704902**	**PX657074**	**PX657410**	**Present study**
C. applanatus	**GDGM80875**	**China**	**–**	**PX664355**	**PX704903**	**PX657077**	**PX657411**	**Present study**
C. applanatus	**GDGM81405**	**China**	**–**	**PX664356**	**PX704904**	**–**	**–**	**Present study**
C. applanatus	**GDGM81822**	**China**	**–**	**PX664357**	**PX704905**	**PX657078**	**PX657416**	**Present study**
C. applanatus	**GDGM81835**	**China**	**PX658657**	**PX664358**	**PX704906**	**PX657079**	**PX657417**	**Present study**
C. applanatus	**GDGM81859**	**China**	**PX658658**	**PX664359**	**–**	**PX657080**	**PX657418**	**Present study**
C. applanatus	**GDGM81863**	**China**	**–**	**PX664360**	**PX704907**	**PX657083**	**PX657421**	**Present study**
C. applanatus	**GDGM81871**	**China**	**PX658660**	**PX664361**	**PX704908**	**PX657084**	**PX657422**	**Present study**
C. applanatus	**GDGM81872**	**China**	**PX658661**	**PX664362**	**–**	**PX657085**	**PX657423**	**Present study**
C. applanatus	**GDGM82520**	**China**	**PX658666**	**PX664363**	**–**	**–**	**–**	**Present study**
C. applanatus	**GDGM82552**	**China**	**PX658669**	**PX664364**	**–**	**–**	**–**	**Present study**
C. applanatus	**GDGM82780**	**China**	**PX658670**	**PX664365**	**PX704909**	**PX657105**	**PX657444**	**Present study**
C. applanatus	**GDGM82804**	**China**	**PX658671**	**PX664366**	**PX704910**	**PX657106**	**PX657447**	**Present study**
C. applanatus	**GDGM82807**	**China**	**PX658672**	**PX523963**	**PX704911**	**PX516701**	**PX590140**	**Present study**
C. applanatus	**GDGM82820**	**China**	**PX658673**	**PX664367**	**PX704912**	**PX657103**	**PX657450**	**Present study**
C. applanatus	**GDGM82845**	**China**	**PX658674**	**PX664368**	**PX704913**	**PX657104**	**PX657451**	**Present study**
C. applanatus	**GDGM82872**	**China**	**PX658675**	**PX523964**	**PX704914**	**PX516702**	**PX590141**	**Present study**
C. applanatus	**GDGM83026**	**China**	**PX658676**	**PX664370**	**–**	**PX657107**	**PX657452**	**Present study**
C. applanatus	**GDGM83055**	**China**	**PX658677**	**PX664371**	**PX704915**	**PX657108**	**PX657453**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. applanatus	**GDGM89618**	**China**	**–**	**PX523965**	**PX704916**	**PX516703**	**PX590142**	**Present study**
C. applanatus	**GDGM90290**	**China**	**–**	**PX664372**	**PX704917**		**PX657469**	**Present study**
C. applanatus	**GDGM97257**	**China**	**–**	**PX664373**	**PX704920**	**PX657136**	**PX657478**	**Present study**
C. applanatus	HKAS 107313	China	–	–	ON089607	ON089584	–	Wang et al. (2023a)
C. applanatus	HKAS 109695	China	–	–	MW368920	ON089579	–	Wang et al. (2023a)
C. applanatus	HKAS 109696	China	–	–	MW368925	ON089587	–	Wang et al. (2023a)
C. applanatus	HKAS 109697	China	–	–	MW368926	ON089588	–	Wang et al. (2023a)
C. applanatus	HKAS 109698	China	–	–	MW368922	ON168705	–	Wang et al. (2023a)
C. applanatus	HKAS 109699	China	–	–	MW368921	ON089580	–	Wang et al. (2023a)
C. applanatus	HKAS 109700	China	–	–	MW368923	ON089581	–	Wang et al. (2023a)
C. applanatus	HKAS 109820	China	–	–	ON089606	ON089583	–	Wang et al. (2023a)
C. applanatus	HKAS 117674	China	–	–	ON089605	ON089582	–	Wang et al. (2023a)
C. applanatus	HKAS 55817	China	ON054213	ON054266	–	–	–	Wang et al. (2023a)
C. applanatus	SSC 1	China	–	KU720305	KM893834	–	–	Unpublished
C. applanatus	SSC 6	China	–	KU720308	KM893837	–	–	Unpublished
C. applanatus	SXF 137	China	–	–	KM893846	–	–	Unpublished
C. applanatus	TIAN 13	China	–	–	KM893851	–	–	Unpublished
C. applanatus	Yuan13983	China	–	MW979527	MW999428	–	–	Cao et al. (2021a)
C. applanatus	Yuan13985	China	–	MW979528	MW999429	–	–	Cao et al. (2021a)
C. applanatus	ZhangJP117	China	–	KU720336	KM893855	–	–	Unpublished
C. aurantinus	GDGM46278 *	China	–	MZ766517	MZ766560	–	**PX590148**	Zhang et al. (2021a) Present study
C. aurantinus	GDGM46279	China	–	MZ766518	MZ766561	MZ766571	**PX657388**	Zhang et al. (2021a) Present study
C. aurantinus	GDGM46413	China	**PX658680**	PX664374	–	–	**PX657389**	Present study
C. aurantinus	GDGM81889	China	–	MZ766519	MZ766562	MZ766574	**PX590149**	Zhang et al. (2021a) Present study
C. aurantinus	GDGM81899	China	–	MZ766520	MZ76563	MZ766573	**PX657424**	Zhang et al. (2021a) Present study
C. aurantinus	**GDGM84972**	**China**	**–**	**PX523967**	**PX704921**	**PX516704**	**PX590143**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. aurantinus	GDGM84974	China	–	MZ766521	MZ766564	MZ766572	**PX590150**	Zhang et al. (2021a) Present study
C. aurantinus	GDGM84975	China	**PX658681**	PX523968	–	PX516705	**PX590144**	Present study
C. aurantinus	GDGM84978	China	**PX658682**	MZ766522	MZ766565	–	**PX590145**	Zhang et al. (2021a) Present study
C. aurantinus	**GDGM91293**	**China**	**–**	**PX664375**	**PX704922**	**PX657121**	**PX657470**	**Present study**
C. aurantinus	**GDGM94591**	**China**	**PX658683**	**PX664376**	**–**	**PX657129**	**PX657475**	**Present study**
C. aurantinus	**GDGM95664**	**China**	**–**	**PX664377**	**–**	**PX657134**	**PX657477**	**Present study**
C. austrosinensis	**GDGM32657**	**China**	**–**	**PX664378**	**PX704925**	**PX657064**	**PX657387**	**Present study**
C. austrosinensis	GDGM60305	China	–	MZ605077	MZ613980	MZ614023	**PX657392**	Zhang et al. (2021a) Present study
C. austrosinensis	GDGM79507	China	–	MZ605078	MZ613981	MZ614024	**PX657405**	Zhang et al. 2021, Present study
C. austrosinensis	GDGM80211	China	**PX658687**	MZ605080	MZ613984	MZ614025	**PX590153**	Zhang et al. (2021a) Present study
C. austrosinensis	GDGM80616	China	**PX658688**	MZ605081	MZ613982	MZ614026	**PX657406**	Zhang et al. (2021a) Present study
C. austrosinensis	GDGM81249 *	China	**PX658689**	MZ605082	MZ613983	MZ614027	**PX590154**	Zhang et al. (2021a) Present study
C. austrosinensis	GDGM81271	China	–	MZ605083	MZ613985	MZ614028	**PX657413**	Zhang et al. (2021a) Present study
C. austrosinensis	GDGM81303	China	**PX658690**	MZ605084	MZ613986	MZ614029	**PX657414**	Zhang et al. (2021a) Present study
C. austrosinensis	GDGM81379	China	**PX658691**	MZ605085	MZ613987	MZ614030	**PX590155**	Zhang et al. (2021a) Present study
C. austrosinensis	GDGM81381	China	**PX658692**	MZ605086	MZ613988	MZ614031	–	Zhang et al. (2021a) Present study
C. austrosinensis	GDGM81985	China	**PX658693**	MZ605087	MZ613989	MZ614032	**PX657425**	Zhang et al. (2021a) Present study
C. austrosinensis	GDGM82877	China	**PX658694**	MZ605088	MZ613990	MZ614033	**PX590156**	Zhang et al. (2021a)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
								Present study
C. austrosinensis	HKAS59093	China	HQ416694	–	–	–	–	Unpublished
C. austrosinensis	HKAS 110470	China	–	–	ON089625/ ON089626	ON089635	–	Wang et al. (2023a)
C.* cf. *austrosinensis	**GDGM78690**	**China**	**PX658684**	**PX523970**	**PX704923**	**PX516706**	**PX590151**	**Present study**
C.* cf. *austrosinensis	**GDGM85994**	**China**	**PX658685**	**PX523971**	**PX704924**	**PX516707**	**PX590152**	**Present study**
C. avellaneus	1217/ER	Madagascar	KX857081	KX857093	–	KX856997	KX857119	Buyck (2016)
C. bellus	FHMU2422	China	–	–	ON340619	–	–	Zhang et al. (2023)
C. betularum	10.08.25.av02A	Canada	MN206944	–	MN181461	–	–	Unpublished
C. betularum	11.08.12.av01	Canada	MN206943	–	MN181460	OM687978	–	Thorn et al. (2020)
C. betularum	12.09.02.av11	Canada	–	–	KX592690	–	–	Thorn et al. (2017)
C. betularum	12.10.03.av01	Canada	KX592697	–	KX592693	–	–	Thorn et al. (2017)
C. betularum	13.09.14.av01	Canada	–	KX592700	–	–	–	Thorn et al. (2017)
C. betularum	17.09.30.av01.1A	Canada	MN206939	–	MN181458	OM687979	–	Thorn et al. (2020)
C. brunneopallidus	1053/BB11.105	Madagascar	–	MK422941	MK422926	MT004809	MT002300	Unpublished
C. brunneopallidus	1054/BB11.116	Madagascar	–	MK422940	MK422925	MT004810	MT002301	Unpublished
C. californicus	OSC122878 *	USA	KX828768	KX828795	KX828820	KX828739	–	Olariaga et al. (2016)
C. californicus	src46	USA	DQ974688	–	–	–	–	Smith et al. (2007)
C. camphoratus	11.08.05.av01	Canada	KX592729	–	–	–	–	Thorn et al. (2017)
C. camphoratus	12.09.06.av01	USA	KX592736	KX592734	KX592735	–	–	Thorn et al. (2017)
C. camphoratus	12.09.22.av02	Canada	KX592737	–	–	–	–	Thorn et al. (2017)
C. camphoratus	18.09.13.av07.1A	Canada	MN206935	–	MN181457	OM687981	–	Thorn et al. (2020)
C. camphoratus	MQ17332.1	Canada	MH571121	–	–	–	–	Unpublished
C. camphoratus	MR3-057	Canada	KX592747	–	–	–	–	Thorn et al. (2017)
C. camphoratus	RAS614	USA	–	–	–	OM687947	–	Unpublished
C. camphoratus	TENN38025	Canada	KX896773	KX896788	–	–	–	Buyck et al. 2016
C. cascadensis	F23801	Canada	KX592705/ MH718193	–	KX592702	–	–	Thorn et al. (2017)
C. cascadensis	ICW1ID	USA	–	JX030440	–	–	–	Foltz et al. (2013)
C. cascadensis	OSC 75908	USA	AY041181	AY041160	–	–	DQ898676	Dunham et al.

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
								(2003), Moncalvo et al. (2006)
C. cascadensis	OSC 75917	USA	AY041180	AY041158	–	–	DQ898675	Dunham et al. (2003), Moncalvo et al. (2006)
C. cascadensis	OSC 75975	USA	AY041183	AY041163	–	–	DQ898677	Dunham et al. (2003), Moncalvo et al. (2006)
C. cascadensis	OSC 75982	USA	–	AY041161	–	–	–	Dunham et al. (2003)
C. cascadensis	OSC 75985	USA	AY041182	AY041162	–	–	DQ898678	Dunham et al. (2003), Moncalvo et al. (2006)
C. cerinoalbus	AV 06.051 *	Malaysia	–	KF294663	–	KF294741	KF294590	Buyck et al. (2014)
C. cerinoalbus	**GDGM53315**	**China**	**PX658695**	**KY346831**	–	**–**	**PX590157**	**Present study**
C. cerinoalbus	**GDGM53341**	**China**	**PX658696**	**KY346833**	–	**PX516708**	**PX590158**	**Present study**
C. cerinoalbus	**GDGM53352**	**China**	**–**	**KY346832**	–	**–**	**PX590159**	**Present study**
C. cerinoalbus	**GDGM53375**	**China**	**–**	**KY346834**	**–**	**–**	**–**	**Unpublished**
C. cerinoalbus	**GDGM75872**	**China**	**PX658697**	**PX523973**	**–**	**–**	**–**	**Present study**
C. cerinoalbus	**GDGM81371**	**China**	**PX658698**	**PX523974**	**PX704926**	**PX516709**	**PX590160**	**Present study**
C. cerinoalbus	**GDGM81388**	**China**	**PX658699**	**PX523975**	**PX704927**	**PX516710**	**PX590161**	**Present study**
C. cerinoalbus	**GDGM91673**	**China**	**–**	**PX523976**	**PX704928**	**PX516711**	**–**	**Present study**
C. cerinoalbus	**GDGM92539**	**China**	**–**	**PX523977**	**PX704929**	**PX516712**	**–**	**Present study**
C. cerinoalbus	**GDGM93183**	**China**	**–**	**PX523978**	**PX704930**	**PX516713**	**PX590162**	**Present study**
C. cerinoalbus	**GDGM93711**	**China**	**–**	**PX523979**	**–**	**PX516714**	**PX590163**	**Present study**
C. chicagoensis	CLM50	USA	KP639197	KP639227	KP639231	–	–	Leacock et al. (2016)
C. chicagoensis	GMM7801	USA	–	KP639226	KP639232	–	–	Leacock et al. (2016)
C. chicagoensis	PRL3910	USA	KP639198	KP639217	–	–	–	Leacock et al. (2016)
C. chicagoensis	PRL8332	USA	KP639200	KP639214	KP639233	–	–	Leacock et al. (2016)
C. chicagoensis	PRL8916	USA	KP639201	KP639218	KP639230	–	–	Leacock et al. (2016)
C.	**GDGM60334**	**China**	**–**	**PX524019**	**–**	**–**	**–**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
chrysanthemoides				**PX664379**				
C. chrysanthemoides	**GDGM80391 ***	**China**	**PX658702**	**PX524020**	**PX704932**	**PX516759**	**PX590227**	**Present study**
C. chrysanthus	GDGM45166	China	**PX658703**	OM978959	ON119074	ON119011	PX590164	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM45937	China	–	OM978960	ON119075	ON119012	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM49628	China	**PX658704**	OM978961	ON119076	ON119013	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM53458	China	**PX658706**	OM978962	ON119077	ON119014	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM60524	China	–	OM978963	ON119078	ON119015	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM77035	China	**PX658707**	OM978964	ON119079	ON229081	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM80204	China	**PX658709**	OM978966	ON119081	ON119017	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM80220 *	China	**PX658711**	OM978970	ON119083	ON119019	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM80436	China	**PX658712**	OM978971	ON119084	ON119020	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM80438	China	–	PX664382	ON119085	ON119021	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM82511	China	–	OM978973	ON119087	ON119023	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM82516	China	–	OM978974	ON119088	ON119024	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM85298	China	–	OM978975	ON119089	ON119025	–	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM87950	China	–	OM978968	–	ON119027	–	Zhang et al. (2022a)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. chrysanthus	GDGM87951	China	–	OM978967	–	ON119028	–	Present study Zhang et al. (2022a) Present study
C. chrysanthus	**Liyi2739**	**China**	–	**PX664383**	**PX704935**	**PX657140**	**–**	**Present study**
C. chrysanthus	**Liyi3142**	**China**	–	**PX664384**	**PX704934**	**PX657141**	**–**	**Present study**
C. chrysanthus	HMAS279434	China	**PX658715**	ON212413	ON119091 **PX704933**	ON229079	**PX657386**	Zhang et al. (2022a) Present study
C. chrysanthus	**GDGM52022**	**China**	**PX658705**	**PX664381**	**–**	**–**	**–**	**Present study**
C. chrysanthus	GDGM80202	China	**PX658708**	OM978965	ON119080	ON119016	**PX590165**	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM80217	China	**PX658710**	OM978969	ON119082	ON119018	**PX590166**	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM82473	China	**PX658713**	OM978972	ON119086	ON119022	**–**	Zhang et al. (2022a) Present study
C. chrysanthus	GDGM85305	China	**PX658714**	OM978976	ON119090	ON119026	–	Zhang et al. (2022a) Present study
C. chuiweifanii	FHMU1703	China	OM835800	OM717949	OM811343	–	–	Zhang et al. (2022b)
C. chuiweifanii	FHMU2412 *	China	–	OM717953	OM811347	–	–	Zhang et al. (2022b)
C. chuiweifanii	FHMU2839	China	OM835803	OM717954	OM811348	–	–	Zhang et al. (2022b)
C. chuiweifanii	FHMU3236	China	–	OM717955	OM811349	–	–	Zhang et al. (2022b)
C. chuiweifanii	FHMU5260	China	–	OM717950	OM811344	–	–	Zhang et al. (2022b)
C. chuiweifanii	FHMU5268	China	–	OM717956	OM811350	–	–	Zhang et al. (2022b)
C. chuiweifanii	FHMU5335	China	OM835797	OM717946	OM811340	–	–	Zhang et al. (2022b)
C. chuiweifanii	FHMU6846	China	OM835798	OM717947	OM811341	–	–	Zhang et al. (2022b)
C. chuiweifanii	FHMU6847	China	OM835799	OM717948	OM811342	–	–	Zhang et al. (2022b)
C. chuiweifanii	FHMU6848	China	OM835801	OM717951	OM811345	–	–	Zhang et al. (2022b)
C. chuiweifanii	FHMU6849	China	OM835802	OM717952	OM811346	–	–	Zhang et al. (2022b)
C. chuiweifanii	**GDGM60392**	**China**	**PX658717**	**–**	**–**	**–**	**PX657393**	**Present study**
C. chuiweifanii	**GDGM60401**	**China**	**PX658718**	**PX664385**	**–**	**–**	**–**	**Present study**
C. chuiweifanii	**GDGM60555**	**China**	**PX658719**	**PX664386**	**–**	**–**	**–**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. chuiweifanii	**GDGM86184**	**China**	**–**	**PX523980**	**PX704936**	**PX516716**	**–**	**Present study**
C. chuiweifanii	**GDGM86214**	**China**	**PX658720**	**PX523981**	**PX704937**	**PX516717**	**–**	**Present study**
C. chuiweifanii	**GDGM86218**	**China**	**PX658721**	**PX664387**	**PX704938**	**PX657114**	**–**	**Present study**
C. chuiweifanii	**GDGM86220**	**China**	**PX658722**	**PX664388**	**PX704939**	**PX657115**	**–**	**Present study**
C. chuiweifanii	**GDGM86240**	**China**	**PX658723**	**PX664389**	**PX704940**	**PX657116**	**–**	**Present study**
C. chuiweifanii	**GDGM86243**	**China**	**PX658724**	**PX664390**	**PX704941**	**PX657117**	**–**	**Present study**
C. chuiweifanii	**GDGM86250**	**China**	**PX658725**	**PX664391**	**PX704942**	**PX657118**	**–**	**Present study**
C. chuiweifanii	**GDGM86253**	**China**	**PX658726**	**PX664392**	**PX704943**	**PX657119**	**–**	**Present study**
C. chuiweifanii	**GDGM86258**	**China**	**–**	**PX523982**	**PX704944**	**PX516718**	**–**	**Present study**
C. cibarius	479/GE 07.025	France	–	KF294658	GQ914949	KF294736	KF294585	Buyck et al. (2011, 2014)
C. cibarius	AFTOL-ID 607	Unknown	DQ200926	–	DQ059050	DQ366285	AY662658	Matheny et al. (2007)
C. cibarius	AH44780	Spain	KR677508	KR677546	KX828821	KX828740	–	Olariaga et al. (2015, 2016)
C. cibarius	BIO-Fungi 10986 *	Sweden	KR677503	–	KX828822	KX828741	–	Olariaga et al. (2015, 2016)
C. cibarius	**HMAS0271173**	**China**	**–**	**–**	**–**	**PX657063**	**PX657385**	**Present study**
C. cibarius	**GDGM56440**	**China**	**PX658727**	**PX664393**	**–**	**–**	**–**	**Present study**
C. cibarius	**GDGM77034**	**Finland**	**–**	**PX523983**	**PX704945**	**–**	**–**	**Present study**
C. cibarius	**GDGM77039**	**Finland**	**PX658728**	**PX523984**	**PX704946**	**–**	**PX590167**	**Present study**
C. cibarius	**GDGM77040**	**Finland**	**PX658729**	**PX523985**	**PX704947**	**PX516719**	**PX590168**	**Present study**
C. cibarius	**GDGM78183**	**Finland**	**PX658731**	**PX523986**	**PX704948**	**PX516720**	**PX590169**	**Present study**
C. cibarius	**GDGM92017**	**China**	**–**	**PX664394**	**PX704949**	**PX657123**	**–**	**Present study**
C. cibarius	HKAS 76096	Sweden	–	–	MW368918	ON263464	–	Wang et al. (2023a)
C. cibarius	WXH 2580	China	–	–	KM893847	–	–	Unpublished
C. cibarius	351/BB07.300	Slovakia	–	KF294641	GQ914950	KF294718	KF294572	Buyck et al. (2011, 2014)
C. cibarius var. *cibarius*	OSC 75940	Sweden	AY041177	AY041157	–	–	–	Dunham et al. (2003)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. cibarius var. *cibarius*	OSC 76027	Sweden	AY041175	AY041155	–	–	–	Dunham et al. (2003)
C. cibarius var. *cibarius*	OSC 76031	Sweden	AY041176	AY041156	–	–	–	Dunham et al. (2003)
C. cibarius var. *longipes*	MSR2c	India	–	HM750924	–	–	–	Dunham et al. (2003)
C. cineraceus	FHMU966 *	China	–	ON089297	OP251152	–	–	Zhang et al. (2023)
C. cineraceus	FHMU968	China	–	ON089298	OP251153	–	–	Zhang et al. (2023)
C. cinnabarinus	BB 04.263	USA	–	–	GQ914983	–	–	Buyck et al. (2011)
C. cinnabarinus	BB 07.001	USA	–	KF294624	GQ914985	KF294698	KF294552	Buyck et al. (2011, 2014)
C. cinnabarinus	BB 07.053	USA	–	KF294630	GQ914984	KF294705	KF294559	Buyck et al. (2011, 2014)
C. cinnabarinus	GRSM 77031	USA	–	DQ898669	–	DQ898747	DQ898649	Moncalvo et al. (2006)
C. cinnabarinus	HKAS 58243	China	–	JF906727	–	–	–	Unpublished
C. cinnabarinus	OSC 69197	USA	–	AY041168	–	–	–	Dunham et al. (2003)
C. citrinus	1691	South Korea	–	–	MW124385	MW286818	–	Buyck et al. (2020b, 2021)
C. citrinus	1710	South Korea	–	–	MW124386	MW286819	–	Buyck et al. (2020b, 2021)
C. citrinus	1711	South Korea	–	–	MW124384	MW286815	–	Buyck et al. (2020b, 2021)
C. citrinus	1715	South Korea	–	–	MW124388	–	–	Buyck et al. (2020b)
C. citrinus	GDGM80723	China	**PX658732**	OM978953	ON119067	ON119029	**PX590171**	Zhang et al. (2022a), Present study
C. citrinus	**GDGM80724**	**China**	**–**	**PX664380**	**PX704950**	**PX516722**	**PX590172**	**Present study**
C. citrinus	GDGM80825	China	**PX658733**	–	ON119069	ON119031	**PX657408**	Zhang et al. (2022a), Present study
C. citrinus	GDGM86140	China	**PX658734**	OM978955	ON119070	ON119032	**PX590173**	Zhang et al. (2022a),

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. citrinus	GDGM86141	China	**PX658735**	OM978956	ON119071	ON119033	**PX657465**	Present study Zhang et al. (2022a), Present study
C. citrinus	GDGM86142	China	**PX658736**	OM978957	ON119072	ON119034	**PX657466**	Zhang et al. (2022a), Present study
C. citrinus	GDGM86143	China	**PX648063**	OM978958	ON119073	ON119035	**PX657467**	Zhang et al. (2022a), Present study
C. coccolobae	1064/RC 14.24	Guadeloupe	–	KX857088	KX857020	KX856992	KX857114	Buyck (2016)
C. coccolobae	1065/RC 11.25	Guadeloupe	–	KX857089	KX857021	KX856993	KX857115	Buyck (2016)
C. coccolobae	Courtecuisse 11.025	Guadeloupe	KX896757	KX907624	–	–	–	Buyck (2016)
C. congolensis	1645/BB16.044	Central African Republic	–	KX857102	KX857075	KX857010	KX857128	Buyck (2016)
C. congolensis	1676/BB16.123	Central African Republic	–	KX857106	KX857078	–	KX857132	Buyck (2016)
C. congolensis	ADK 5214	RD Congo	–	–	KX834368	KX834424	–	Buyck (2016), De Kesel et al. (2016)
C. congolensis	ADK 5215	RD Congo	–	–	KX834369	KX834425	–	De Kesel et al. (2016)
C. congolensis	BB 98.039	Tanzania	–	KF294609	JX193015	–	KF294542	Buyck et al. (2014)
C. congolensis	BB 98.058	Tanzania	–	KF294673	JX192996	–	KF294599	Buyck et al. (2014)
C. congolensis	DDT76	Tanzania	JQ976945	JQ976976	–	–	–	Tibuhwa et al. (2012)
C. congolensis	DDT77	Tanzania	JQ976946	JQ976977	–	–	–	Tibuhwa et al. (2012)
C. congolensis	S08	Cameroon	KR819027	–	–	–	–	Unpublished
C. aff. *congolensis*	BB 06.166	Madagascar	–	–	JX192998	–	–	Unpublished
C. aff. *congolensis*	BB 06.176	Madagascar	–	KF294606	JX192967	KF294680	KF294538	Buyck et al. (2014)
C. aff. *congolensis*	BB 06.197	Madagascar	–	KF294608	GQ914982	KF294683	KF294541	Buyck et al. (2011,

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
								2014)
C. conspicuus	1629/EDC14.407	Togo	–	KX857100	KX857073	KX857004	KX857126	Buyck (2016)
C. conspicuus	GE 99.560	Zimbabwe	–	–	–	KF294751	KF294598	Buyck et al. (2014)
C. convexus	GDGM54841	China	–	OM978940	ON119052	ON119036	**PX590174**	Zhang et al. (2022a), Present study
C. convexus	GDGM70307 *	China	**PX648064**	OM978941	ON119053	ON119037	**PX590175**	Zhang et al. (2022a), Present study
C. convexus	**GDGM95158**	**China**	**PX648066**	**PX664395**	**PX704951**	**PX657132**	**PX657476**	**Present study**
C. convexus	**GDGM95608**	**China**	**PX648067**	**PX664396**	–	–	–	**Present study**
C. corallinus	1083/JJ MO/CANT-2 *	USA	–	KX896776	KX857031	MW286813 /ON260862	–	Buyck 2016; 2021
C. corallinus	1086/JJ MO/CANT-5	USA	KX896758	–	KX857034	MW286814 /ON260863	–	Buyck (2016), Buyck et al. (2021)
C. corallinus	FLAS-F-60530	USA	–	–	MK045367	–	–	Unpublished
C. corallinus	FLAS-F-61106	USA	MH211747	–	MK045368	–	–	Unpublished
C. curvatus	BRNM:825749	South Korea	–	–	MW124390	–	–	Buyck et al. (2020b)
C. curvatus	HKAS 73570	China	–	–	ON089627	ON089636	–	Wang et al. (2023a)
C. cuticulatus	DS 06.283	Malaysia	–	KF294662	–	–	KF294589	Buyck et al. (2014)
C. cyanescens	DDT63	Tanzania	–	JQ976970	–	–	–	Tibuhwa et al. (2012)
C. cyphelloides	TNS:F-61721	Japan	LC047743	LC047741	–	–	–	Suhara & Kurogi (2015)
C. cyphelloides	TNS:F-61726	Japan	–	LC047742	–	–	–	Suhara & Kurogi (2015)
C. danxiaensis	**GDGM77227 ***	**China**	**–**	**PX524022**	**PX704952**	**–**	**PX590229**	**Present study**
C. danxiaensis	**GDGM77228**	**China**	**–**	**PX524023**	**PX704953**	**–**	**PX590230**	**Present study**
C. deceptivus	JJ13/WI-CANT-1	USA	KX896761	KX896779	KX857026	ON260859	–	Buyck (2016); Wang et al. (2023a)
C. deceptivus	JJ NC-CANT-5	USA	KX896760	KX896778	KX857030	ON260860	–	Buyck (2016); Wang

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
								et al. (2023a)
C. deceptivus	RAS056	USA	–	–	–	OM687963	–	Unpublished
C. deceptivus	RAS447	USA	–	–	–	OM687956	–	Unpublished
C. deceptivus	RGT130716/01 (UWO)	Canada	–	KX592763	KX592764	–	–	Thorn et al. (2017)
C. decolorans	BB 08.278	Madagascar	KX907203/ KF981367	KF294654	GQ914968	KF294731	–	Buyck et al. (2011, 2014), Olariaga et al. (2016)
C. decolorans	ER8	Madagascar	–	KR349271	–	–	–	Unpublished
C. aff. *decolorans*	BB 06.145	Madagascar	–	–	JX193003	–	–	Buyck et al. (2011)
C. aff. *decolorans*	BB 06.146	Madagascar	–	KF294603	JX192964	KF294677	–	Buyck et al. (2014)
C. aff. *decolorans*	BB 06.151	Madagascar	–	–	JX193004	–	–	Unpublished
C. aff. *decolorans*	BB 06.168	Madagascar	–	–	JX192999	–	–	Unpublished
C. aff. *decolorans*	BB 08. 243	Madagascar	–	KF294653	JX192987	KF294730	–	Buyck et al. (2014)
C. aff. *decolorans*	BB 08. 260	Madagascar	–	–	JX193000	–	–	Unpublished
C. aff. *decolorans*	BB 08. 290	Madagascar	–	–	JX193001	–	–	Unpublished
C. aff. *decolorans*	BB 08. 291	China	–	–	JX193002	–	–	Unpublished
C. defibulatus	ADK 5511	RD Congo	–	–	KX834370	KX834426	–	De Kesel et al. (2016)
C. defibulatus	ADK 6070	RD Congo	–	–	KX834371	KX834427	–	De Kesel et al. (2016)
C. densifolius	1641/BB16.021	Central African Republic	–	MK422938	MG450680	MT004798	MT002289	Unpublished
C. densifolius	1649/BB16.065	Central African Republic	–	MT002283	MG450681	MT004801	MT002292	Unpublished
C. densifolius	1666/BB16.098	Central African Republic	–	MT002282	MG450682	MT004800	MT002291	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. densifolius	1672/BB16.113	Central African Republic	–	MT002281	MG450683	MT004799	MT002290	Unpublished
C. densifolius	1681/BB16.137	Central African Republic	–	MK422939	MG450684	MT004797	MT002288	Unpublished
C. densifolius	BB 98.013	Tanzania	–	KF294616	JX193014	KF294690	–	Buyck et al. (2014)
C. densifolius	DDT40	Tanzania	JQ976935	JQ976963	–	–	–	Tibuhwa et al. (2012)
C. densifolius	DDT58	Tanzania	JQ976938	JQ976968	–	–	–	Tibuhwa et al. (2012)
C. diminutivus	DS 06.033	Malaysia	–	KF294661	–	KF294740	KF294588	Buyck et al. (2014)
C. elongatipes	HKAS 110274	China	–	–	ON089624	ON089633	–	Wang et al. (2023a)
C. elongatipes	HKAS 110275	China	–	ON074610	–	ON089634	–	Wang et al. (2023a)
C. enelensis	11.08.16.av03	Canada	–	KX592710	–	–	–	Thorn et al. (2017)
C. enelensis	13.08.21.av02	Canada	–	KX592712	–	–	–	Thorn et al. (2017)
C. enelensis	17.08.13.av01.1	Canada	MN206917	MN206918	MN181448	–	–	Unpublished
C. enelensis	17.08.15.av01.1	Canada	MN206913	–	MN181446	–	–	Unpublished
C. enelensis	Cassia E5	Canada	KX592719	–	KX592720	–	–	Thorn et al. (2017)
C. enelensis	Cassia W3	Canada	KX592722	–		–	–	Thorn et al. (2017)
C. enelensis	HRL2585A	Canada	MN206931	–	MN181455	–	–	Unpublished
C. enelensis	MR3-020	Canada	KX592725	–	KX592726	–	–	Thorn et al. (2017)
C. enelensis	RAS859	USA	–	OM654546	OM751872	OM687976	–	Unpublished
C. eucalyptorum	BB06.149	USA	–	KF294605	JX192966	KF294679	–	Buyck et al. (2014)
C. eucalyptorum	BB06.247	USA	JN944001	JN940590	–	–	–	Unpublished
C. eyssartieri	BB 99.528	Madagascar	–	MK422936	MH643965	MT004803	MT002294	Unpublished
C. ferruginascens	347/BB07.221	Slovakia	–	KX907212	KX907235	KX907224	–	Olariaga et al. (2016)
C. ferruginascens	AH44782	France	KR677488	KR677526	KX828826	KX828747	–	Olariaga et al. (2015, 2016)
C. ferruginascens	AH44794	Spain	KR677485	KR677523	KX828827	KX828748	–	Olariaga et al. (2015,

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
								2016)
C. ferruginascens	BB07.283	Slovakia	–	KF294638	GQ914952	KF294715	KF294569	Buyck et al. (2011, 2014)
C. ferruginascens	BIO-Fungi 11700	Spain	KR677486	KR677524	KX828829	KX828750	–	Olariaga et al. (2015, 2016)
C. ferruginascens	ICH471F	Iran	MH463385	MH463386	MH463387	–	–	Parad et al. (2018)
C. ferruginascens	K(M)180009	United Kingdom	KX828774	KX828799	–	KX828746	–	Olariaga et al. (2016)
C. fistulosus	DDT31	Tanzania	–	JQ976959	–	–	–	Tibuhwa et al. (2012)
C. fistulosus	DDT43 *	Tanzaniač	–	JQ976965	JX192997	–	–	Tibuhwa et al. (2012)
C. flavolateritius	1068/JJ AR-CANT-4	USA	–	–	KX857024	–	–	Buyck (2016)
C. flavolateritius	1076/JJ NC-CANT-2	USA	KX896766/ MG450675	KX896783	KX857027	–	–	Buyck (2016)
C. flavolateritius	1078/JJ NC-CANT-4	USA	–	–	KX857029	–	–	Buyck (2016)
C. flavolateritius	AG174_FLAS-F-60202	USA	–	–	MK045370	–	–	Unpublished
C. flavolateritius	AG309_FLAS-F-60206	USA	–	–	MK045371	–	–	Unpublished
C. flavolateritius	Halling6252	USA	–	MT371334	–	–	–	Montoya et al. (2021)
C. flavolateritius	RAS463	USA	–	–	–	OM687966	–	Unpublished
C. flavolateritius	RAS474	USA	–	–	–	OM687967	–	Unpublished
C. flavolateritius	RAS590	USA	–	–	–	OM687968	–	Unpublished
C. flavus	1077/JJ NC-CANT-3	USA	–	KM484682	KX857028	–	–	Buyck (2016)
C. flavus	BB 07.027	USA	–	KR349274	–	ON168706	–	Wang et al. (2023a)
C. flavus	C067	USA	JX030467	–	JX030416	–	–	Foltz et al. (2013)
C. flavus	C068	USA	JX030468	JX030436	–	–	–	Foltz et al. (2013)
C. flavus	CH1	USA	JX030456	JX030427	–	–	–	Foltz et al. (2013)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. flavus	CH5	USA	JX030457	JX030430	–	–	–	Foltz et al. (2013)
C. flavus	MWG1115	USA	–	MF797653	–	OM687960	–	Unpublished
C. flavus	RAS473	USA	–	OR460920/ OM654533	–	OM687959	–	Unpublished
C. floridulus	DDT33	Tanzania	–	JQ976960	–	–	–	Tibuhwa et al. (2012)
C. formosus	1198/BB13.015	Canada	–		KX857039	ON168707	–	Buyck (2016), Wang et al. (2023a)
C. formosus	1206/BB13.108	Unknown	–	–	KX857041	–	–	Buyck (2016)
C. formosus	1207/BB13.120	Unknown	–	–	KX857042	–	–	Buyck (2016)
C. formosus	1211/BB13.153	Unknown	–	–	KX857043	–	–	Buyck (2016)
C. formosus	1212/BB13.163	USA	–	KM484683	ON168700	ON260861	–	Buyck (2016), Wang et al. (2023a)
C. formosus	CAF1ID	USA	–	JX030424	–	–	–	Foltz et al. (2013)
C. formosus	DAVP 28141	Canada	HQ650760	KX592748	KX592749	–	–	Thorn et al. (2017)
C. formosus	DAVP 28291	Canada	–	–	KX592750	–	–	Thorn et al. (2017)
C. formosus	OSC 75930	USA	–	AY041164	–	–	–	Dunham et al. (2003)
C. formosus	OSC 76054	USA	AY041184	AY041165	–	–	DQ898681	Dunham et al. (2003), Moncalvo et al. (2006)
C. formosus	SAR220712	Canada	KR677515	KR677553	KX828830	KX828751	–	Olariaga et al. (2015, 2016)
C. formosus	SAT-13-298-20	USA	KX592752	–	KX592751	–	–	Olariaga et al. (2016)
C. formosus	UBC F15948	Canada	–	–	KX592753	–	–	Olariaga et al. (2016)
C. formosus	UBC F16607	Canada	–	–	KX592754	–	–	Olariaga et al. (2016)
C. friesii	1001/EC 09.16	Italy	KX907208	KX857083	KX857015	KX856987	KX857109	Buyck (2016); Olariaga et al. (2016)
C. friesii	1004/EC 09.43	Italy	–	KX857084	KX857016	KX856988	KX857110	Buyck (2016)
C. friesii	AH44798	Spain	KR677484	KR677522	KX828831	KX828752	–	Olariaga et al. (2015, 2016)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. friesii	ARAN-Fungi A3020106B	Spain	KR677483	KR677521	–	–	–	Olariaga et al. (2015)
C. friesii	GE 07.077	France	–	KF294659		KF294737	KF294586	Buyck et al. (2014)
C. friesii	VDKO 1165	Germany	–	–	KX834408	KX881922	–	De Kesel et al. (2016)
C. furcatus	K(M)173247	Mexico	–	MT371345	–	–	–	Montoya et al. (2021)
C. galbanus	GDGM86249 *	China	–	ZM766516	MZ766569	MZ766577	–	Zhang et al. (2021a), Present study
C. garnierii	1020/BB 09.024	New Caledonia	–	KX857085	KX857017	KX856989	KX857111	Buyck (2016)
C. garnierii	1021/BB 09.033	New Caledonia	–	KX857086	KX857018	KX856990	KX857112	Buyck (2016)
C. garnierii	1030/BB 09.283	New Caledonia	–	KX857087	KX857019	KX856991	KX857113	Buyck (2016)
C. goossensiae	1644/BB16.032	Central African Republic	–	MK422950	MK422929	–	–	Unpublished
C. goossensiae	1647/BB16.063	Central African Republic	–	MK422953	MK422932	MT002273	MT006319	Buyck et al. (2020a)
C. goossensiae	1648/BB16.064	Central African Republic	–	MK422949	MK422928	MT002274	MT006320	Buyck et al. (2020a)
C. goossensiae	1660/BB16.087	Central African Republic	–	MK422954	MK422933	–	–	Unpublished
C. goossensiae	1664/BB16.096	Central African Republic	–	MK422951	MK422930	–	–	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. goossensiae	1665/BB16.097	Central African Republic	–	MK422948	MK422927	–	–	Unpublished
C. goossensiae	1679/BB16.127	Central African Republic	–	MK422952	MK422931	–	–	Unpublished
C. gracilis	BB 98.234	Tanzania	–	KF294612	JX192970	KF294686	–	Buyck et al. (2014)
C. griseoisabellinus	1734/TH10387	Cameroon	–	MK422944	MH643966	–	–	Unpublished
C. griseoisabellinus	1828/TH10533	Cameroon	–	MK422943	MH643967	–	–	Unpublished
C. griseotinctus	1048/BB11.054	Madagascar	–	MK422945	–	MT004811	–	Unpublished
C. guineensis	ADK 3005	Benin	–	–	KX834372	KX834428	–	De Kesel et al. (2016)
C. guineensis	ADK 3366	Benin	–	–	KX834373	KX834429	–	De Kesel et al. (2016)
C. guineensis	ADK 3489	Benin	–	–	KX834374	KX834430	–	De Kesel et al. (2016)
C. guineensis	ADK 3525	Benin	–	–	KX834375	KX834431	–	De Kesel et al. (2016)
C. guyanensis	1501/MRG07	Guyane	–	KX857094	KX857060	KX856998	KX857120	Buyck (2016), De Kesel et al. (2016)
C. guyanensis	1517/MR	Guyane	–	KX857095	KX857061	KX856999	KX857121	Buyck (2016), De Kesel et al. (2016)
C. guyanensis	G1866	Guyana	KJ786677	KJ786572	–	–	–	Unpublished
C. guyanensis	MCA3112	Guyana	JQ915096	JQ915122	–	–	–	Wilson et al. (2012)
C. guyanensis	MCA981	Guyana	JQ915099	JQ915125	–	–	–	Wilson et al. (2012)
C. guyanensis	TH9201	Guyana	JQ915106	JQ915132	–	–	–	Wilson et al. (2012)
C. guyanensis	TH9732 1	French Guiana	KC897654	KC897656	–	–	–	Wilson et al. (2012), Henkel et al. (2014)
C. hainanensis	HKAS 109711	China	ON054216/	ON054270/	ON089608/	ON089589		Wang et al. (2023a)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
			ON054217	ON054271	ON089609			
C. hainanensis	N.K.Zeng2289	China	KY407529	KY407524	–	–	–	An et al. (2017)
C. hainanensis	N.K.Zeng2739	China	KY407530	KY407525	–	–	–	An et al. (2017)
C. hainanensis	N.K.Zeng2918	China	KY407531	KY407526	–	–	–	An et al. (2017)
C. heinemannianus	BB 96.307	Zambia	–	KF294665	–	KF294743	–	Buyck et al. (2014)
C. himalayensis	113	India	–	HM750917	–	–	–	Deepika et al. (2013)
C. himalayensis	169	India	HQ270129	HM750928	–	–	–	Deepika et al. (2013)
C. hongneungensis	1687/VA 2013.120 *	USA	–	–	–	MW286820	–	Buyck et al. (2021)
C. humidicolus	BB 98.036	Tanzania	–	KF294666	JX193005	KF294744	–	Buyck et al. (2014)
C. humidicolus	BB 98.0362	Tanzania	–	–	JX193006	–	–	Unpublished
C. hygrophoroides	**GDGM40070**	**China**	**PX648075**	**–**	**–**	**–**	**–**	**Present study**
C. hygrophoroides	**GDGM85304**	**China**	**PX648069**	**PX664398**	**PX704954**	**PX516724**	–	**Present study**
C. hygrophoroides	**GDGM86017**	**China**	**PX648070**	**PX664399**	**PX704955**	**PX516723**	–	**Present study**
C. hygrophoroides	**GDGM86219-1**	**China**	**PX648071**	**PX664400**	**PX704956**	**PX516725**	–	**Present study**
C. hygrophoroides	**GDGM91694**	**China**	**–**	**PX664402**	**PX704957**	**PX657122**	–	**Present study**
C. hygrophoroides	**Liyi4710**	**China**	**PX648073**	**PX664397**	**PX704958**	**PX657142**	–	**Present study**
C. hygrophoroides	HKAS 80614 *	China	KJ004004	KJ004002	KJ004003	–	–	Unpublished
C. hygrophoroides	FHMU813	China	–	ON102899	ON191967	–	–	Zhang et al. (2023)
C. hygrophoroides	FHMU2417	China	–	ON102892	ON237707	–	–	Zhang et al. (2023)
C. hygrophoroides	FHMU2420	China	–	ON102895	ON191964	–	–	Zhang et al. (2023)
C. hygrophoroides	FHMU1635	China	–	ON102891	ON237706	–	–	Zhang et al. (2023)
C. hygrophoroides	FHMU2421	China	–	ON102893	ON237708	–	–	Zhang et al. (2023)
C. hygrophoroides	FHMU1878	China	–	ON102897	ON191966	–	–	Zhang et al. (2023)
C. hygrophoroides	FHMU2398	China	–	ON102902	ON191968	–	–	Zhang et al. (2023)
C. ibityensis	BB 08.196	Madagascar	KF981368	KF294650	GQ914980	KF294727	–	Buyck et al. (2011, 2014)
C. ibityensis	BB 08.203 *	Madagascar	–	KF294651	JX192985	KF294728	–	Buyck et al. (2014)
C. ilicis	BB 12.089	Italy	–	KM484685	–	–	–	Unpublished
C. indicus	272	India	HQ270126	–	–	–	–	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. indicus	274	India	HQ270127	HM750921	–	–	–	Deepika et al. (2013)
C. infundibuliformis	FRI<AUST>:959	Greece	MT747300	MT747326	–	–	–	Unpublished
C. intensissimus	PBM4601	USA	–	OM654544	–	OM687974	–	Unpublished
C. intensissimus	PBM4615	USA	OM964478	OM654545	–	OM687975	–	Unpublished
C. isabellinus	1594/Henkel 9989	Cameroon	–	MK422935	MH643963	MT004802	MT002293	Unpublished
C. isabellinus	1598/Henkel DJA31	Democratic Republic of the Congo	–	MK422934	MH643964	–	–	Unpublished
C. isabellinus	1726/Henkel 10.311	Democratic Republic of the Congo	–	–	MH643960	–	–	Unpublished
C. isabellinus	1727/Henkel 10.312	Democratic Republic of the Congo	–	–	MH643959	–	–	Unpublished
C. isabellinus	1728/Henkel 10.337	Democratic Republic of the Congo	–	–	MH643961	–	–	Unpublished
C. isabellinus	1730/Henkel 10.361	Democratic Republic of the Congo	–	–	MH643962	–	–	Unpublished
C. iuventateviridis	1542/SH13.7.2012	USA	–	–	KX857063	–	–	Buyck (2016)
C. iuventateviridis	1543/SH14.7.2012	USA	–	–	KX857064	ON168708	–	Buyck (2016), Wang et al. (2023a)
C. iuventateviridis	BP Looney 523	USA	KX896762	KX896780	KX857047	–	–	Buyck (2016); Buyck et al. (2016b)
C. koreanus	1689/V A 13.136	Republic of Korea	–	–	KY271941	ON260857	–	Antonín et al. (2017), Wang et al. (2023a)
C. koreanus	1697/VA 14.115	Republic of Korea	–	–	KY271940	–	–	Antonín et al. (2017)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. koreanus	GDGM79233	China	–	OM978977	ON119092	ON229078	**PX590178**	Zhang et al. (2022a) Present study
C. koreanus	GDGM85306	China	**PX648076**	OM978978	ON119093	ON229077	**PX590179**	Zhang et al. (2022a) Present study
C. koreanus	**GDGM90865**	**China**	**–**	**–**	**–**	**PX516726**	**PX590177**	**Present study**
C. koreanus	VA 15.114	South Korea	–	–	ON260864	ON260858	–	Wang et al. (2023a)
C. laevigatus	FHMU6956	China	–	ON117821	ON340614	–	–	Zhang et al. (2023)
C. laevigatus	FHMU6950	China	–	ON117819	ON340612	–	–	Zhang et al. (2023)
C. laevigatus	FHMU6953	China	–	ON117823	ON340616	–	–	Zhang et al. (2023)
C. laevigatus	FHMU6955	China	–	ON117824	ON340615	–	–	Zhang et al. (2023)
C. laevigatus	FHMU6952	China	–	ON117820	ON340613	–	–	Zhang et al. (2023)
C. laevigatus	FHMU6954	China	–	ON117818	ON340611	–	–	Zhang et al. (2023)
C. laevihymeninus	HKAS 125910	China	–	–	OP846964	OP846965	–	Wang et al. (2023a)
C. laevis	IFP 019441	China	MW980543	MW979520	–	–	MW980526	Cao et al. (2021a)
C. laevis	IFP 019442	China	MW980544	MW979521	–	–	MW980527	Cao et al. (2021a)
C. lateritius	215/BB06.319	USA	–	ON150913	ON168701/ GQ914958	ON168712	–	Wang et al. (2023a)
C. lateritius	BB 07.025	USA	–	KF294628	GQ914957	KF294703	KF294557	Buyck et al. (2011, 2014)
C. lateritius	BB 07.058	USA	–	KF294633	GQ914959	KF294708	KF294562	Buyck et al. (2011, 2014)
C. lateritius	BB 07.062	USA	KX896767	KX896784	GQ914956	ON168711	–	Buyck et al. (2011, 2016b), Wang et al. (2023a)
C. lateritius	BB O7.004	USA	–	–	GQ914955	–	–	Buyck et al. (2011)
C. lateritius	FLAS-F-61661	USA	–	–	MK045372	–	–	Unpublished
C. lateritius	MS0-08_FLAS-F-61858	USA	–	–	MK045373	–	–	Unpublished
C. albidohymenius	**GDGM90220**	**China**	–	**PX524025**	**PX704885**		**PX590232**	**Present study**
C. albidohymenius	**GDGM90224**	**China**	–	**PX524026**	**PX704886**		**PX590233**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. albidohymenius	**GDGM90244**	**China**	–	**–**	**–**	**–**	**PX657468**	**Present study**
C. albidohymenius	**GDGM90302 ***	**China**	–	**PX524027**	**–**	**–**	**PX590234**	**Present study**
C. lewisii	1394/BB 14.148	USA	MG450668	MG450676	ON168702	ON168709	–	Wang et al. (2023a)
C. lewisii	1395/BB 14.149	USA	MG450669	MG450677	–	–	–	Unpublished
C. lewisii	BB 02.197	USA	–	KF294623	GQ914961	KF294697	KF294551	Buyck et al. (2011, 2014)
C. lewisii	BB 07.003	USA	JN944021	JN940597	–	KF294700	KF294554	Buyck et al. (2014)
C. lilacinopruinatus	BB 07.221	Slovakia	–	KF294637	GQ914951	KF294714	KF294568	Buyck et al. (2011, 2014)
C. lilacinopruinatus	EC 09.91	Italy	–	KM484687	–	–	–	Unpublished
C. littoralis	1007/E. Randrianjohany 107	Madagascar	–	MT006311	MT002279	MT002275	MT006323	Buyck et al. (2020a)
C. littoralis	1008/E. Randrianjohany 2 *	Madagascar	–	MT006312	MT002280	MT002276	MT006324	Buyck et al. (2020a)
C. longipes	184	India	HQ270115	HM750929	–	–	–	Deepika et al. (2013)
C. longisporus	Arora27	Africa	–	JQ915115	–	–	–	Wilson et al. (2012)
C. longisporus	ER 107	Madagascar	–	KM484688	–	–	–	Unpublished
C. luteocomus	2A5	Japan	–	AB973796	–	–	AB973797	Unpublished
C. luteocomus	2M01	Japan	LC373239		–	–	–	Vaario et al. 2019
C. luteolus	GDGM44258	China	**–**	MZ766514	MZ766566	MZ766570	**PX590181**	Zhang et al. (2021a), Present study
C. luteolus	GDGM60393 *	China	**PX648077**	MZ766515	MZ766568	MZ766575	**PX590182**	Zhang et al. (2021a), Present study
C. luteolus	GDGM86247	China	**PX648078**	MZ766513	MZ766567	MZ766576	**–**	Zhang et al. (2021a), Present study
C. luteopunctatus	1723/Henkel 10.285	Cameroon	–	MK422942	MH643949	–	–	Unpublished
C. luteostipitatus	BB 11.042	Madagascar	–	–	KP033509	–	–	Unpublished
C. luteostipitatus	BB 11.044	Madagascar	–	–	KP033510	–	–	Unpublished
C. luteostipitatus	BB 11.045	Madagascar	–	–	KP033511	–	–	Unpublished
C. luteovirens	GDGM80296	China	**–**	MZ605089	MZ613991	MZ614034	**PX590184**	Zhang et al. (2021a),

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
								Present study
C. luteovirens	GDGM80672 *	China	–	MZ605090	MZ613992	MZ614035	**PX590185**	Zhang et al. (2021a), Present study
C. luteovirens	GDGM80680	China	–	MZ605091	MZ613993	PX516727	**PX590186**	Zhang et al. (2021a), Present study
C. luteovirens	GDGM81079	China	–	MZ605092	MZ613994	MZ614036	**PX657412**	Zhang et al. (2021a), Present study
C. luteovirens	GDGM81395	China	–	MZ605093	MZ613995	MZ614037	**PX657415**	Zhang et al. (2021a), Present study
C. luteovirens	**GDGM85861**	**China**	–	**PX523989**	–	**PX516728**	**PX590183**	**Present study**
C. luteovirens	GDGM85963	China	–	MZ605094	MZ613996	MZ614040	**PX590187**	Zhang et al. (2021a), Present study
C. luteovirens	**GDGM94428**	**China**	–	**PX664403**	–	**PX657126**	**PX657472**	**Present study**
C. luteovirens	**GDGM95083**	**China**	–	**PX664404**	–	**PX657131**	–	**Present study**
C. macrocarpus	**GDGM60539**	**China**	–		**PX704959**		**PX590188**	**Present study**
C. macrocarpus	**GDGM82474**	**China**	**PX658700**	**PX664405**	–	**PX657095**	**PX657443**	**Present study**
C. macrocarpus	**GDGM86209**	**China**	**PX648079**	**PX523990**	–	**PX657113**	**PX590189**	**Present study**
C. macrocarpus	FHMU6385	China	OM835796	–	OM811339	–	–	Zhang et al. (2022b)
C. macrocarpus	N.K.Zeng4036	China	–	MT986060	MT990633	–	–	Zhang et al. (2021b)
C. macrocarpus	N.K.Zeng4050	China	MT990453	MT986061	MT990634	–	–	Zhang et al. (2021b)
C. magnus	**GDGM32009**	**China**	–	**PX523991**	**PX704961**	**PX516729**	**PX590190**	**Present study**
C. magnus	**GDGM32011**	**China**	–	**PX523992**	**PX704962**	**PX516730**	**PX590191**	**Present study**
C. magnus	**GDGM32013**	**China**	–	**PX523993**	**PX704963**	**PX516731**	**PX590192**	**Present study**
C. magnus	**GDGM32014**	**China**	–	**PX523994**	**PX704964**	**PX516732**	**PX590193**	**Present study**
C. magnus	**GDGM32061**	**China**	–	**PX523995**	**PX704965**	**PX516733**	**PX590194**	**Present study**
C. magnus	**GDGM32846**	**China**	–	**PX523996**	**PX704967**	**PX516734**	**PX590195**	**Present study**
C. magnus	**GDGM60328**	**China**	–	**PX523997**	**PX704968**	**PX516735**	**PX590196**	**Present study**
C. magnus	**GDGM60332**	**China**	–	**PX523998**	**PX704969**	**PX516736**	**PX590197**	**Present study**
C. magnus	**GDGM60350**	**China**	–	**PX523999**	**PX704970**	**PX516737**	**PX590198**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. magnus	**GDGM85139**	**China**	**–**	**PX524000**	**PX704971**	**PX516738**	**PX590199**	**Present study**
C. magnus	**GDGM85140**	**China**	**–**	**PX524001**	**PX704972**	**PX516739**	**PX590200**	**Present study**
C. magnus	**GDGM94577**	**China**	**–**	**PX664401**	**PX704973**	**PX657127**	**PX657473**	**Present study**
C. magnus	IFP 019443	China	–	MW979516	MW999420	MW999452	MW980524	Cao et al. (2021a)
C. magnus	IFP 019444	China	–	MW979517	MW999421	MW999451	MW980525	Cao et al. (2021a)
C. mikemboensis	ADK 6039	RD Congo	–	–	KX834376	KX834432	–	De Kesel et al. (2016)
C. mikemboensis	ADK 6065	RD Congo	–	–	KX834377	KX834433	–	De Kesel et al. (2016)
C. mikemboensis	ADK 6073	RD Congo	–	–	KX834378	KX834434	–	De Kesel et al. (2016)
C. mikemboensis	JD 866	RD Congo	–	–	KX834379	KX834435	–	De Kesel et al. (2016)
C. mikemboensis	JD 918	RD Congo	–	–	KX834380	KX834436	–	De Kesel et al. (2016)
C. miniatescens	1671/BB16.112	Unknown	KX857082	KX857105	–	KX857009	KX857131	Buyck (2016)
C. miniatescens	1682/TH9852	Unknown	–	KX857107	–	KX857011	KX857133	Buyck (2016)
C. miniatescens	1683/TH9870	Unknown	–	KX857108	KX857079	KX857012	KX857134	Buyck (2016)
C. minioalbus	GDGM78883	China	**PX648081**	MZ605096	MZ613997	MZ614041	**PX657396**	Zhang et al. (2021a), Present study
C. minioalbus	GDGM78901 *	China	**PX648082**	MZ605097	MZ613998	MZ614042	**PX590201**	Zhang et al. (2021a), Present study
C. minioalbus	GDGM78910	China	**PX648083**	MZ605098	MZ613999	MZ614043	**PX590202**	Zhang et al. (2021a), Present study
C. minioalbus	GDGM78915	China	**PX648084**	MZ605099	MZ614000	MZ614044	**PX657397**	Zhang et al. (2021a), Present study
C. minioalbus	GDGM78916	China	**PX648085**	MZ605100	MZ614001	MZ614045	**PX590203**	Zhang et al. (2021a), Present study
C. minioalbus	GDGM78926	China	–	MZ605101	MZ614002	MZ614046	**PX657398**	Zhang et al. (2021a), Present study

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. minioalbus	GDGM78934	China	**PX648086**	MZ605102	MZ614003	MZ614047	**PX590204**	Zhang et al. (2021a), Present study
C. minor	BB 07.002	USA	–	KF294625	JX192978	KF294699	KF294553	Buyck et al. (2014)
C. minor	BB 07.057	USA	–	KF294632	JX192979	KF294707	KF294561	Buyck et al. (2014)
C. minutissimus	1621/EDC14.281	Cameroon	–	KX857099	–	KX857003	KX857125	Buyck (2016)
C. miomboensis	1608/EDC 14.018	Zambia	–	KX857097	KX857071	KX857001	KX857123	Buyck (2016)
C. miomboensis	ADK 3908	Kenya	–	–	KX834381	KX834437	–	De Kesel et al. (2016)
C. miomboensis	ADK 5392	RD Congo	–	–	KX834382	KX834438	–	De Kesel et al. (2016)
C. miomboensis	ADK 6006	RD Congo	–	–	KX834383	KX834439	–	De Kesel et al. (2016)
C. miomboensis	BB 98.021 *	Tanzania	–	KF294613	JX192971	KF294687	KF294544	Buyck et al. (2014)
C. miomboensis	JD 877	RD Congo	–	–	KX834384	KX834440	–	De Kesel et al. (2016)
C. miomboensis	JD 895	RD Congo	–	–	KX834385	KX834441	–	De Kesel et al. (2016)
C. natarajanii	DK 2010F 106	India	–	HM750926	–	–	HQ270120	Deepika et al. (2013)
C. neopersicinus	GDGM85145	China	**PX648089**	OM978946	ON119056	ON119041	**PX590207**	Zhang et al. (2022a), Present study
C. neopersicinus	GDGM87366 *	China	**PX648094**	OM978943	ON119057	ON119042	**PX590208**	Zhang et al. (2022a), Present study
C. neopersicinus	**GDGM93256**	**China**	**–**	**PX524002**	**PX704974**	**PX516740**	**PX590205**	**Present study**
C. neopersicinus	**GDGM93715**	**China**	**–**	**PX524003**	**PX704975**	**PX516741**	**PX590206**	**Present study**
C. nigrescens	66/BB 06.176	Madagascar	KX907202	–	–	–	–	Olariaga et al. (2016)
C. aff. nigrescens	ADK 5441	RD Congo	–	–	KX834386	–	–	De Kesel et al. (2016)
C. aff. nigrescens	ADK 5471	RD Congo	–	–	KX834387	–	–	De Kesel et al. (2016)
C. odoratus	FLAS-F-60653	USA	MH211678	–	–	–	–	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. pallens	1110/BB 12.077	Italy	KX907210	KX857091	KX857035	KX856995	KX857117	Buyck (2016), Olariaga et al. (2016)
C. pallens	1115/BB 12.082	Italy	KX907211	KX857092	KX857036	KX856996	KX857118	Buyck (2016), Olariaga et al. (2016)
C. pallens	995/BB 09.392/441	Italy	–	–	KX857013	–	–	Eukaryota et al. (2016)
C. pallens	996/BB 09.409	Italy	KX929162	KX907215	KX857014	KX929160	–	Buyck (2016), Olariaga et al. (2016)
C. pallens	997/BB 09.418	Italy	KX907206	KX907216	KX907238	KX907227	–	Olariaga et al. (2016)
C. pallens	998/BB 09.430	Italy	KX907207	KX907217	KX907239	KX907228	–	Olariaga et al. (2016)
C. pallens	999/BB 09.441	Italy	–	KX907218	KX907240	KX907229	–	Olariaga et al. (2016)
C. pallens	AH39124	Morocco	KX828781	KX828804	KX828834	KX828755	–	Olariaga et al. (2016)
C. pallens	AH44799	Spain	KR677499	KR677537	KX828833	KX828754	–	Olariaga et al. (2015, 2016)
C. pallens	BIO-Fungi 11150	Spain	KR677494	KR677532	–	KX828745	–	Olariaga et al. (2015, 2016)
C. parvisporus	BB 98.020	Tanzania	–	KF294614	JX192972	KF294688	–	Buyck et al. (2014)
C. parvisporus	BB 98.037	Tanzania	–	KF294611	GQ914966	KF294685	–	Buyck et al. (2011, 2014)
C. parvisporus	DDT22	Tanzania	JQ976933	JQ976957	–	–	–	Tibuhwa et al. (2012)
C. parvoflavus	Herrera204	Mexico	–	MT371338	MT449707	–	–	Montoya et al. (2021)
C. parvoflavus	Herrera229	Mexico	–	MT371339	MT449708	–	–	Montoya et al. (2021)
C. parvoflavus	Montoya5423	Mexico	–	MT371337	MT449706	–	–	Montoya et al. (2021)
C. paucifurcatus	BB 08.320	Madagascar	KF981369	KF294655	JX192988	KF294732	–	Buyck et al. (2014)
C. persicinus	JJ/MO-CANT-4	USA	KX896775	KX896790	KX857033	–	–	Buyck (2016)
C. persicinus	1685/Hopping M.	USA	MG450671	KX896791	KX857080	–	–	Buyck (2016),

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
	15.001							Buyck et al. (2018)
C. persicinus	PBM3933	USA	–	–	–	OM687961	–	Unpublished
C. persicinus	RAS468	USA	–	–	–	OM687972	–	Unpublished
C. phasmatis	C057	USA	JX030464	JX030431	JX030417	–	–	Foltz et al. (2013)
C. phasmatis	C059	USA	JX030463	–	–	–	–	Foltz et al. (2013)
C. phasmatis	C073WI	USA	–	JX030426	–	–	–	Foltz et al. (2013)
C. phasmatis	C074WI	USA	–	JX030438	JX030418	–	–	Foltz et al. (2013)
C. phasmatis	C075	USA	JX030465	–	–	–	–	Foltz et al. (2013)
C. phasmatis	CH2	USA	JX030458	JX030428	–	–	–	Foltz et al. (2013)
C. phasmatis	CH7	USA	JX030462	–	–	–	–	Foltz et al. (2013)
C. phloginus	1690/VA 2013.152 *	Korea	–	–	KY271942	MW286816	–	Antonín et al. (2017), Eukaryota et al. (2021)
C. phloginus	1799/Buyck 2017.122	Korea	–	–	–	MW286821	–	Buyck et al. (2021)
C. phloginus	1800/Buyck 2017.123	Korea	–	–	–	MW286822	–	Buyck et al. (2021)
C. phloginus	GDGM79007-1	China	**PX648095**	OM978979	ON119094	ON119044	–	Zhang et al. (2022a), Present study
C. phloginus	GDGM82514	China	**PX658701**	–	ON119096	ON229080	–	Zhang et al. (2022a), Present study
C. phloginus	GDGM85142	China	**PX648096**	OM978949	ON119059	ON229082	–	Zhang et al. (2022a), Present study
C. phloginus	GDGM85846	China	**PX648097**	OM978950	ON119060	ON119004	–	Zhang et al. (2022a), Present study
C. phloginus	GDGM85852	China	–	OM978951	ON119061	ON119005	–	Zhang et al. (2022a), Present study
C. phloginus	GDGM85853	China	**PX648098**	OM978952	ON119062	ON119006	–	Zhang et al. (2022a), Present study
C. phloginus	**GDGM90713**	**China**	**PX648099**	**PX664406**	**–**	**–**	**–**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. phloginus	**GDGM90714**	**China**	**PX648100**	**PX664407**	**–**	**–**	**–**	**Present study**
C. phloginus	**GDGM92536**	**China**		**PX524004**	**PX704976**	**PX516742**	**–**	**Present study**
C. phloginus	**GDGM94711**	**China**	**PX648101**	**PX664408**	**PX704977**	**PX657130**	**–**	**Present study**
C. phloginus	**GDGM97179**	**China**	**–**	**PX664409**	**PX704978**	**PX657135**	**–**	**Present study**
C. phloginus	HMAS279284	China	–	ON212414	ON119064	ON119008	–	Zhang et al. 2022
C. phloginus	HMAS279292	China	–	ON212412	ON119065	ON119009	–	Zhang et al. 2022
C. phloginus	HMAS279296	China	–	OM978948	ON119066	ON119010	–	Zhang et al. 2022
C. phloginus	HKAS 110230	China	–	–	ON156022	ON156031	–	Wang et al. (2023a)
C. phloginus	HKAS 110288	China	–	–	ON156019	ON156028	–	Wang et al. (2023a)
C. phloginus	HKAS 121395	China	–	–	ON156017	ON156026	–	Wang et al. (2023a)
C. phloginus	HKAS 121413	China	–	–	ON156020	ON156029	–	Wang et al. (2023a)
C. phloginus	HKAS 73553	China	–	–	ON156016	ON156024	–	Wang et al. (2023a)
C. phloginus	HKAS 73555	China	–	–	ON156018	ON156027	–	Wang et al. (2023a)
C. phloginus	Yuan14468	China	–	MW979518	MW999424	–	–	Cao et al. (2021a)
C. phloginus	Yuan14490	China	–	MW979519	MW999425	–	–	Cao et al. (2021a)
C. pinetorus	**GDGM77219**	**China**	**–**	**PX664410**	**PX704986**	**–**	**PX657394**	**Present study**
C. pinetorus	**GDGM78927**	**China**	**PX648102**	**–**	**PX704983**	**PX657066**	**–**	**Present study**
C. pinetorus	**GDGM78930**	**China**	**PX648103**	**PX524005**	**PX704984**	**PX516743**		**Present study**
C. pinetorus	**GDGM78935**	**China**	**–**	**PX664411**	**PX704985**	**PX657067**	**PX657399**	**Present study**
C. pinetorus	**GDGM80626**	**China**	**–**	**PX664412**	**PX704987**	**–**	**–**	**Present study**
C. pinetorus	**GDGM85722**	**China**	**PX648104**	**PX524006**	**PX704988**	**PX516744**	**–**	**Present study**
C. pinetorus	**GDGM85830**	**China**	**PX648105**	**PX524007**	**PX704989**	**PX516745**	**–**	**Present study**
C. pinetorus	**GDGM90996**	**China**	**PX648106**	**PX524008**	**PX704990**	**PX516746**	**PX590209**	**Present study**
C. pinetorus	**GDGM91691**	**China**	**–**	**PX664413**	**–**	**–**	**PX657471**	**Present study**
C. pinetorus	**GDGM93135**	**China**	**–**	**PX524010**	**PX704992**	**PX516748**	**PX590210**	**Present study**
C. pinetorus	**GDGM93203**	**China**	**–**	**PX524011**	**PX704993**	**PX516749**	**PX590211**	**Present study**
C. pinetorus	FHMU3759 *	China	–	OM691482	OM811323	–	–	Zhang et al. (2022b)
C. platyphyllus	BB 98.012	Tanzania	–	KF294617	GQ914969	KF294691	KF294546	Buyck et al. (2011, 2014)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. platyphyllus	BB 98.126	Tanzania	–	KF294620	JX192975	KF294694	KF294549	Buyck et al. (2011, 2014)
C. platyphyllus	JD 1107	RD Congo	–	–	KX834390	–	–	De Kesel et al. (2016)
C. platyphyllus	JD 857	RD Congo	–	–	KX834388	KX834444	–	De Kesel et al. (2016)
C. platyphyllus	JD 919	RD Congo	–	–	KX834389	KX834445	–	De Kesel et al. (2016)
C. platyphyllus f. *platyphyllus*	DDT03	Tanzania	JQ976929	JQ976950	–	–	–	Tibuhwa et al. (2012)
C. platyphyllus f. *platyphyllus*	DDT78	Tanzania	JQ976947	JQ976978	–	–	–	Tibuhwa et al. (2012)
C. platyphyllus subsp. *bojeriensis*	BB 08.158	Madagascar	–	KF294647	JX192983	KF294724	KF294578	Buyck et al. (2014)
C. platyphyllus subsp. *bojeriensis*	BB 08.160	Madagascar	–	KF294648	JX192984	KF294725	KF294579	Buyck et al. (2014)
C. platyphyllus subsp. *bojeriensis*	BB 08.164	Madagascar	–	–	JX193007	–	–	Unpublished
C. pseudoaustrosinensis	**GDGM53452**	**China**	**–**	**PX524017**	**PX704996**	**PX516757**	**–**	**Present study**
C. pseudoaustrosinensis	**GDGM53492**	**China**	**–**	**PX524018**	**PX704997**	**PX516758**	**PX590226**	**Present study**
C. pseudoaustrosinensis	**GDGM81426 ***	**China**	**PX648107**	**PX524021**	**PX704998**	**PX516760**	**PX590228**	**Present study**
C. pseudocibarius	DDT02	Tanzania	JQ976928	JQ976949	–	–	–	Tibuhwa et al. (2012)
C. pseudocibarius	DDT05	Tanzania	JQ976930		–	–	–	Tibuhwa et al.

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
								(2012)
C. pseudocibarius	Tibuhwa 1005.2004	Tanzania	–	JQ976952	–	–	–	Tibuhwa et al. (2012)
C. pseudoformosus	MSR-4	India	FJ769255	–	–	–	–	Kumari et al. (2011)
C. pseudoformosus	MSR-b	India	HM776721	–	–	–	–	Kumari et al. (2011)
C. pseudoformosus	PUN3883 *	India	–	GU237071	–	–	–	Kumari et al. (2011)
C. pseudohainanensis	**GDGM81402**	**China**	**–**	**PX664414**	**–**	**–**	**PX590180**	**Present study**
C. pseudohainanensis	**GDGM81902**	**China**	**–**	**PX524029**	**–**	**–**		**Present study**
C. pseudohainanensis	**GDGM84979 ***	**China**	**PX648108**	**PX524030**	**PX704999**	**PX516763**	**PX590236**	**Present study**
C. pseudohainanensis	**GDGM85112**	**China**	**–**	**PX524031**	**PX705000**	**PX516764**	**PX590237**	**Present study**
C. pseudominimus	JV 00.663	Portugal	–	KF294657	JX192991	KF294735	KF294584	Buyck et al. (2014)
C. pseudomiomboensis	ADK 6029	RD Congo	–	–	KX834391	KX834446	–	De Kesel et al. (2016)
C. pseudomiomboensis	JD 927	RD Congo	–	–	KX834392	KX834447	–	De Kesel et al. (2016)
C. quercophilus	AG310_FLAS-F-60217	USA	–	–	MK045377	–	–	Unpublished
C. quercophilus	BB 07.097 *	USA	–	KF294644	JX192981	KF294721	KF294575	Buyck et al. (2014)
C. ravus	FHMU6845 *	China	–	OM717944	OM811338	–	–	Zhang et al. (2022b)
C. rhodophyllus	1638/BB16.006	Congo	MG450688	MK422958	MG450695	–	–	Unpublished
C. rhodophyllus	1678/BB16.126	Congo	MG450689	MK422957	MG450696	–	–	Unpublished
C. romagnesianus	1002/EC 09.17	Italy	–	KM484689	–	–	–	Unpublished
C. romagnesianus	AH44218	Spain	KX828784	KX828807	KX828836	KX828757		Olariaga et al. (2016)
C. romagnesianus	AH44788	Spain	KR677481	KR677519	–	–	–	Olariaga et al. (2015)
C. romagnesianus	ARAN-Fungi A3007090A	Spain	KR677479	KR677517	–	–	–	Olariaga et al. (2015)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. romagnesianus	LOU-Fungi 18012	Spain	KR677482	KR677520	–	–	–	Olariaga et al. (2015)
C. romagnesianus	PC0085043 *	France	KX828783	KX828806	–	–	–	Olariaga et al. (2016)
C. romagnesianus	PC0142170	France	KX828785	KX828808	–	–	–	Olariaga et al. (2016)
C. roseocanus	CC29	USA	JX030469	JX030445	JX030415		–	Foltz et al. (2013)
C. roseocanus	DAOM 220723	Canada	KX828787	KX828810	KX828837	KX828758	–	Olariaga et al. (2016)
C. roseocanus	DAOM 220724	Canada	KX828788	KX828811	KX828838	KX828759	–	Olariaga et al. (2016)
C. roseocanus	JLF3397	USA	MK256925	–	–	–	–	Unpublished
C. roseocanus	JR4	USA	–	KP639219	KP639234	–	–	Leacock et al. (2016)
C. roseocanus	JR7	USA	KP639204	KP639220	KP639228	–	–	Leacock et al. (2016)
C. roseocanus	SAT-12-299-06	USA	KX592757	–	KX592756	–	–	Thorn et al. (2017)
C. roseocanus	UBC F23802	Canada	KX592760	–	KX592761	–	–	Thorn et al. (2017)
C. roseocastaneus	**GDGM91302 ***	**China**	**–**	**PX523969**	**PX705001**	**PX516750**	**PX590146**	**Present study**
C. roseocastaneus	**GDGM91690**	**China**	**–**	**PX523966**	**PX705002**	**PX516751**	**PX590147**	**Present study**
C. roseofagetorum	AH44786	Georgia	KX828790	KX828813	KX828840	KX828761	–	Olariaga et al. (2016)
C. roseofagetorum	AH44789	Georgia	KX828789	KX828812	KX828839	KX828760	–	Olariaga et al. (2016)
C. ruber	DDT45	Tanzania	JQ976936	–	–	–	–	Tibuhwa et al. (2012)
C. ruber	DDT60	Tanzania	JQ976939	–	–	–	–	Tibuhwa et al. (2012)
C. ruber	Tibuhwa 1045.2007	Tanzania	–	JQ976966	–	–	–	Tibuhwa et al. (2012)
C. ruber	Tibuhwa 1060.2007	Tanzania	–	JQ976969	–	–	–	Tibuhwa et al. (2012)
C. rubrosalmoneus	1057/BB 11.133	Madagascar	–	–	MG450693	–	–	Unpublished
C. rubrosalmoneus	1058/BB 11.166	Madagascar	–	–	MG450694	–	–	Unpublished
C. rufopunctatus	ADK 5892	RD Congo	–	–	KX834393	KX834448	–	De Kesel et al. (2016)
C. rufopunctatus	ADK 5949 *	RD Congo	–	–	KX834394	KX834449	–	De Kesel et al. (2016)
C. sebosus	BB 08.162	Madagascar	KF981371	KF294649	–	KF294726	KF294580	Buyck et al. (2014)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. sebosus	BB 08.234	Madagascar	KF981370	KF294652	JX192986	KF294729	KF294581	Buyck et al. (2014)
C. septentrionalis	Smith 67.052	USA	KX896768	KX896785	–	–	–	Buyck et al. 2016
C. sikkimensis	AB-2015	India	–	KP938966	–	–	–	Unpublished
C. sikkimensis	KD 13-024	India	KR001903		–	–	–	Unpublished
C. sinocinnabarinus	GDGM83023	China	**PX648109**	OM978981	ON119097	ON119050	**PX590212**	Zhang et al. (2022a), Present study
C. sinocinnabarinus	GDGM83027	China	**PX648110**	OM978982	–	ON119046	**PX590213**	Zhang et al. (2022a), Present study
C. sinocinnabarinus	GDGM83229	China	**PX648111**	OM978983	ON119098	ON119047	**PX590214**	Zhang et al. (2022a), Present study
C. sinocinnabarinus	GDGM83230 *	China	**PX648112**	OM978984	ON119099	ON119048	**PX590215**	Zhang et al. (2022a), Present study
C. sinocinnabarinus	GDGM83232	China	**PX648113**	–	ON119100	ON119049	**PX657463**	Zhang et al. (2022a), Present study
C. sinocinnabarinus	GDGM83238	China	–	OM978985	ON119101	ON119051	PX590216	Zhang et al. (2022a), Present study
C. sinolateritius	**GDGM78501 ***	**China**	**–**	**PX524028**	**PX705003**	**PX516762**	**PX590235**	**Present study**
C. sinominor	**GDGM56448**	**China**	**PX648115**	**PX664415**	**PX705005**	**PX657065**	**PX657390**	**Present study**
C. sinominor	**GDGM78662**	**China**		**PX524013**	**PX705006**	**PX516753**	**PX590217**	**Present study**
C. sinominor	GDGM80788	China	PX648116	MZ605105	MZ614004	MZ614048	**PX590222**	Zhang et al. (2022a), Present study
C. sinominor	GDGM80791	China	–	MZ605106	MZ614005	MZ614049	**PX590223**	Zhang et al. (2022a), Present study
C. sinominor	GDGM80842 *	China	–	MZ605107	MZ614006	MZ614050	**PX590224**	Zhang et al. (2022a), Present study
C. sinominor	GDGM80885	China	–	MZ605108	MZ614007	MZ614051	**PX590225**	Zhang et al. (2022a), Present study
C. sinominor	**GDGM84626**	**China**	**PX648117**	**PX524014**	**PX705007**	**PX516754**	**PX590218**	**Present study**
C. sinominor	**GDGM86029**	**China**	**PX648118**	**PX524015**	**PX705008**	**PX516755**	**PX590219**	**Present study**
C. sinominor	**GDGM86091**	**China**	**–**	**PX524016**	**PX705009**	**PX516756**	**PX590220**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. sinominor	**GDGM45019**	**China**	**–**	**PX524012**	**PX705004**	**PX516752**	**PX590221**	**Present study**
Cantharellus sp.	MEL:2382739	Australia	KP012921	–	–	–	–	Unpublished
***Cantharellus* sp.**	**GDGM45898**	**China**	**–**	**PX664416**	**–**	**–**	**–**	**Present study**
***Cantharellus* sp.**	**GDGM81533**	**China**	**–**	**PX524033**	**PX705010**	**PX516765**	**PX590238**	**Present study**
Cantharellus sp.	MEL:2383016	Australia	KP012868	–	–	–	–	Unpublished
Cantharellus sp.	170-164	Japan	AB509586	–	–	–	–	Unpublished
Cantharellus sp.	171-16	Japan	AB509477	–	–	–	–	Unpublished
Cantharellus sp.	MEL:2382856	Australia	KP012730	–	–	–	–	Unpublished
Cantharellus sp.	MEL:2382988	Australia	KP012843	–	–	–	–	Unpublished
Cantharellus sp.	MEL:2383001	Australia	KP012855	–	–	–	–	Unpublished
Cantharellus sp.	MEL:2382776	Australia	KP012958	–	–	–	–	Unpublished
Cantharellus sp.	MEL:2382633	Australia	KP012995	–	–	–	–	Unpublished
Cantharellus sp.	MEL:2382635	Australia	KP012997	–	–	–	–	Unpublished
Cantharellus sp.	C-141	Japan	LC085396	LC085422	LC085476	–	–	Unpublished
Cantharellus sp.	C-142	Japan	–	LC085423	LC085477	–	–	Unpublished
Cantharellus sp.	HKAS111824	China	ON794235	–	–	–	–	Wang et al. (2023a)
Cantharellus sp.	JPN2 C-100	Japan	LC085385	–	–	–	–	Unpublished
Cantharellus sp.	JPN2 C-15	Japan	LC085383	–	–	–	–	Unpublished
Cantharellus sp.	JPN2 C-88	Japan	LC085381	–	LC085472	–	–	Unpublished
Cantharellus sp.	JPN2 SAPA-5067	Japan	LC085401	–	–	–	–	Unpublished
Cantharellus sp.	JPN3_C-118	Japan	LC085388	–	–	–	–	Unpublished
Cantharellus sp.	JPN3 C-21	Japan	LC085389	–	–	–	–	Unpublished
Cantharellus sp.	JPN4 RTMFU-174	Japan	LC085402	–	–	–	–	Unpublished
Cantharellus sp.	JPN4 SAPA-5065	Japan	LC085403	–	–	–	–	Unpublished
Cantharellus sp.	LAM 0163	Malaysia	–	KY090948	–	–	–	Unpublished
Cantharellus sp.	LAM 0229	Malaysia	–	KY091000	–	–	–	Unpublished
Cantharellus sp.	FHMU5266	China	–	OM691494	OM811335	–	–	Zhang et al. (2022b)
Cantharellus sp.	FHMU3834	China	–	OM691493	OM811334	–	–	Zhang et al. (2022b)
Cantharellus sp.	FHMU4592	China	OM835808	OM691495	OM811336	–	–	Zhang et al. (2022b)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cantharellus sp.	ZD12-30	China	KU165838	–	KU166117	–	–	Unpublished
C. spectaculus	C081WI	USA	–	JX030421	JX030414	–	–	Foltz et al. (2013)
C. spectaculus	JJ MO-Canth4	USA	–	KM484691	–	–	–	Unpublished
C. spectaculus	SAT1519702	USA	–	–	–	–	OR470847	Unpublished
C. spectaculus	SAT1519702 SV1	USA	–	OR471013	–	OR473936	–	Unpublished
C. spectaculus	SAT1519702 SV2	USA	–	OR471014	–	OR473933	–	Unpublished
C. splendens	ADK 6071	RD Congo	–	–	KX834395	KX834450	–	De Kesel et al. (2016)
C. splendens	BB 96.306	Zambia	–	KF294670		KF294748	KF294595	Buyck et al. (2014)
C. splendens	DDT17	Tanzania	JQ976932	JQ976956	–	–	–	Tibuhwa et al. (2012)
C. splendens	DDT57	Tanzania	JQ976937	JQ976967	–	–	–	Tibuhwa et al. (2012)
C. splendens	JD 896	RD Congo	–	–	KX834396	KX834451	–	De Kesel et al. (2016)
C. splendens	JD 968	RD Congo	–	–	KX834397	KX834452	–	De Kesel et al. (2016)
C. stramineus	ADK 6051	RD Congo	–	–	KX834398	KX834453	–	De Kesel et al. (2016)
C. stramineus	JD 1035	RD Congo	–	–	KX834399	KX834454	–	De Kesel et al. (2016)
C. stramineus	JD 1098	RD Congo	–	–	KX834400	KX834455	–	De Kesel et al. (2016)
C. subalbidus	1196/BB 13.014	USA	KX896764	KX896781	KX857037	–	–	Buyck (2016); Buyck et al. (2016b)
C. subalbidus	1197/BB 13.014B	USA	KX896765	KX896782	KX857038	–	–	Buyck (2016); Buyck et al. (2016b)
C. subalbidus	1201/BB 13.045	USA	–	–	KX857040	–	–	Buyck (2016)
C. subalbidus	DAVP 28155	Canada	–	–	KX592766	–	–	Thorn et al. (2017)
C. subalbidus	DAVP 28283	Canada	–	KX592767	KX592768	–	–	Thorn et al. (2017)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. subalbidus	HC-PNNT-022	Mexico	KT874978	–	–	–	–	Unpublished
C. subalbidus	HC-PNNT-252	Mexico	KT874977	–	–	–	–	Unpublished
C. subalbidus	OSC 75937	USA	AY041179	AY041149	–	–	DQ898680	Dunham et al. (2003), Moncalvo et al. (2006)
C. subalbidus	OSC 75983	USA	–	AY041146	–	–	–	Dunham et al. (2003)
C. subalbidus	OSC 76034	USA	AY041178	AY041147	–	–	–	Dunham et al. (2003)
C. subalbidus	OSC81782	USA	KX828791	KX828814	KX828841	KX828762	–	Olariaga et al. (2016)
C. subamethysteus	1533/Verbeken M. 12.003	Malaya	MG450674	–	–	–	–	Unpublished
C. subamethysteus	488/DS 06.218 *	Malaysia	–	KF294664	–	KF294742	KF294591	Buyck et al. (2014)
C. cf. *subamethysteus*	1533/AV12.003	Thailand	–	KX857096	KX857062	KX857000	KX857122	Buyck (2016)
C. aff. *subcyanoxanthus*	BB 00.1137 *	Madagascar	–	–	JX192990	KF294734	KF294583	Buyck et al. (2014)
C. aff. *subcyanoxanthus*	BB 98. 014	Tanzania	–	KF294615	JX192973	KF294689	KF294545	Buyck et al. (2014)
C. cf. *subcyanoxanthus*	1609/EDC14.034	Zambia	–	KX857098	KX857072	KX857002	KX857124	Buyck (2016)
C. subfloridulus	1650/BB16.016	Central African Republic	–	MK422947	MG450686	–	–	Unpublished
C. subfloridulus	1668/BB16.106	Central African Republic	–	MK422946	MG450687	–	–	Unpublished
C. subincarnatus subsp. *rubrosalmoneus*	BB 06.080	Madagascar	–	KF294601	JX192962	KF294675	KF294536	Buyck et al. (2014)
C. subincarnatus subsp.	BB 06.096	Madagascar	KF981372	KF294602	JX192963	KF294676	KF294537	Buyck et al. (2014)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
rubrosalmoneus								
C. sublaevis	ADK 6057	RD Congo	–	–	KX834401	KX834456	–	De Kesel et al. (2016)
C. sublaevis	JD 942	RD Congo	–	–	KX834402	KX834457	–	De Kesel et al. (2016)
C. sublaevis	JD 964	RD Congo	–	–	KX834403	KX834458	–	De Kesel et al. (2016)
C. subminor	IFP 019445	China	MW980545	MW979522	MW999415	MW999455	MW980528	Cao et al. (2021a)
C. subminor	IFP 019446	China	MW980546	MW979523	MW999416	MW999456	MW980529	Cao et al. (2021a)
C. subminor	IFP 019447	China	MW980547	MW979524	MW999417	MW999457	MW980530	Cao et al. (2021a)
C. subpruinosus	GE 07.080	France	–	KF294660	–	KF294739	KF294587	Buyck et al. (2014)
C. subtilis	**GDGM81310 ***	**China**	–	**PX524024**	–	**PX516761**	**PX590231**	**Present study**
C. subvaginatus	1692/AV. 13.163	Republic of Korea	MG450670	MG450678	–	–	–	Unpublished
C. subvaginatus	**GDGM91679**	**China**	**–**	**PX524054**	**–**	**PX516777**	**PX590254**	**Present study**
C. subvaginatus	**GDGM91693**	**China**	**–**	**PX524056**	**PX705012**	**PX516779**	**PX590256**	**Present study**
C. subvaginatus	**GDGM93712**	**China**	**–**	**PX524059**	**PX705013**	**PX516780**	**PX590258**	**Present study**
C. subvaginatus	HKAS 73528	South Korea	–	–	MW368927	ON168713		Wang et al. (2023a)
C. symoensii	261/BB98.113 *	Tanzania	–	KF294619	JX192974	KF294693	KF294548	Buyck et al. (2014)
C. symoensii	BB 98.011	Tanzania	–	KF294618	GQ914970	KF294692	KF294547	Buyck et al. (2014)
C. symoensii	DDT36	Tanzania	JQ976934	JQ976961	–	–	–	Tibuhwa et al. (2012)
C. symoensii	DDT66	Tanzania	JQ976940	JQ976971	–	–	–	Tibuhwa et al. (2012)
C. symoensii	DDT67	Tanzania	JQ976941	JQ976972	–	–	–	Tibuhwa et al. (2012)
C. symoensii	JD 912	RD Congo	–	–	KX834405	KX834460	–	De Kesel et al. (2016)
C. symoensii	KMP 2	RD Congo	–	–	KX834404	KX834459	–	De Kesel et al. (2016)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. aff. symoensii	BB 08. 210	Madagascar	–	KM484692	JX193008	–	–	Unpublished
C. tabernensis	BB 07.040	USA	JN944013	JN940609	GQ914977	–	–	Buyck et al. (2011)
C. tabernensis	BB 07.042	USA	JN944014	JN940596	GQ914973	–	–	Buyck et al. (2011)
C. tabernensis	BB 07.056	USA	–	KF294631	GQ914974	KF294706	KF294560	Buyck et al. (2011, 2014)
C. tabernensis	BB 07.064	USA	JN944012	JN940608	GQ914975			Buyck et al. (2011)
C. tabernensis	BB 07.119	USA	–	KF294634	GQ914976	KF294709	KF294563	Buyck et al. (2011, 2014)
C. tabernensis	Herrera120	Mexico	–	MT371340	MT449709	–	–	Buyck et al. (2011)
C. tabernensis	Herrera121	Mexico	–	MT371341	MT449710	–	–	Buyck et al. (2011)
C. tanzanicus	268/BB 98.040 *	Tanzania	–	KF294622	JX192977	KF294696	–	Buyck et al. (2011, 2014)
C. tanzanicus	BB 06.148	Madagascar	–	KF294604	JX192965	KF294678	–	Buyck et al. (2011, 2014)
C. tanzanicus	BB 06.149		–	KF294605	JX192966	KF294679	–	Buyck et al. (2011, 2014)
C. tanzanicus	BB 06.153	Madagascar	–	–	JX193009/GQ914963	–	–	Buyck et al. (2011)
C. tanzanicus	BB 06.159	Madagascar	–	–	JX193010	–	–	Buyck et al. (2011)
C. tanzanicus	BB 06.165	Madagascar	–	–	JX193011	–	–	Buyck et al. (2011)
C. tanzanicus	JD 867	RD Congo	–	–	KX834406	KX834461	–	De Kesel et al. (2016)
C. tanzanicus	JD 878	RD Congo	–	–	KX834407	KX834462	–	De Kesel et al. (2016)
C. tenuithrix	1306/BB 14.008	USA	–	–	KX857045	–	–	Buyck (2016)
C. tenuithrix	1307/BB 14.009	USA	–	–	KX857046	–	–	Buyck (2016)
C. tenuithrix	1310/BB 14.010	USA	–	–	KX857048	–	–	Buyck (2016)
C. tenuithrix	1353/BB 14.098	USA	–	–	KX857053	–	–	Buyck (2016)
C. tenuithrix	1354/BB 14.099	USA	–	–	KX857054	–	–	Buyck (2016)
C. tenuithrix	343/BB 07.125 *	USA	JN944017	JN940600	–	KF294712	KF294566	Buyck et al. (2014)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. tenuithrix	BB 07.035	USA	–	KF294629	–	KF294704	KF294558	Buyck et al. (2014)
C. tenuithrix	FLAS-F-60656	USA	MH016824	–	MK045369	–	–	Unpublished
C. tenuithrix	PBM4268	USA	–	–	–	OM687964	–	Unpublished
C. tenuithrix	PBM4292	USA	–	–	–	OM687957	–	Unpublished
C. tenuithrix	RAS584	USA	–	–	–	OM687965	–	Unpublished
C. texensis	341/BB 07.120 *	USA	JN944016	JN940601	–	KF294710	KF294564	Buyck et al. (2014)
C. texensis	BB 07.018 *	USA	–	KF294626	–	KF294701	KF294555	Buyck et al. (2014)
C. texensis	BB 07.113	USA	–	–	GQ914986	–	–	Buyck et al. (2011)
C. tomentosoides	1639/BB16.007	Central African Republic	–	MK422937	MG450685	MT004804	MT002295	Unpublished
C. tomentosus	BB 98.038	Tanzania	–	KF294610	GQ914965	KF294684	KF294543	Buyck et al. (2011, 2014)
C. tomentosus	BB 98.060	Tanzania	–	KF294672	JX192995	KF294750	KF294597	Buyck et al. (2014)
C. tomentosus	DDT68	Tanzania	JQ976942	JQ976973	–	–	–	Tibuhwa et al. (2012)
C. tomentosus	DDT69	Tanzania	JQ976943	JQ976974	–	–	–	Tibuhwa et al. (2012)
C. tricolor	BB 06.179	Madagascar	–	KF294607	JX192968	KF294681	KF294539	Buyck et al. (2014)
C. tricolor	BB 06.180	USA	JN944015	JN940604	JX192969	JN993597/ KF294682	KF294540	Buyck et al. (2014)
C. tricolor	BB 06.247	Madagascar	–	–	JX193017	JN993615	–	Unpublished
C. tuberculosporus	**GDGM79327**	**China**	**PX648121**	**PX523987**	**PX705014**	**PX516721**	**PX590170**	**Present study**
C. tuberculosporus	**GDGM94580**	**China**	**–**	**–**	**–**	**PX657128**	**PX657474**	**Present study**
C. tuberculosporus	**GDGM97266**	**China**	**PX648122**	**PX664417**	**PX705015**	**PX657137**	**–**	**Present study**
C. tuberculosporus	HKAS 28930	China	ON311287	ON248967	–	–	–	Wang et al. (2023a)
C. tuberculosporus	HKAS 94043	China	ON262332/ ON262331	ON428227/ ON256659	ON462037	ON462040	–	Wang et al. (2023a)
C. umbonata	317	India	HQ270116	HM750922	–	–	–	Deepika et al. (2013)
C. vaginatus	DC 16-42	India	MG519608	MG519609	–	–	–	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. vaginatus	**GDGM78625**	**China**	**–**	**PX524036**	**PX705017**	**–**	**PX590240**	**Present study**
C. vaginatus	**GDGM78912**	**China**	**PX648123**	**PX524037**	**PX705018**	**PX516767**	**PX590241**	**Present study**
C. vaginatus	**GDGM78923**	**China**	**PX648124**	**PX524038**	**–**	**–**	**–**	**Present study**
C. vaginatus	**GDGM78948**	**China**	**PX648125**	**PX524039**	**PX705019**	**PX516768**	**PX590242**	**Present study**
C. vaginatus	**GDGM78954**	**China**	**–**	**PX524040**	**PX705020**	**PX516769**	**PX590243**	**Present study**
C. vaginatus	**GDGM78975**	**China**	**–**	**PX524041**	**PX705021**	**PX516770**	**PX590244**	**Present study**
C. vaginatus	**GDGM79025**	**China**	**–**	**PX524042**	**PX705022**	**PX516771**	**PX590245**	**Present study**
C. vaginatus	**GDGM79889**	**China**	**–**	**PX524043**	**–**	**–**	**–**	**Present study**
C. vaginatus	HKAS 55730 *	China	HQ416692	HM594681	–	–	–	Unpublished
C. vaginatus	HKAS 55731	China	–	HM594682	–	–	–	Unpublished
C. vaginatus	HKAS55728	China	–	HM594680	–	–	–	Unpublished
C. vaginatus	HKAS 110224	China	–	–	ON089610	ON089590	–	Wang et al. (2023a)
C. vaginatus	HKAS 110225	China	–	–	ON089611	ON089591	–	Wang et al. (2023a)
C. vaginatus	FHMU6851	China	–	OM691484	OM811325	–	–	Zhang et al. (2022b)
C. vaginatus	FHMU6852	China	–	OM691485	OM811326	–	–	Zhang et al. (2022b)
C. vaginatus	FHMU6855	China	OM835807	OM691492	OM811333	–	–	Zhang et al. (2022b)
C. vaginatus	FHMU6853	China	–	OM691486	OM811327	–	–	Zhang et al. (2022b)
C. vaginatus	FHMU6854	China	–	OM691491	OM811332	–	–	Zhang et al. (2022b)
C. vaginatus	FHMU1533	China	OM835805	OM691489	OM811330	–	–	Zhang et al. (2022b)
C. vaginatus	FHMU1638	China	OM835806	OM691490	OM811331	–	–	Zhang et al. (2022b)
C. vaginatus	FHMU1961	China	–	OM691487	OM811328	–	–	Zhang et al. (2022b)
C. vaginatus	FHMU1970	China	–	OM691488	OM811329	–	–	Zhang et al. (2022b)
C. vaginatus	**GDGM97481**	**China**	**–**	**–**	**PX705032**	**PX657139**	**PX657481**	**Present study**
C. vaginatus	**GDGM48618**	**China**	**–**	**PX524035**				**Present study**
C. vaginatus	**GDGM80775**	**China**	**–**	**PX524044**	**PX705023**	**PX516772**	**PX590246**	**Present study**
C. vaginatus	**GDGM80779**	**China**	**–**	**PX524045**	**PX705024**	**PX516773**	**PX590247**	**Present study**
C. vaginatus	**GDGM82492**	**China**	**–**	**PX524046**		**PX516774**	**PX590248**	**Present study**
C. vaginatus	**GDGM88621**	**China**	**–**	**PX524047**	**PX705025**		**PX590249**	**Present study**
C. vaginatus	**GDGM89235**	**China**	**–**	**PX524048**	**–**	**–**	**–**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. vaginatus	**GDGM89425**	**China**	**PX648126**	**PX524049**	**–**	**–**	**PX590250**	**Present study**
C. vaginatus	**GDGM90866**	**China**	**–**	**PX524050**	**PX705026**	**PX516775 PX657120**	**PX590251**	**Present study**
C. vaginatus	**GDGM91295**	**China**	**–**	**PX524051**	**PX705027**	**–**	**PX590252**	**Present study**
C. vaginatus	**GDGM91303**	**China**	**–**	**PX524052**				**Present study**
C. vaginatus	**GDGM91675**	**China**	**–**	**PX524053**	**PX705028**	**PX516776**	**PX590253**	**Present study**
C. vaginatus	**GDGM91680**	**China**	**–**	**PX524055**	**PX705029**	**PX516778**	**PX590255**	**Present study**
C. vaginatus	**GDGM91703**	**China**	**–**	**PX524057**	**–**	**–**	**–**	**Present study**
C. vaginatus	**GDGM92540**	**China**	**–**	**PX524058**	**PX705030**		**PX590257**	**Present study**
C. vaginatus	**GDGM93719**	**China**	**–**	**PX524060**	**PX705031**		**PX590259**	**Present study**
C. vaginatus	**GDGM95539**	**China**	**–**	**PX664418**	**PX705033**	**PX657133**	**PX657480**	**Present study**
C. velutinus	1066/JJ AR-CANT-1	USA	–	–	KX857022	–	–	Buyck (2016)
C. velutinus	1067/JJ AR-CANT-2	USA	–	–	KX857023	–	–	Buyck (2016)
C. velutinus	1321/BB 14.038 *	USA	KX896774	KX896789	KX857049	–	–	Buyck (2016), Buyck et al. (2016b)
C. velutinus	1326/BB 14.045	USA	KX896763	–	KX857052	–	–	Buyck (2016), Buyck et al. (2016b)
C. velutinus	1346/BB14.078	USA	–	–	ON168703	ON168710	–	Wang et al. (2023a)
C. velutinus	1581/WR WV07.074	USA	–	–	KX857068	–	–	Buyck (2016)
C. velutinus	1583/DM WV13.36	USA	–	–	KX857070	–	–	Buyck (2016)
C. velutinus	PBM4602	USA	–	–	–	OM687971	–	Unpublished
C. veraecrucis	Bandala 4505	Mexico	–	MT371344	MT449712	–	–	Montoya et al. (2021)
C. veraecrucis	Herrera142	Mexico	–	MT371342	–	–	–	Montoya et al. (2021)
C. veraecrucis	Herrera58	Mexico	–	MT371343	MT449711	–	–	Montoya et al. (2021)
C. versicolor	**GDGM79332**	**China**	**–**	**PX664419**	**PX705034**	**PX657068**	**PX657400**	**Present study**
C. versicolor	**GDGM79336**	**China**	**PX648130**	**PX664420**	**PX705035**	**PX657069**	**PX657402**	**Present study**
C. versicolor	**GDGM79337**	**China**	**PX648131**	**–**	**–**	**PX657070**	**PX657403**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. versicolor	GDGM79339	China	–	PX664421	PX705036	PX657071	PX657404	Present study
C. versicolor	GDGM81860	China	PX648132	–	–	PX657081	PX657419	Present study
C. versicolor	GDGM81861	China	PX648133	PX664422	–	PX657082	PX657420	Present study
C. versicolor	GDGM82370	China	–	PX664423	PX705037	PX657086	PX657426	Present study
C. versicolor	GDGM82371	China	PX648134	PX524061	PX705038	PX516781	PX590260 PX657427	Present study
C. versicolor	GDGM82373	China	PX648135	PX664424	PX705039	PX657087	PX657428	Present study
C. versicolor	GDGM82378	China	PX648136	PX664425	PX705040	PX657088	PX657429	Present study
C. versicolor	GDGM82381	China	PX648137	PX664426	PX705041	PX657089	PX657430	Present study
C. versicolor	GDGM82383	China	PX648138	PX664427	PX705042	PX657090	PX657431	Present study
C. versicolor	GDGM82384	China	PX648139	PX524062	PX705043	PX516782	PX590261	Present study
C. versicolor	GDGM82404	China	PX648142	PX664428		PX657091	PX657435	Present study
C. versicolor	GDGM82407	China	–	PX664429	PX705044		PX657436	Present study
C. versicolor	GDGM82412	China	PX648143	PX664430	–	PX657092	PX657437	Present study
C. versicolor	GDGM82414	China	PX648144	PX664431	PX705045	PX657093	PX657438	Present study
C. versicolor	GDGM82420	China	PX648145	PX664432	PX705046	PX657099	PX657439	Present study
C. versicolor	GDGM82429	China	PX648147	PX664433	PX705047	PX657094	PX657440	Present study
C. versicolor	GDGM82430	China	PX648148	PX524063	PX705048	PX516783	PX590262	Present study
C. versicolor	GDGM82438	China	PX648149	PX664434	PX705049	PX657100	PX657441	Present study
C. versicolor	GDGM82440	China	PX648150	PX664435	PX705050	PX657098	PX657442	Present study
C. versicolor	GDGM82802	China	PX648151	–	–	PX657096	PX657445	Present study
C. versicolor	GDGM82803	China	PX648152	PX664436	PX705051	PX657097	PX657446	Present study
C. versicolor	GDGM82805	China	–	PX664437	PX705052	PX657101	PX657448	Present study
C. versicolor	GDGM82806	China	PX648153	PX664438	PX705053	PX657102	PX657449	Present study
C. versicolor	GDGM83098	China	PX648154	PX664439	PX705054	PX657109	PX657454	Present study
C. versicolor	GDGM83172	China	PX648155	PX664440	PX705055	PX657110	PX657456	Present study
C. versicolor	GDGM83177	China	PX648156	PX524064	PX705057	PX516784	PX590263	Present study
C. versicolor	GDGM83185	China	–	PX664441	PX705058	PX657111	PX657460	Present study
C. versicolor	GDGM83192	China	PX648157	PX524065	PX705059	PX516785	PX590264	Present study

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. versicolor	**GDGM83198**	**China**	**PX648158**	**PX664442**	**PX705060**	**PX657112**	**PX657462**	**Present study**
C. versicolor	**GDGM83227**	**China**	**–**	**PX524066**	**PX705061**	**PX516786**	**PX590265**	**Present study**
C. versicolor	HKAS 58242	China	ON054233	ON054283	–	–	–	Wang et al. (2023a)
C. versicolor	HKAS 55776	China	–	JF906720	–	–	–	Unpublished
C. versicolor	HKAS 55784	China	–	JF906721	–	–	–	Unpublished
C. versicolor	HKAS 109701	China	–	–	MW368934	ON089595	–	Wang et al. (2023a)
C. versicolor	HKAS 109702	China	–	–	MW368930	ON263465	–	Wang et al. (2023a)
C. versicolor	HKAS 109703	China	–	–	MW368935	ON089596	–	Wang et al. (2023a)
C. versicolor	HKAS 109704	China	–	–	MW368936	ON089597	–	Wang et al. (2023a)
C. versicolor	HKAS 109705	China	–	–	MW368933	ON089594	–	Wang et al. (2023a)
C. versicolor	HKAS 109707	China	–	–	MW368931	ON089592	–	Wang et al. (2023a)
C. versicolor	HKAS 109708	China	–	–	MW368932	ON089593	–	Wang et al. (2023a)
C. versicolor	HKAS 123176	China	–	–	ON089618	ON089603	–	Wang et al. (2023a)
C. versicolor	HKAS 123178	China	–	–	ON089614	ON089599	–	Wang et al. (2023a)
C. versicolor	HKAS 123179	China	–	–	ON089615	ON089600	–	Wang et al. (2023a)
C. versicolor	HKAS 123180	China	–	–	ON089616	ON089601	–	Wang et al. (2023a)
C. versicolor	HKAS 123181	China	–	–	ON089617	ON089602	–	Wang et al. (2023a)
C. versicolor	HKAS 55762 *	China	–	–	–	ON462041	–	Wang et al. (2023a)
C. vicinus	RAS426	USA	–	–	–	OM687942	–	Unpublished
C. vicinus	RAS577	USA	–	–	–	OM687943	–	Unpublished
C. vicinus	RAS586	USA	–	–	–	OM687944	–	Unpublished
C. violaceoflavescens	1757/BR5020167050163 *	Togo	–	MT006307	–	–	MT006317	Buyck et al. (2020)
C. violaceoflavescens	1758/BR5020167046128 *	Togo	MT006318	MT006308	–	–	MT006318	Buyck et al. (2020)
C. violaceovinosus	Bandala 4513	Mexico	–	MF616524	MF616520	–	–	Herrera et al. (2018)
C. violaceovinosus	Corona 648	Mexico	–	MF616525	MF616521	–	–	Herrera et al. (2018)
C. violaceovinosus	Herrera 125	Mexico	–	MF616526	MF616522	–	–	Herrera et al. (2018)
C. violaceovinosus	Herrera 126	Mexico	–	MF616527	MF616523	–	–	Herrera et al. (2018)
C. xanthocyaneus	1751/S.N. Ebika	Republic of	–	MT006309	MT002277	–	MT006321	Buyck et al. (2020)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
C. xanthocyaneus	2333* 1752/S.N. Ebika 2353 *	the Congo Republic of the Congo	MT006322	MT006310	MT002278	–	MT006322	Buyck et al. (2020)
C. zangii	GDGM82374	China	–	MZ605109	MZ614008	MZ614052	**PX590266**	Zhang et al. (2021a), Present study
C. zangii	GDGM82389	China	–	MZ605110	MZ614009	MZ614053	**PX657432**	Zhang et al. (2021a), Present study
C. zangii	GDGM82393	China	–	MZ605111	MZ614010	MZ614054	**PX657433**	Zhang et al. (2021a), Present study
C. zangii	GDGM82399	China	MZ818336	MZ605112	MZ614011	MZ614055	**PX657434**	Zhang et al. (2021a) Present study
C. zangii	GDGM83171	China	–	MZ605113	MZ614012	MZ614056	**PX657455**	Zhang et al. (2021a) Present study
C. zangii	GDGM83173	China	MZ818337	MZ605114	MZ614013	MZ614057	**PX657457**	Zhang et al. (2021a) Present study
C. zangii	GDGM83176	China	–	MZ605115	MZ614014	MZ614058	**PX657458**	Zhang et al. (2021a) Present study
C. zangii	GDGM83181	China	–	MZ605116	MZ614015	MZ614059	**PX657459**	Zhang et al. (2021a) Present study
C. zangii	GDGM83186	China	–	MZ605117	MZ614016	MZ614060	**PX590267**	Zhang et al. (2021a) Present study
C. zangii	GDGM83193	China	MZ818338	MZ605118	MZ614017	MZ614061	**PX657461**	Zhang et al. (2021a) Present study
C. zangii	GDGM83228	China	–	MZ605119	MZ614018	MZ614062	**PX590268**	Zhang et al. (2021a) Present study
C. zangii	HKAS 118077	China	–	–	ON089619	ON089628		Wang et al. (2023a)
C. zangii	HKAS 118276	China	–	–	ON089622	ON089631		Wang et al. (2023a)
C. zangii	HKAS 118876	China	–	–	ON089621	ON089630		Wang et al. (2023a)
C. zangii	HKAS 55791 1	China	–	–	ON462039	ON089632		Wang et al. (2023a)
Craterellus albidus	20200803055	China	–	MT921162	–	–	–	Zhang et al. (2020b)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. albidus	D1049	China	MW031159	–	–	–	–	Zhang et al. (2020b)
Cr. albidus	D1966	China	MW031160	–	–	–	–	Zhang et al. (2020b)
Cr. albidus	DCY2044	China	–	MT921161	–	–	–	Zhang et al. (2020b)
Cr. albidus	**GDGM97252**	**China**	**–**	**PX647578**	**–**	**PX712270**	**–**	**Present study**
Cr. albidus	**GDGM84494**	**China**	**PX647983**	**PX647577**	**–**	**PX712271**	**–**	**Present study**
Cr. albimarginatus	Zx039 *	China	PQ611003	PQ604676	–	–	–	Jiang et al. (2025)
Cr. albimarginatus	Zx039-1	China	PQ611004	–	–	–	–	Jiang et al. (2025)
Cr. albostrigosus	CAL 1624	India	–	MG593194	–	–	–	Bijeesh et al. (2018)
Cr. aprilis	**GDGM91206**	**China**	**PX647985**	**PX647575**	**–**	**PX712273**	**PX647880**	**Present study**
Cr. aprilis	**GDGM91208**	**China**	**–**	**–**	**PX704802**	**PX712274**	**PX647881**	**Present study**
Cr. aprilis	**GDGM91209 ***	**China**	**PX647986**	**PX647574**	**PX704803**	**PX712277**	**PX647882**	**Present study**
Cr. aprilis	**GDGM92096**	**China**	**–**	**PX647573**	**PX704804**	**PX712278**	**PX647883**	**Present study**
Cr. aprilis	**GDGM92099**	**China**	**PX647987**	**PX647572**	**PX704805**	**PX712280**	**PX647884**	**Present study**
Cr. aprilis	**GDGM93625**	**China**	**–**	**PX647571**	**PX704806**	**PX712276**	**PX647885**	**Present study**
Cr. aprilis	**GDGM93659**	**China**	**–**	**PX647569**	**–**	**PX712279**	**PX647887**	**Present study**
Cr. aprilis	**GDGM93956**	**China**	**–**	**PX647567**	**PX704807**	**PX712275**	**PX647889**	**Present study**
Cr. armeniacus	**GDGM70945**	**Vietnam**	**PX647988**	**–**	**–**	**–**	**–**	**Present study**
Cr. atratoides	AMV1870	Colombia	KT354698	–	–	–	–	Unpublished
Cr. atratoides	AMV1965a	Colombia	KT724106	KT724157	–	–	–	Unpublished
Cr. atratoides	AMV1990	Colombia	KT354699	–	–	–	–	Unpublished
Cr. atratoides	AMV1992	Colombia	KT354700	–	–	–	–	Unpublished
Cr. atratoides	MCA1313	Guyana	JQ915093	JQ915119	–	–	–	Wilson et al. (2012)
Cr. atratoides	TH8243	Guyana	KT339209	–	–	–	–	Unpublished
Cr. atratoides	TH8473	Guyana	JQ915103	JQ915129	–	–	–	Wilson et al. (2012)
Cr. atratoides	TH9232 1*	Guyana	JQ915111	JQ915137	–	–	–	Wilson et al. (2012)
Cr. atratoides	TH9232 2	Guyana	JQ915111	NG_042660	–	–	–	Wilson et al. (2012)
Cr. atratus	AMV1832	Colombia	KT724107	KT724158	–	–	–	Unpublished
Cr. atratus	KH-MYA16-168 (TNS)	Myanmar	MW577303	–	–	–	–	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. atratus	MCA1070	Guyana	JQ915092	JQ915118	–	–	–	Wilson et al. (2012)
Cr. atratus	MCA990	Guyana	JQ915100	JQ915126	–	–	–	Wilson et al. (2012)
Cr. atratus	MN21-2006	Thailand	AB445115	–	–	–	–	Unpublished
Cr. atratus	TH9203	Guyana	JQ915107	JQ915133	–	–	–	Wilson et al. (2012)
Cr. atrobrunneolus	**GDGM81396**	**China**	**–**	**PX647563**	**PX704808**	**PX712307**	**PX647891**	**Present study**
Cr. atrobrunneolus	**GDGM83803**	**China**	**PX647991**	**PX647564**	**–**	**PX712308**		**Present study**
Cr. atrobrunneolus	**GDGM89523**	**China**	**PX647992**	**PX647565**	**–**	**PX712309**	**PX647892**	**Present study**
Cr. atrobrunneolus	**GDGM97177**	**China**	**PX647989**	**PX647562**	**–**	**PX712310**	**PX647893**	**Present study**
Cr. atrobrunneolus	**GDGM97178**	**China**	**PX647990**	**PX647561**	**PX704809**	**PX712311**	**PX647894**	**Present study**
Cr. atrobrunneolus	FHMU7704	China	PQ611005	PQ604677	–	–	–	Jiang et al. (2025)
Cr. atrobrunneolus	Yuan13878	China	MN902353	MN894058	–	–	–	Cao et al. (2021b)
Cr. atrocinereus	Arora15001	USA	KR560049	–	–	–	–	Unpublished
Cr. atrocinereus	JLF3750	USA	KR560048	–	–	–	–	Unpublished
Cr. aureus	Su145	China	–	OL439673	–	–	–	Unpublished
Cr. aureus	Su196	China	OL439545	OL439676	–	–	–	Unpublished
Cr. aureus	MHHNU32154	China	OL439547	OL439677	–	–	–	Unpublished
Cr. aureus	FHMU2407	China	OM469019	OL439672	–	–	–	Unpublished
Cr. aureus	FHMU7703	China	PQ611013	PQ604690	–	–	–	Jiang et al. (2025)
Cr. aureus	Zeng3139	China	–	OL439675	–	–	–	Unpublished
Cr. aureus	FHMU2102	China	OM469020	OL439674	–	–	–	Unpublished
Cr. aureus	Y.J. Hao2080	China	OL439546	–	–	–	–	Unpublished
Cr. aureus	**GDGM27609**	**China**	**PX648013**	**PX647531**	**–**	**PX712312**	**PX647925**	**Present study**
Cr. aureus	**GDGM46327**	**China**	**PX648015**	**PX647529**	**PX704837**	**PX712314**	**PX647927**	**Present study**
Cr. aureus	GDGM46432	China	MG727897 **PX648016**	MG727898 **PX647528**	–	–	–	Zhong et al. (2018) Present study
Cr. aureus	**GDGM46455**	**China**	**PX648017**	**PX647527**	**PX704838**	**PX712315**	**PX647928**	**Present study**
Cr. aureus	GDGM48105	China	MG727896 **PX648018**	MG701171 **PX647526**	–	–	–	Zhong et al. (2018) Present study
Cr. aureus	GDGM49495	China	MG806930 **PX648019**	MG806926 **PX647525**	–	–	–	Unpublished Present study

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. aureus	**GDGM60384**	**China**	**PX648020**	**PX647524**	**–**	**–**	**–**	**Present study**
Cr. aureus	**GDGM85856**	**China**	**PX648024**	**PX647519**	**PX704843**	**PX712320**	**PX647933**	**Present study**
Cr. aureus	**GDGM86251**	**China**	**–**	**PX647517**	**PX704845**	**PX712322**	**PX647935**	**Present study**
Cr. aureus	**GDGM91697**	**China**	**–**	**PX647515**	**PX704846**	**PX712323**	**PX647937**	**Present study**
Cr. aureus	**GDGM91713**	**China**	**–**	**PX647514**	**–**	**–**	**–**	**Present study**
Cr. aureus	**GDGM92541**	**China**	**–**	**–**	**–**		**PX647938**	**Present study**
Cr. aureus	**GDGM93208**	**China**	**–**	**PX647513**	**PX704847**	**PX712324**	**PX647939**	**Present study**
Cr. aureus	**GDGM93717**	**China**	**–**	**PX647512**	**PX704848**	**–**	**PX647940**	**Present study**
Cr. aureus	**MHHNU32154**	**China**	**PX648014**	**PX647530**	**–**	**PX712313**	**PX647926**	**Present study**
Cr. aureus	**GDGM78640**	**China**	**PX648029**	**PX647523**	**PX704839**	**PX712316**	**PX647929**	**Present study**
Cr. aureus	**GDGM78716**	**China**	**PX648021**	**PX647522**	**PX704840**	**PX712317**	**PX647930**	**Present study**
Cr. aureus	**GDGM79168**	**China**	**PX648022**	**PX647521**	**PX704841**	**PX712318**	**PX647931**	**Present study**
Cr. aureus	**GDGM82525**	**China**	**PX648023**	**PX647520**	**PX704842**	**pX712319**	**PX647932**	**Present study**
Cr. aureus	**GDGM86060**	**China**	**PX648025**	**PX647518**	**PX704844**	**PX712321**	**PX647934**	**Present study**
Cr. aureus	**GDGM87037**	**China**	**PX648026**	**–**	**–**	**–**		**Present study**
Cr. aureus	**GDGM89898**	**China**	**PX648027**	**PX647516**	**–**	**–**	**PX647936**	**Present study**
Cr. aureus	**GDGM95670**	**China**	**PX648028**	**–**	**–**	**–**	**–**	**Present study**
Cr. badiogriseus	**GDGM94500**	**China**	**PX647993**	**PX647560**	**PX704811**	**PX726014**	**PX647895**	**Present study**
Cr. badiogriseus	**GDGM96736**	**China**	**PX647994**	**PX647559**	**PX704812**	**PX726015**	**PX647896**	**Present study**
Cr. badiogriseus	IFP 019452	China	MW980548	MW979532	MW999432	–	–	Cao et al. (2021a)
Cr. badiogriseus	IFP 019453	China	MW980549	MW979533	MW999433	–	–	Cao et al. (2021a)
Cr. brunneus	**GDGM55075**	**China**	**PX647995**	**–**	**PX704814**	**PX726016**	**PX647897**	**Present study**
Cr. brunneus	**GDGM91705 ***	**China**	**–**	**PX647558**	**PX704813**	**PX726017**	**PX647898**	**Present study**
Cr. caeruleofuscus	LJ2020-1	USA	OR471229	–	–	–	OR470849	Unpublished
Cr. caeruleofuscus	RAS674 SV1	USA	OR471214	–	–	–	OR470838	Unpublished
Cr. caeruleofuscus	RAS674 SV2	USA	OR471215	–	–	–	–	Unpublished
Cr. caeruleofuscus	RAS674 SV3	USA	OR471216	–	–	–	–	Unpublished
Cr. caeruleofuscus	TENN:073179	USA	MH558300	–	–	–	–	Unpublished
Cr. calicornucopioides	Arora15002 *	USA	KR560047	–	–	–	–	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. calicornucopioides	JLF3744	USA	KR560046	–	–	–	–	Unpublished
Cr. calyculus	MGW969 SV1	USA	OR471222	–	–	–	–	Unpublished
Cr. calyculus	MGW969 SV2	USA	OR471223	–	–	–	–	Unpublished
Cr. calyculus	Mushroom Observer 321697	USA	MK607596	–	–	–	–	Unpublished
Cr. cantharellus	217-147	Japan	AB509577	–	–	–	–	Unpublished
Cr. carolinensis	FLAS-F-59997	USA	KY654712	–	–	–	–	Unpublished
Cr. carolinensis	iNat67732367	Canada	ON943343	–	–	–	–	Unpublished
Cr. carolinensis	PBM4446	USA	–	–	–	OR473981	–	Unpublished
Cr. carolinensis	PBM4446 SV1	USA	OR471217	–	–	–	OR470839	Unpublished
Cr. carolinensis	PBM4446 SV2	USA	OR471218	–	–	–	OR470840	Unpublished
Cr. carolinensis	PBM4446 SV3	USA	OR471219	–	–	–	OR470841	Unpublished
Cr. carolinensis	iNaturalist 129744112	USA	OP643223	–	–	–	–	Unpublished
Cr. cinereofimbriatus	AMV2245	Colombia	KT354702	–	–	–	–	Unpublished
Cr. cinereus	107-08	India	JF412278	JF412276	–	–	–	Unpublished
Cr. cinereus	AST12B	Pakistan	MF374489	–	–	–	–	Unpublished
Cr. cinereus	AST2015	Pakistan	MF374488	–	–	–	–	Unpublished
Cr. cinereus	iNAT:16409133	USA	ON366757	–	–	–	–	Unpublished
Cr. connatus	Zhang 103 2	China	–	–	ON125916	–	–	Zhao et al. (2022)
Cr. connatus	Zhang103-1	China	–	OM509448	ON125915	–	–	Zhao et al. (2022)
Cr. cornucopioides	4525	Italy	JF907967	–	–	–	–	Osmundson et al. 2013
Cr. cornucopioides	Champ-2	France	KX449405	–	–	–	–	Unpublished
Cr. cornucopioides	CNF 1/7292	Croatia	MK169230	–	–	–	–	Unpublished
Cr. cornucopioides	G.M. 2014-10-12.1	Luxembourg	OM200246	–	–	–	–	Unpublished
Cr. Cornucopioides	groc_11399	USA	KT693263					Raja et al. 2017

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. cornucopioides	HbO-53302	Norway	–	AF105301	–	–	–	Dahlman et al. (2000)
Cr. cornucopioides	UPSF-11792	Sweden	–	AF105297	–	–	–	Dahlman et al. (2000)
Cr. cornucopioides	UPSF-11798	USA	–	AF105305	–	–	–	Dahlman et al. (2000)
Cr. cornucopioides	UPSF-11800	USA	–	AF105298	–	–	–	Dahlman et al. (2000)
Cr. cornucopioides	UPSF-11801	USA	–	AF105299	–	–	–	Dahlman et al. (2000)
Cr. cornucopioides	HKAS111827	China	ON794236	–	–	–	–	Wang et al. 2022
Cr. cornucopioides	iNat64572090	USA	OP020400	–	–	–	–	Unpublished
Cr. cornucopioides	WA0000071019	Poland	MK028881	–	–	–	–	Unpublished
Cr. cornucopioides	Zhang194	China	–	OM509442	–	–	–	Unpublished
Cr. cornucopioides	Zhang221	China	–	OM509441	–	–	–	Unpublished
Cr. cornucopioides	Zhang226	China	–	OM509440	–	–	–	Unpublished
Cr. cornucopioides	Zhang227	China	–	OM509439	–	–	–	Unpublished
Cr. cornucopioides	Zhang250	China	–	OM509443	–	–	–	Unpublished
Cr. cornucopioides	Zhang253	China	–	OM509444	–	–	–	Unpublished
Cr. cornucopioides	Zhang258	China	–	OM509445	–	–	–	Unpublished
Cr. cornucopioides	**GDGM78973**	**China**	**–**	**PX647555**	**PX704815**	**–**	**PX647902**	**Present study**
Cr. cornucopioides	**GDGM93963**	**China**	**–**	**PX647554**	**PX704816**	**PX712327**	**PX647903**	**Present study**
Cr. cornucopioides	**GDGM94561**	**China**	**PX647997**	**PX647553**	**PX704817**	**PX712328**	**–**	**Present study**
Cr. cornucopioides	**GDGM94585**	**China**		**PX647552**	**PX704818**	**PX712329**	**PX647904**	**Present study**
Cr. cornucopioides var. mediosporus	268-06	India	JF412277	JF412275	–	–	–	Unpublished
Cr. croceialbus	**GDGM86694**	**China**	**PX647998**	**PX647551**	**PX704819**	**PX712330**	**PX647905**	**Present study**
Cr. croceialbus	**GDGM91689**	**China**	**–**	**PX647549**	**PX704821**	**PX712331**	**PX647907**	**Present study**
Cr. croceialbus	**GDGM91292**	**China**	**PX647999**	**PX647550**	**PX704820**	–	**PX647906**	**Present study**
Cr. croceialbus	**GDGM93013**	**China**	**–**	**PX647548**	**PX704822**	**PX712332**	**PX647908**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. croceialbus	Yuan14623	China	MW980572	MW979529	MW999430	MW999460		Cao et al. (2021a)
Cr. croceialbus	Yuan14647	China	MW980573	MW979530	MW999431	MW999461		Cao et al. (2021a)
Cr. dubius	MH17001	USA	–	MT237468	–	OR473793	OR464314	Unpublished
Cr. dubius	MH17001 SV1	USA	OR464444	OR460923	–	–	–	Unpublished
Cr. dubius	MH17001 SV2	USA	OR464443	–	–	–	–	Unpublished
Cr. dubius	MH20007	USA	–	OR471012	–	OR473987	OR470837	Unpublished
Cr. dubius	MH20007 SV1	USA	OR471212	–	–	–	–	Unpublished
Cr. dubius	MH20007 SV2	USA	OR471213	–	–	–	–	Unpublished
Cr. excelsus	MCA3107	Guyana	JQ915095	JQ915121	–	–	–	Wilson et al. (2012)
Cr. excelsus	TH7515	Guyana	JQ915101	JQ915127	–	–	–	Wilson et al. (2012)
Cr. excelsus	TH8235	Guyana	JQ915102	JQ915128	–	–	–	Wilson et al. (2012)
Cr. excelsus	TH9733	Guyana	KC897655	–	–	–	–	Henkel et al. (2014)
Cr. aff. *excelsus*	G1865	Guyana	KJ786676	KJ786571	–	–	–	Unpublished
Cr. aff. *excelsus*	G3184	Guyana	–	KJ786602	–	–	–	Unpublished
Cr. aff. *excelsus*	G3279	Guyana	–	KJ786625	–	–	–	Unpublished
Cr. aff. *excelsus*	G3302	Guyana	–	KJ786629	–	–	–	Unpublished
Cr. fallax	695	USA	KX389109	–	–	–	–	Unpublished
Cr. fallax	14726	USA	–	MN227280	–	–	–	Unpublished
Cr. fallax	AFTOL-ID 286	USA	DQ205680	–	–	DQ366287	AY771604	Matheny et al. (2007)
Cr. fallax	CNV30	USA	MT345207	–	–	–	–	Unpublished
Cr. fallax	ECM1	USA	GU590926	–	–	–	–	Matheny et al. (2010)
Cr. fallax	ECM2	USA	GU590927	–	–	–	–	Matheny et al. (2010)
Cr. fallax	EEApvecm2	USA	OR464445	OR460924	–	–	OR464315	Unpublished
Cr. fallax	FLAS_AC739	USA	MH496809	–	–	–	–	Unpublished
Cr. fallax	FLAS-F-60401	USA	MH281835	–	MH822842	–	–	Unpublished
Cr. fallax	iNaturalist 135577299	USA	OQ363118	–	–	–	–	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. fallax	MBP080209B	USA	GU590925	–	–	–	–	Matheny et al. 2010
Cr. fallax	MGW652	USA	GU590924	–	–	–	–	Matheny et al. 2010
Cr. fallax	MQ15002	Canada	MH571125	–	–	–	–	Unpublished
Cr. fallax	PBM2427	Unknown	–	AY700188	–	–	–	Unpublished
Cr. fallax	Dirks:ACD0584	USA	OQ785313	OQ785297	–	–	–	Unpublished
Cr. fallax	RAS576	USA	OR471224	–	–	OR473988	OR470846	Unpublished
Cr. fallax	iNaturalist 130676795	USA	OP748999	–	–	–	–	Unpublished
Cr. fallax	TENN072344	USA	OR464463	OR460939	–	–	OR464327	Unpublished
Cr. fallax	VSC-F 0000031	USA	ON080990	–	–	–	–	Unpublished
Cr. fallax	VSC-F-0000142	USA	ON080992	–	–	–	–	Unpublished
Cr. foetidus	LJ2020-3	USA	–	–	–	OR473986	OR470850	Unpublished
Cr. foetidus	LJ2020-3 SV1	USA	OR471230	–	–	–	–	Unpublished
Cr. foetidus	LJ2020-3 SV2	USA	OR471231	–	–	–	–	Unpublished
Cr. foetidus	RAS277B	USA	OR471221	–	–	OR473985	OR470844	Unpublished
Cr. fulviceps	MHHNU10567*	China	OL439548	OL439678	–	–	–	Unpublished
Cr. fulviceps	Zeng7833	China	PQ611006	PQ604678	–	–	–	Jiang et al. (2025)
Cr. fulviceps	Zeng7833-1	China	PQ611007	PQ604679	–	–	–	Jiang et al. (2025)
Cr. fulviceps	Zeng8163	China	PQ611009	PQ604682	–	–	–	Jiang et al. (2025)
Cr. fulviceps	Zeng7940	China	–	PQ604680	–	–	–	Jiang et al. (2025)
Cr. grisellonigricans	**GDGM70794**	**Vietnam**	**PX648000**	**PX647547**	**PX704823**	**PX712305**	**PX647909**	**Present study**
Cr. grisellonigricans	**GDGM70814 ***	**Vietnam**	**PX648001**	**PX647546**	**PX704824**	**PX712306**	**PX647910**	**Present study**
Cr. guizhouensis	**GDGM77697 ***	**China**	**PX648002**	**PX647545**	**PX704825**	**PX726019**	**PX647911**	**Present study**
Cr. guizhouensis	**GDGM77716**	**China**	**PX648003**	**PX647544**	**PX704826**	**PX726020**	**PX647914**	**Present study**
Cr. gypseus	**GDGM86113 ***	**China**	**PX648005**	**PX647543**	**PX704810**	**PX726022**	**PX647912**	**Present study**
Cr. gypseus	**GDGM60415**	**China**	**PX648004**	**–**	–	**–**		**Present study**
Cr. hesleri	RHP55560	USA	GU590931	–	–	–	–	Matheny et al. (2010)
Cr. ignicolor	iNaturalist 33240168	USA	MZ919173	–	–	–	–	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. ignicolor	AJF19 SV1	USA	OR464451	OR460931	–	–	–	Unpublished
Cr. ignicolor	AJF19 SV2	USA	OR464452	OR460932	–	–	–	Unpublished
Cr. ignicolor	AJF19 SV3	USA	OR464453	OR460933	–	–	–	Unpublished
Cr. ignicolor	AJF19 SV4	USA	OR464454	OR460934	–	–	–	Unpublished
Cr. ignicolor	UPSF-11794	USA	–	AF105314	–	–	–	Dahlman et al. (2000)
Cr. ignicolor	iNaturalist 170187787	USA	OR732021	–	–	–	–	Unpublished
Cr. ignicolor	RAS444	USA	–	OR460885	–	–	OR464265	Unpublished
Cr. ignicolor	RAS444 SV1	USA	OR464400	–	–	OR473794	–	Unpublished
Cr. ignicolor	RAS444 SV2	USA	OR464401	–	–	OR473795	–	Unpublished
Cr. ignicolor	RAS589	USA	–	OR471011	–	–	OR470836	Unpublished
Cr. ignicolor	RAS589 SV1	USA	OR471209	–	OR490252	OR473979	–	Unpublished
Cr. ignicolor	F 074668	USA	ON412912	–	–	–	–	Unpublished
Cr. ignicolor	RAS589 SV2	USA	OR471210	–	OR490256	OR473980	–	Unpublished
Cr. indicus	MSR6	India	HQ450769	–	–	–	–	Kumari et al. (2012)
Cr. indicus	MSR7	India	–	HQ450770	–	–	–	Kumari et al. (2012)
Cr. indicus	MSR8	India	–	HQ450771	–	–	–	Kumari et al. (2012)
Cr. indicus	PUN3884 *	India	HM113530	HM113529	–	–	–	Kumari et al. (2012)
Cr. inusitatus	CAL 1625	India	–	MG593195	–	–	–	Bijeesh et al. (2018)
Cr. involutus	**GDGM78644**	**China**	**–**	**PX647542**	**PX704827**	**PX712333**	**PX647915**	**Present study**
Cr. involutus	**GDGM78893**	**China**	**PX648006**	**PX647541**	**PX704828**	**PX712334**	**PX647916**	**Present study**
Cr. involutus	**GDGM78913**	**China**	**PX648007**	**PX647540**	**–**	**PX712335**	**PX647917**	**Present study**
Cr. involutus	**GDGM78922**	**China**	**PX648008**	**PX647539**	**PX704829**	**PX712336**	**PX647918**	**Present study**
Cr. involutus	**GDGM93237**	**China**	**–**	**PX647538**	**PX704830**	**PX712337**	**PX647919**	**Present study**
Cr. involutus	**GDGM93720**	**China**	**–**	**PX647537**	**PX704831**	**PX712338**	**PX647920**	**Present study**
Cr. involutus	Zeng8178 *	China	–	PQ604686	–	–	–	Jiang et al. (2025)
Cr. involutus	Zeng8119	China	–	PQ604685	–	–	–	Jiang et al. (2025)
Cr. longitipes	Zeng8131 *	China	PQ611010	PQ604683	–	–	–	Jiang et al. (2025)
Cr. longitipes	Zeng8131-1	China	PQ611011	–	–	–	–	Jiang et al. (2025)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. longitipes	Zeng8131-2	China	PQ611012	PQ604684	–	–	–	Jiang et al. (2025)
Cr. cf. *lutescens*	BB 13.048	China	–	KM484696	–	–	–	Unpublished
Cr. lutescens	ANT067-QFB28662	Canada	MN992367	–	–	–	–	Unpublished
Cr. lutescens	**GDGM83242**	**China**	**PX648010**	**PX647535**	**PX704833**	**PX712301**	**PX647921**	**Present study**
Cr. lutescens	**GDGM83245**	**China**	**PX648011**	**PX647534**	**PX704834**	–	**PX647923**	**Present study**
Cr.*cf. *lutescens	**GDGM85143**	**China**	**PX648009**	**PX647536**	**PX704832**	**PX712303**	**PX647924**	**Present study**
Cr. lutescens	**GDGM93445**	**China**	**–**	**PX647533**	**PX704835**	**PX712302**	**PX647922**	**Present study**
Cr. lutescens	**GDGM95071**	**China**	**PX648012**	**PX647532**	**PX704836**	**PX712304**	–	**Present study**
Cr. lutescens	FHMU6547	China	OL439549	OL439679	–	–	–	Unpublished
Cr. lutescens	TM02 22	China	–	EU522746	–	–	–	Porter et al. 2008
Cr. lutescens	FHMU6548	China	–	OL439680	–	–	–	Unpublished
Cr. lutescens	SS575	China	–	JQ976982	–	–	–	Tibuhwa et al. (2012)
Cr. lutescens	FHMU6544	China	–	–	–	–	–	
Cr. lutescens	FHMU6545	China	–	MN592820	–	–	–	Unpublished
Cr. lutescens	ma023	Italy	MN595294	MN592820	–	–	–	Unpublished
Cr. lutescens	W.H. Zhang441-1	China	OL439550	OL439681	–	–	–	Unpublished
Cr. lutescens	W.H. Zhang441-2	China	OL439551	OL439682	–	–	–	Unpublished
Cr. lutescens	W.H. Zhang441-3	China	OL439552	OL439683	–	–	–	Unpublished
Cr. macrosporus	IFP 019456	China	MW980574	MW979531	–	–	–	Cao et al. (2021a)
Cr. melanoxeros	420526MF0891	China	–	MG712381	–	–	–	Unpublished
Cr. melanoxeros	SS576	Sweden	–	JQ976983	–	–	–	Tibuhwa et al. (2012)
Cr. minor	C78	Unknown	–	–	–	–	–	Unpublished
Cr. minor	**MHHNUM32505-1**	**China**	**PX648032**	**PX647511**	**PX704849**	**PX712287**	–	**Present study**
Cr. minor	**GDGM92979**	**China**	**–**	**PX647510**	**PX704850**	**PX712285**	**PX647942**	**Present study**
Cr. minor	**GDGM93000**	**China**	**–**	**PX647509**	**PX704851**	**PX712286**	**PX647943**	**Present study**
Cr. minor	**GDGM96888**	**China**	**–**	**PX647508**	**–**	**–**	**–**	**Present study**
Cr. minor	**GDGM97432**	**China**	**PX648031**	**PX647507**	**–**	**PX712284**	**PX647944**	**Present study**
Cr. minor	**MHHNU32505 ***	**China**	**OL439553**	**OL439684**	**–**	**–**	**PX647941**	**Unpublished**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
			PX648030	**PX647506**				
Cr. murinus	**GDGM70969 ***	**Vietnam**	**PX648033**	**–**	**–**	**–**	**PX647945**	**Present study**
Cr. odoratus	14026h1	USA	–	MN227278	–	–	–	Unpublished
Cr. odoratus	14026h2	USA	–	MN227279	–	–	–	Unpublished
Cr. odoratus	RAS331	USA	OR471220	–	–	–	OR470843	Unpublished
Cr. parvofuscus	**GDGM92785**	**China**	**–**	**PX647489**				**Present study**
Cr. parvofuscus	**GDGM97394 ***	**China**	**–**	**PX647503**	**PX704852**	**PX712325**	**PX647947**	**Present study**
Cr. parvofuscus	**GDGM77895**	**China**	**PX648034**	**PX647505**	**–**	**–**	**–**	**Present study**
Cr. parvofuscus	**GDGM92335**	**China**	**–**	**PX647504**	**–**	**–**	**PX647946**	**Present study**
Cr. parvogriseus	CAL_1533	India	MF421099	MF421098	–	–	–	Das et al. (2017)
Cr. parvogriseus	**GDGM94575**	**China**	**–**	**PX647500**	**PX704855**	**PX726025**	**PX647950**	**Present study**
Cr. parvogriseus	HKAS122486	China	ON794320	–	–	–	–	Wang et al. (2022)
Cr. parvogriseus	KNPS_WC18158	South Korea	–	MT974136	–	–	–	Unpublished
Cr.* cf. *parvogriseus	**GDGM77880**	**China**	**PX648035**	**PX647502**	**PX704853**	**PX726023**	**PX647948**	**Present study**
Cr.* cf. *parvogriseus	**GDGM84174**	**China**	**PX648036**	**PX647501**	**PX704854**	**PX726024**	**PX647949**	**Present study**
Cr. parvopullus	**GDGM90715**	**China**	**PX648037**	**PX647499**	**PX704856**	–	**PX647953**	**Present study**
Cr. parvopullus	**GDGM97180**	**China**	**PX648038**	**PX647498**	**PX704857**	**PX712326**	**PX647954**	**Present study**
Cr. parvopullus	FHMU6557	China	OM334827	OL439687	–	–	–	Unpublished
Cr. parvopullus	FHMU6556	China	OM334828	OL439686	–	–	–	Unpublished
Cr. parvopullus	FHMU6555 *	China	OM334829	OL439685	–	–	–	Unpublished
Cr. parvopullus	FHMU7719	China	–	PQ604689	–	–	–	Jiang et al. (2025)
Cr. parvopullus	FHMU7718	China	–	PQ604688	–	–	–	Jiang et al. (2025)
Cr. parvopullus	FHMU7717	China	–	PQ604687	–	–	–	Jiang et al. (2025)
Cr. pleurotoides	MCA3124	Guyana	JQ915097	JQ915123	–	–	–	Wilson et al. (2012)
Cr. pleurotoides	TH8877	Guyana	KT339208	–	–	–	–	Unpublished
Cr. pleurotoides	TH9220	Guyana	JQ915110	JQ915136	–	–	–	Wilson et al. (2012)
Cr. shoreae	CAL_F-1396	India	–	KY290585	–	–	–	Unpublished
Cr. sinensis	**GDGM96693 ***	**China**	**PX648039**	**PX647497**	**–**	**PX726026**	**PX647951**	**Present study**
Cr. sinensis	**GDGM96806**	**China**	**PX648040**	**PX647496**	–	**PX726027**	**PX647952**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. sinocornucopioides	**HMAS247101**	**China**	**PX648041**	**PX647495**	**–**	**PX712340**	**PX647955**	**Present study**
Cr. sinocornucopioides	**HMAS254856 ***	**China**	**PX648042**	**PX647494**	**PX704858**	**PX712341**	**PX647957**	**Present study**
Cr. sinocornucopioides	**HMAS254991**	**China**	**PX648043**	**PX647493**	**PX704859**	**PX712342**	**PX647958**	**Present study**
Cr. sinocornucopioides	**HMAS280813**	**China**	**PX648045**	**PX647492**	**–**	**PX712343**	**–**	**Present study**
Cr. sinocornucopioides	**HMAS281036**	**China**	**PX648046**	**PX647491**	**PX704860**	**PX712344**	**–**	**Present study**
Cr. sinocornucopioides	**HMAS279300**	**China**	**PX648044**	**–**	**–**	**–**	**–**	**Present study**
Cr. sinocornucopioides	**GDGM83074**	**China**	**–**	**PX647490**	**PX704861**	**PX712339**	**PX647956**	**Present study**
Cr. sinuosus	U87992 1	USA	–	CSU87992	–	–	–	Feibelman et al. (1997)
Cr. sinuosus	14581	Slovakia	–	MN227285	–	–	–	Unpublished
Cr. sinuosus	TFB12700	Sweden	GU590932	–	–	–	–	Matheny et al. (2010)
Cr. sordidus	**GDGM50482**	**China**	**–**	**PX647488**	**PX704862**	**–**	**PX647959**	**Present study**
Cr. sordidus	**GDGM50496**	**China**	**–**	**PX647487**		**PX712298**		**Present study**
Cr. sordidus	**GDGM51546**	**China**	**PX648047**	**PX647486**	**PX704863**	**–**	**PX647960**	**Present study**
Cr. sordidus	**GDGM53447**	**China**	**PX648048**	**PX647485**	**PX704864**	**PX712300**	**PX647961**	**Present study**
Cr. sordidus	**GDGM53511**	**China**	**–**	**PX647484**	**PX704865**	**PX712299**	**PX647962**	**Present study**
Cr. sordidus	**GDGM53517**	**China**	**–**	**PX647482**	**–**	**–**	**–**	**Present study**
Cr. sordidus	**GDGM93446**	**China**	**PX647982**	**–**	**–**	**–**	**–**	**Present study**
Cr. sordidus	**GDGM43147**	**China**	**PX647980**	**–**	**–**	**–**	**–**	**Present study**
Cr. sordidus	**GDGM53516**	**China**	**–**	**PX647483**	**–**	**–**	**–**	**Present study**
Cr. sordidus	**GDGM81386**	**China**	**PX648049**	**PX647481**	**PX704866**	**PX712294**	**PX647964**	**Present study**
Cr. sordidus	**GDGM84177**	**China**	**PX648050**	**PX647480**	**PX704867**	**PX712297**	**PX647965**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. sordidus	**GDGM85141**	**China**	**PX648051**	**PX647479**	**PX704868**	**PX712295**	**PX647966**	**Present study**
Cr. sordidus	**GDGM93721**	**China**	**–**	**–**	**PX704869**	**PX712296**	**PX647967**	**Present study**
Craterellus sp.	**GDGM93014**	**China**	**–**	**PX647478**	**PX704873**	**PX726030**	**PX647968**	**Present study**
Craterellus sp.	**GDGM88559**	**China**	**–**	**PX647556**	**–**	**PX726028**	**PX647901**	**Present study**
Craterellus sp.	**GDGM93633**	**China**	**–**	**PX647570**	**PX704875**	**PX712283**	**PX647886**	**Present study**
Craterellus sp.	**GDGM93773**	**China**	**–**	**PX647568**	**PX704876**	**PX712282**	**PX647888**	**Present study**
Craterellus sp.	**GDGM93739**	**China**	**–**	**PX647477**	**–**	**PX726021**	**PX647969**	**Present study**
Craterellus sp.	**GDGM93740**	**China**	**–**	**PX647476**	**–**	**PX726031**	**PX647970**	**Present study**
Craterellus sp.	16450	India	MF589901	–	–	–	–	Unpublished
Craterellus sp.	AMV1879	Colombia	KT724108	KT724161	–	–	–	Unpublished
Craterellus sp.	AMV1939	Colombia	–	KT724160	–	–	–	Unpublished
Craterellus sp.	AWW263	Guyana	JQ915091	JQ915117	–	–	–	Wilson et al. (2012)
Craterellus sp.	Ba41	Indonesia	LC483929	–	–	–	–	Unpublished
Craterellus sp.	Ba42	Indonesia	LC483930	–	–	–	–	Unpublished
Craterellus sp.	Ba43	Indonesia	LC483931	–	–	–	–	Unpublished
Craterellus sp.	BB 09.079	China	–	KM484695	–	–	–	Unpublished
Craterellus sp.	DOB 2489	Malaysia	–	KY090820	–	–	–	Unpublished
Craterellus sp.	G1340	Guyana	KJ786670	KJ786565	–	–	–	Unpublished
Craterellus sp.	G2070	Guyana	KJ786682	KJ786577	–	–	–	Unpublished
Craterellus sp.	G3112	Guyana	–	KJ786587	–	–	–	Unpublished
Craterellus sp.	G3154	Guyana	KJ786692	KJ786597	–	–	–	Unpublished
Craterellus sp.	G3211	Guyana	KJ786699	KJ786611	–	–	–	Unpublished
Craterellus sp.	G3228	Guyana	–	KJ786613	–	–	–	Unpublished
Craterellus sp.	G3237	Guyana	KJ786704	KJ786614	–	–	–	Unpublished
Craterellus sp.	G4818	French Guiana	ON838464	–	–	–	–	Jaouen et al. (2019)
Craterellus sp.	G5024	French Guiana	ON838466	–	–	–	–	Jaouen et al. (2019)
Craterellus sp.	G5049	French Guiana	ON838467	–	–	–	–	Jaouen et al. (2019)
Craterellus sp.	HKAS122460	China	ON794304	–	–	–	–	Wang et al. (2022)
Craterellus sp.	HKAS122643	China	ON794412	–	–	–	–	Wang et al. (2022)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Craterellus sp.	HMJAU 61527-1	China	ON204601	–	ON203959	–	–	Unpublished
Craterellus sp.	HMJAU 61527-2	China	ON204602	–	ON203958	–	–	Unpublished
Craterellus sp.	HMJAU 61528	China	ON204598	–	ON203955	–	–	Unpublished
Craterellus sp.	HMJAU 61529	China	ON204603	–	ON203948	–	–	Unpublished
Craterellus sp.	HMJAU 61530-1	China	ON204599	–	ON203956	–	–	Unpublished
Craterellus sp.	HMJAU 61530-2	China	ON204600	–	ON203957	–	–	Unpublished
Craterellus sp.	HMJAU 61532	China	ON204597	–	ON203953	–	–	Unpublished
Craterellus sp.	HMJAU 61533	China	–	–	ON203954	–	–	Unpublished
Craterellus sp.	LAM 0254	Malaysia	–	KY091020	–	–	–	Unpublished
Craterellus sp.	LAM 0257	Malaysia	–	KY091022	–	–	–	Unpublished
Craterellus sp.	MBP06012010	Australia	OR464450	OR460929	–	–	OR464320	Unpublished
Craterellus sp.	MCA3186	Guyana	JQ915098	JQ915124	–	–	–	Wilson et al. (2012)
Craterellus sp.	MEL:2382717	Australia	KP012898	–	–	–	–	Unpublished
Craterellus sp.	MEL:2383015	Australia	KP012867	–	–	–	–	Unpublished
Craterellus sp.	MES-3362 SV1	Chile	OR471225	OR471015	OR490247	OR473984	OR470848	Unpublished
Craterellus sp.	MES-3362 SV2	Chile	OR471226	OR471016	–	–	–	Unpublished
Craterellus sp.	MES-3362 SV3	Chile	OR471227	OR471017	–	–	–	Unpublished
Craterellus sp.	MES-3362 SV4	Chile	OR471228		–	–	–	Unpublished
Craterellus sp.	MMCR00083	Thailand	OK073900	OK067672	–	–	–	Unpublished
Craterellus sp.	MMCR00268	Thailand	OK073898	OK067673	–	–	–	Unpublished
Craterellus sp.	MMCR00308.1	Thailand	OK073901	OK067675	–	–	–	Unpublished
Craterellus sp.	NJJ15_53	USA	–	OR471010	–	–	OR470835	Unpublished
Craterellus sp.	PL230519	New Caledonia	–	MZ827874	–	–	–	Unpublished
Craterellus sp.	PL880619	New Caledonia	–	MZ827875	–	–	–	Unpublished
Craterellus sp.	TH8913	Guyana	–	JN168668	–	–	–	Smith et al. 2011
Craterellus sp.	TH8999	Guyana	JQ915104	JQ915130	–	–	–	Wilson et al. (2012)
Craterellus sp.	TH9075	Guyana	JQ915105	JQ915131	–	–	–	Wilson et al. (2012)
Craterellus sp.	TH9205	Guyana	JQ915109	JQ915135	–	–	–	Wilson et al. (2012)

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Craterellus sp.	TH9264	Guyana	JQ915112	JQ915138	–	–	–	Wilson et al. (2012)
Craterellus sp.	Zhang231	China	–	OM509451	–	–	–	Unpublished
Craterellus sp.	Zhang231-2	China	–	OM509450	–	–	–	Unpublished
Craterellus sp.	TH9885	Cameroon	MZ355614	–	–	–	–	Unpublished
Craterellus sp.	TH10368	Cameroon	MZ355610	–	–	–	–	Unpublished
Craterellus sp.	TH10434	Cameroon	MZ355612	–	–	–	–	Unpublished
Craterellus sp.	TH10664	Cameroon	MZ355613	–	–	–	–	Unpublished
Craterellus sp.	TH9940	Cameroon	MZ355611	–	–	–	–	Unpublished
Craterellus sp.	JKU199	Cameroon	MZ355620	–	–	–	–	Unpublished
Craterellus sp.	JKU261	Cameroon	MZ355621	–	–	–	–	Unpublished
Craterellus sp.	MCA7583	Cameroon	MZ355622	–	–	–	–	Unpublished
Craterellus sp.	BD707	Cameroon	MZ355616	–	–	–	–	Unpublished
Craterellus sp.	TH10438	Cameroon	MZ355615	–	–	–	–	Unpublished
Craterellus sp.	JKU203	Cameroon	MZ355618	–	–	–	–	Unpublished
Craterellus sp.	JKU252	Cameroon	MZ355619	–	–	–	–	Unpublished
Craterellus sp.	JKU220	Cameroon	MZ355617	–	–	–	–	Unpublished
***Craterellus* sp.**	**GDGM53453**	**China**	–	**PX647557**	**PX704870**	–	**PX647899**	**Present study**
***Craterellus* sp.**	**GDGM81311**	**China**	**PX647996**	–	**PX704871**	**PX726029**	**PX647900**	**Present study**
***Craterellus* sp.**	**GDGM95043**	**China**	**PX647984**	**PX647576**	**–**	**PX726018**	**PX647879**	**Present study**
***Craterellus* sp.**	**GDGM97478**	**China**	**PX648052**	**PX647475**	**PX704872**	**PX726032**	**–**	**Present study**
Cr. squamatus	IFP 019457	China	MW980571	MW979534	MW999434	MW999462	–	Cao et al. (2021a)
Cr. squamatus	IFP 019458	China	MW980570	MW979535	MW999435	MW999463	–	Cao et al. (2021a)
Cr. striatus	HMJAU60412-1	China	–	–	ON125913	–	–	Zhao et al. (2022)
Cr. striatus	HMJAU60412-2	China	–	–	ON125914	–	–	Zhao et al. (2022)
Cr. strigosus	AMV1460	Colombia	KT724109	KT724163	–	–	–	Unpublished
Cr. strigosus	MCA1750	Guyana	JQ915094	JQ915120	–	–	–	Wilson et al. (2012)
Cr. strigosus	TH9204	Guyana	JQ915108	JQ915134	–	–	–	Wilson et al. (2012)
Cr. subalpinus	**GDGM94566**	**China**	**–**	**–**	**–**	**PX712292**	**PX647913**	**Present study**
Cr. subalpinus	**GDGM78888**	**China**	**–**	**PX647474**	**PX704877**	**PX712291**	**PX647963**	**Present study**

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. subalpinus	**GDGM81821**	**China**	**PX648053**	**PX647473**	**PX704878**	**PX712289**	**PX647971**	**Present study**
Cr. subalpinus	**GDGM81825 ***	**China**	**PX648054**	**PX647472**	**PX704879**	**PX712288**	**PX647972**	**Present study**
			PX648055					
Cr. subalpinus	**GDGM83076**	**China**	**PX648056**	**PX647471**	**PX704880**	**PX712293**	**PX647973**	**Present study**
			PX648057					
Cr. subalpinus	**GDGM94586**	**China**	**PX648058**	**PX647470**	**PX704881**	**PX712290**	**PX647974**	**Present study**
Cr. sublutescens	**GDGM78931 ***	**China**	**–**	**PX647469**	**PX704874**	**PX726033**	**PX647975**	**Present study**
Cr. tengii	**GDGM94459 ***	**China**	**–**	**PX647468**	**PX704882**	**PX726034**	**PX647976**	**Present study**
Cr. tengii	**GDGM94461**	**China**	**–**	**PX647467**	**–**	**PX726035**	**PX647977**	**Present study**
Cr. tengii	**GDGM94462**	**China**	**–**	**PX647463**	**PX704883**	**PX726036**	**PX647979**	**Present study**
Cr. tropicus	**GDGM94563**	**China**	**PX647566**	**–**	**–**	**PX712281**	**PX647890**	**Present study**
Cr. tropicus	**GDGM79152 ***	**China**	**PX648059**	**PX647466**	**PX704884**	**PX712272**	**PX647978**	**Present study**
Cr. tropicus	**GDGM89869**	**China**	**PX648060**	**–**	**–**	**–**	**–**	**Present study**
Cr. tubaeformis	14398	Canada	–	MN227283	–	–	–	Unpublished
Cr. tubaeformis	14416	Canada	–	MN227284	–	–	–	Unpublished
Cr. tubaeformis	1D3	Japan	AB973729	–	–	–	–	Unpublished
Cr. tubaeformis	2A4	Japan	AB973799	AB973798	–	–	–	Unpublished
Cr. tubaeformis	AJF66 SV1	USA	OR464455	OR460938	–	OR473799	OR464325	Unpublished
Cr. tubaeformis	BB 07.293	Slovakia	–	KF294640	GQ914989	KF294717	–	Buyck et al. (2011, 2016)
Cr. tubaeformis	BR089347	Canada	HM468493	–	–	–	–	Unpublished
Cr. tubaeformis	BR089350	Canada	HM468492	–	–	–	–	Unpublished
Cr. tubaeformis	DAVFP26257	Canada	HM468491	–	–	–	–	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. tubaeformis	DAVFP26339	Canada	HM468489	–	–	–	–	Unpublished
Cr. tubaeformis	DAVFP26685	Canada	HM468490	–	–	–	–	Unpublished
Cr. tubaeformis	DM1094	Denmark	MT640258	–	–	–	–	Unpublished
Cr. tubaeformis	DSH93-209	USA	–	AF287851	–	–	AF393099	Hibbet et al. (2000), Binder & Hibbett (2002)
Cr. tubaeformis	F315	Czech Republic	–	OR602365	–	–	–	Unpublished
Cr. tubaeformis	F709	Czech Republic	–	OR602423	–	–	–	Unpublished
Cr. tubaeformis	GCB1905	Belgium	MT004784	–	–	–	–	Unpublished
Cr. tubaeformis	H:6003981	Unknown	GU373507	–	–	–	–	Unpublished
Cr. tubaeformis	UPSF-11797	USA	–	AF105311	–	–	–	Dahlman et al. (2000)
Cr. tubaeformis	UPSF-11795	USA	–	AF105308	–	–	–	Dahlman et al. (2000)
Cr. tubaeformis	UPSF-11796	USA	–	AF105310	–	–	–	Dahlman et al. (2000)
Cr. tubaeformis	HKAS111843	China	ON794237	–	–	–	–	Wang et al. 2022
Cr. tubaeformis	JLY2017-06	Canada	MH752448	–	–	–	–	Unpublished
Cr. tubaeformis	MTH3	Unknown	MN959777	–	–	–	–	Unpublished
Cr. tubaeformis	MV369	USA	AF385632	–	–	–	–	Unpublished
Cr. tubaeformis	MV374	Sweden	AF385633	–	–	–	–	Unpublished

Species name	Sample No.	Country	GenBank Accession No.					References
			ITS	nrLSU	*tef*1	*rpb*2	mtSSU	
Cr. tubaeformis	OSC 49915	USA	–	AF105309	–	–	DQ898683	Dahlman et al. (2000), Moncalvo 2006
Cr. tubaeformis	OSC49916	USA	HM468494	–	–	–	–	Unpublished
Cr. tubaeformis	OSC49917	USA	HM468495	–	–	–	–	Unpublished
Cr. tubaeformis	PF2002ektyp	Unknown	AY195573	–	–	–	–	Unpublished
Cr. tubaeformis	PF2002tallboll	Unknown	AY195572	–	–	–	–	Unpublished
Cr. tubaeformis	PRM 951334	Czech Republic	–	OR602280	–	–	–	Unpublished
Cr. tubaeformis	RAS387	USA	OR464356	OR460857	–	OR473796	OR464231	Unpublished
Cr. tubaeformis	RAS485 SV1	USA	OR464440	–	–	–	OR464301	Unpublished
Cr. tubaeformis	SS572	Sweden	–	JQ976980	–	–	–	Tibuhwa et al. (2012)
Cr. tubaeformis	TM 0268	Canada	–	DQ898741	–	DQ898749	–	Moncalvo et al. (2006)
Cr. tubaeformis	TRTC52235	Belgium	HM468497	–	–	–	–	Unpublished
Cr. tubaeformis	TRTC52516	Belgium	HM468496	–	–	–	–	Unpublished
Cr. tubaeformis	UBC F28404	Canada	KP454008	–	–	–	–	Unpublished
Cr. virifufuscus	**GDGM60559 ***	**China**	**PX648061**	**PX647465**	**–**	**–**	**–**	**Present study**
Cr. virifufuscus	**GDGM72957**	**China**	**PX648062**	**PX647464**	**–**	**PX726037**	**–**	**Present study**
Pterygellus polymorphus	CU2-2006	Thailand	AB445116	–	–	–	–	Unpublished

RESULTS

Phylogenetic analyses

For phylogenetic analyses, a total of 1231 sequences are newly generated in this study, comprising 307 ITS, 230 28S, 239 *tef1*, 190 *rpb2*, and 265 mtSSU sequences. Furthermore, sequences retrieved from public databases were combined with these for analyses. To accurately and clearly analyze the phylogenetic relationships within *Cantharellus* and *Craterellus*, phylogenetic frameworks were respectively reconstructed based on ITS, *tef1* and multi-gene sequences for the two genera.

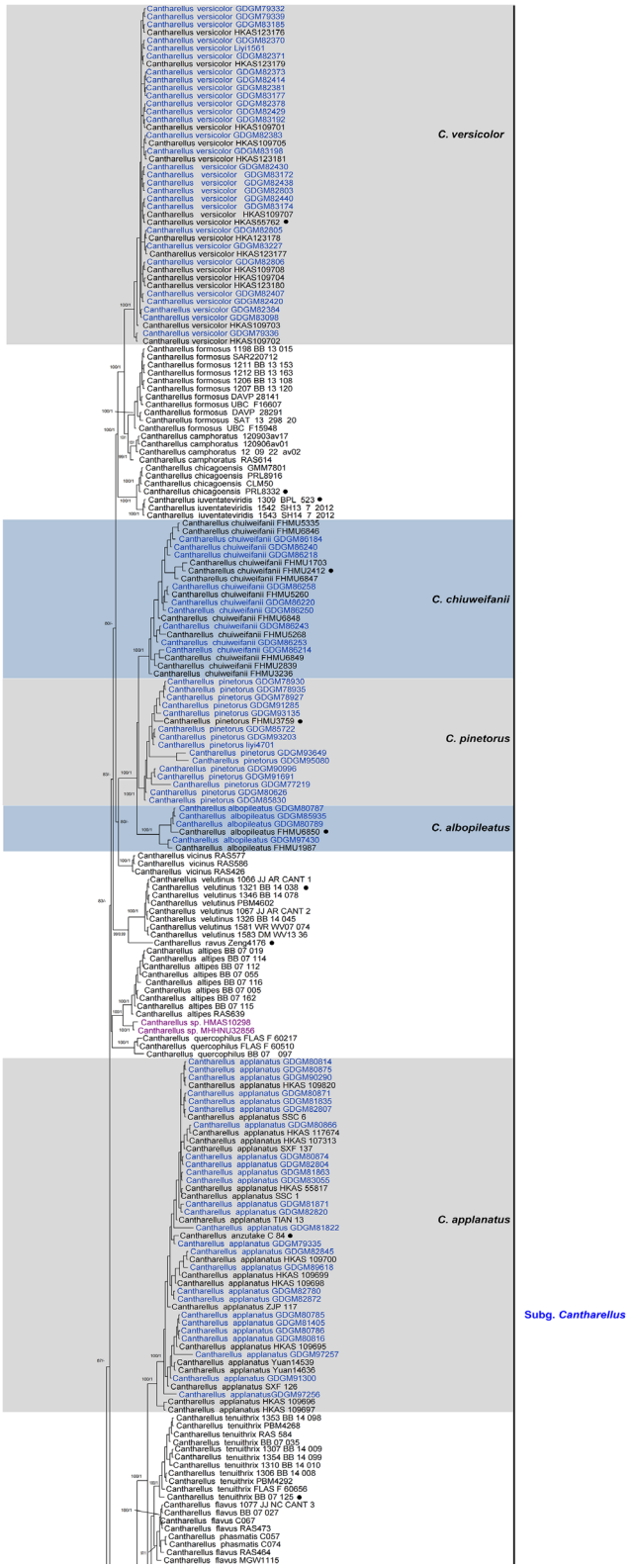


Figure 1- Continued

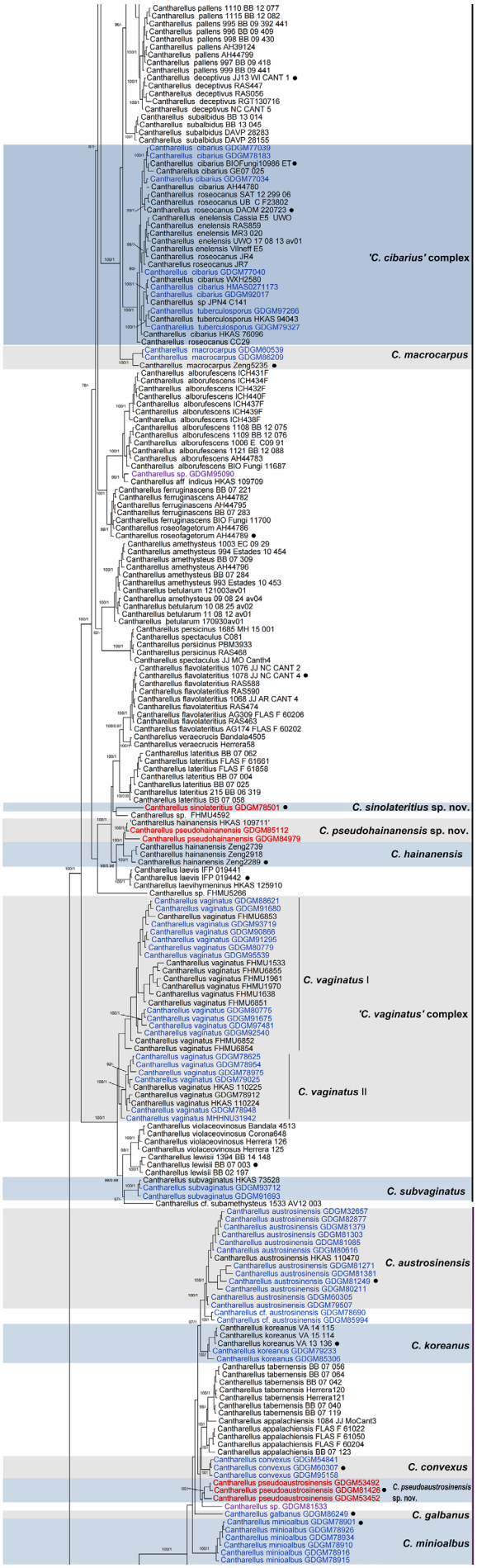


Figure 1- Continued

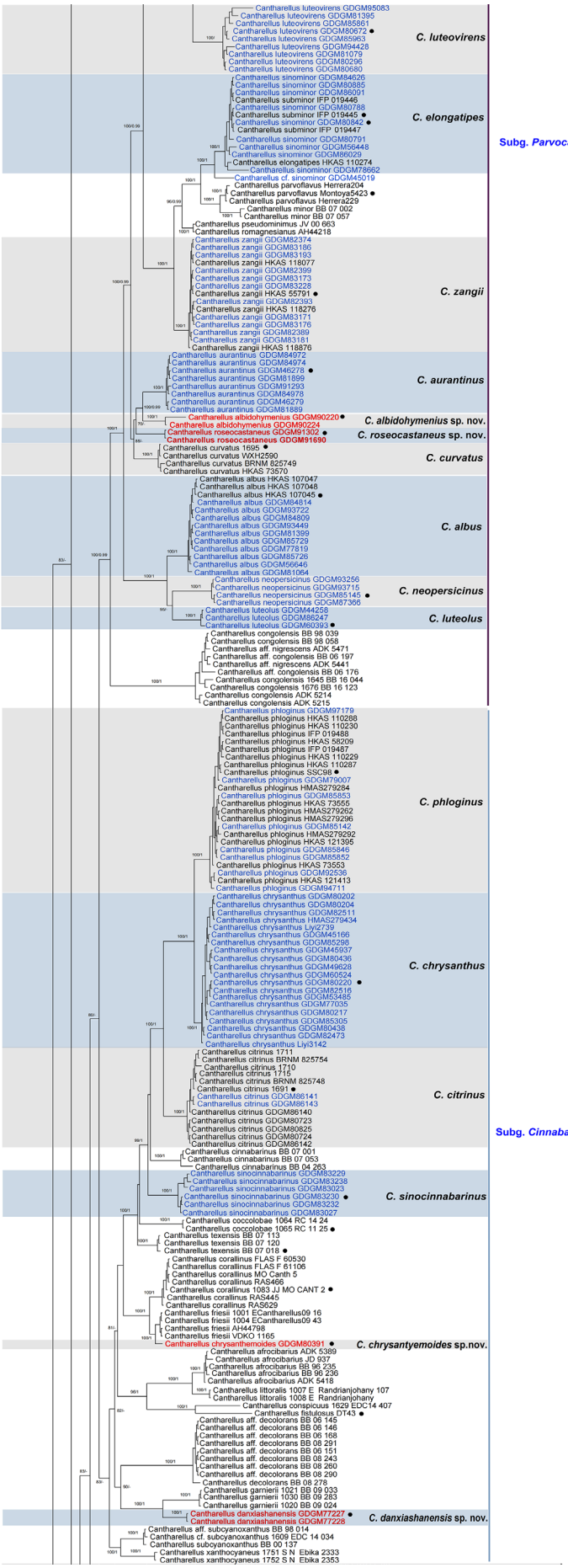


Figure 1- Continued

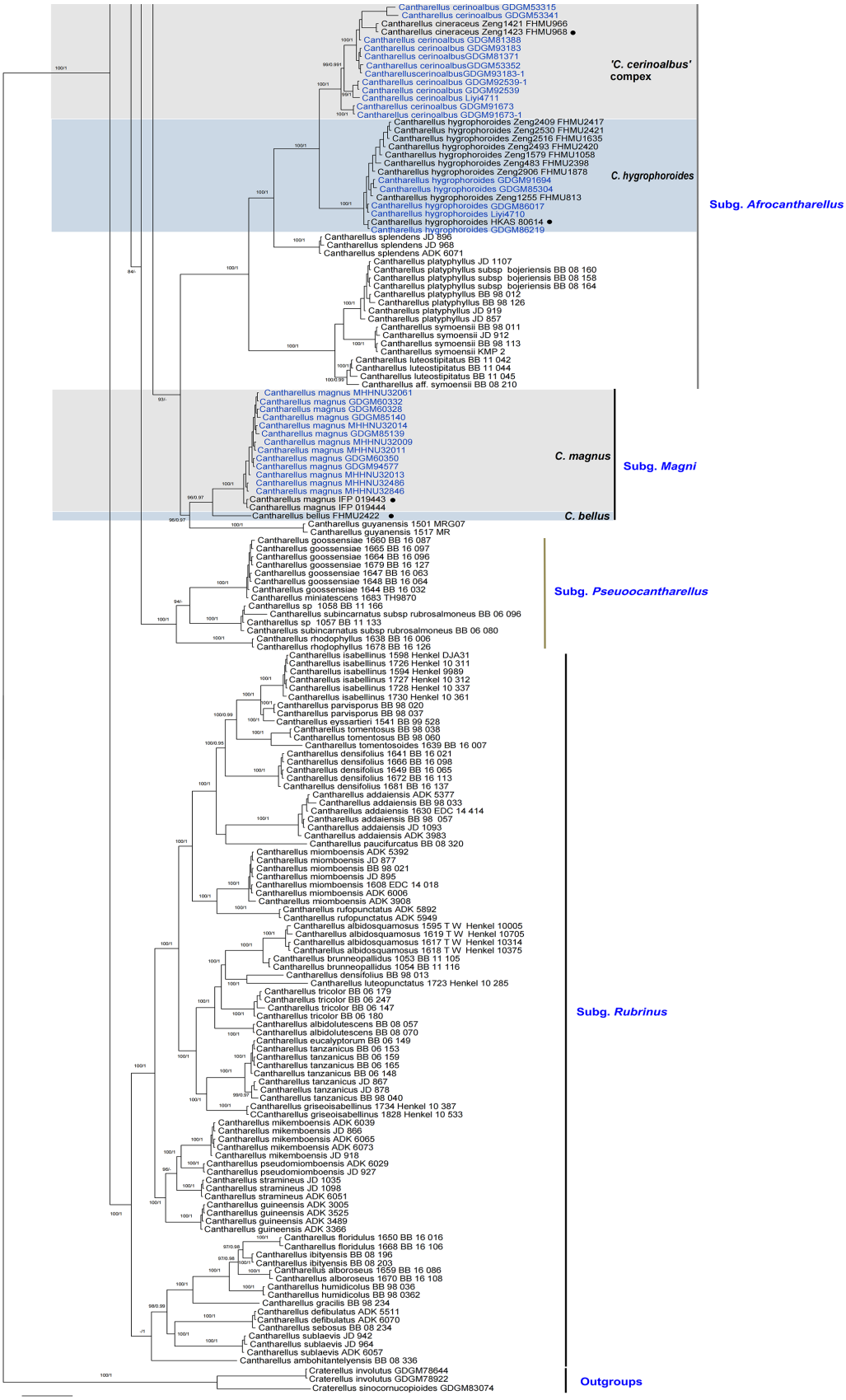


Figure 1 – Phylogram of *Cantharellus* species obtained from Bayesian analyses based on the *tef1* sequence dataset. New taxa are marked in red and bold. The known species with newly obtained collections in this study are marked in blue colour. The type specimens are marked with "●". Branches are labelled with maximum likelihood bootstrap ≥ 75 % and Bayesian posterior probabilities ≥ 0.95.

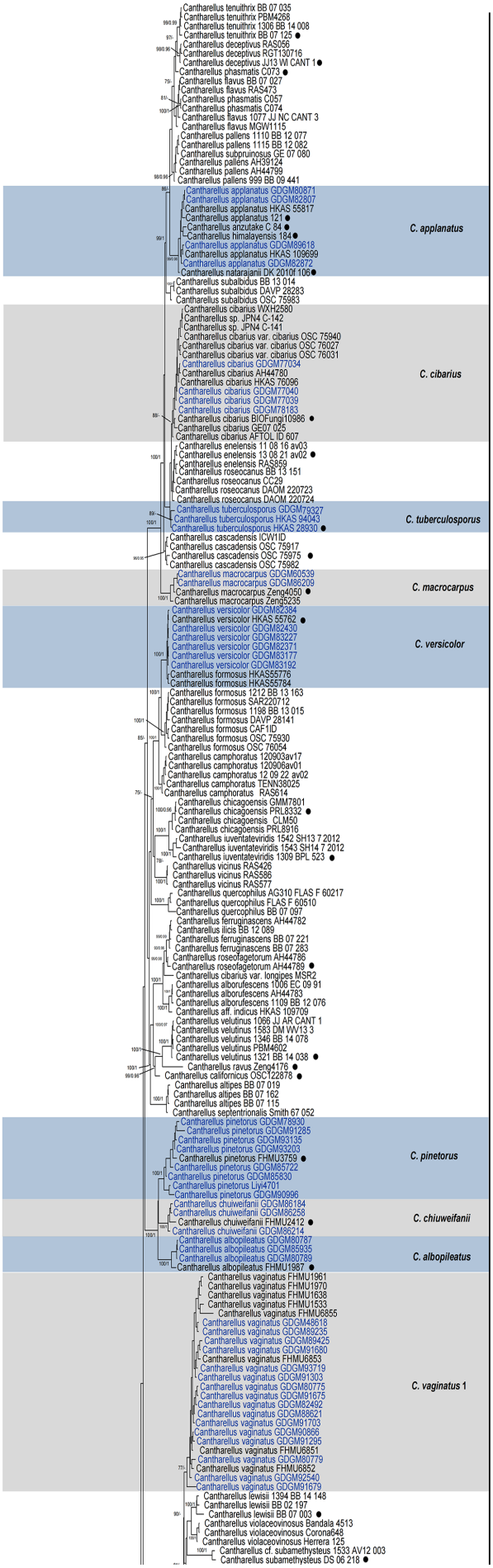


Figure 2 - Continued

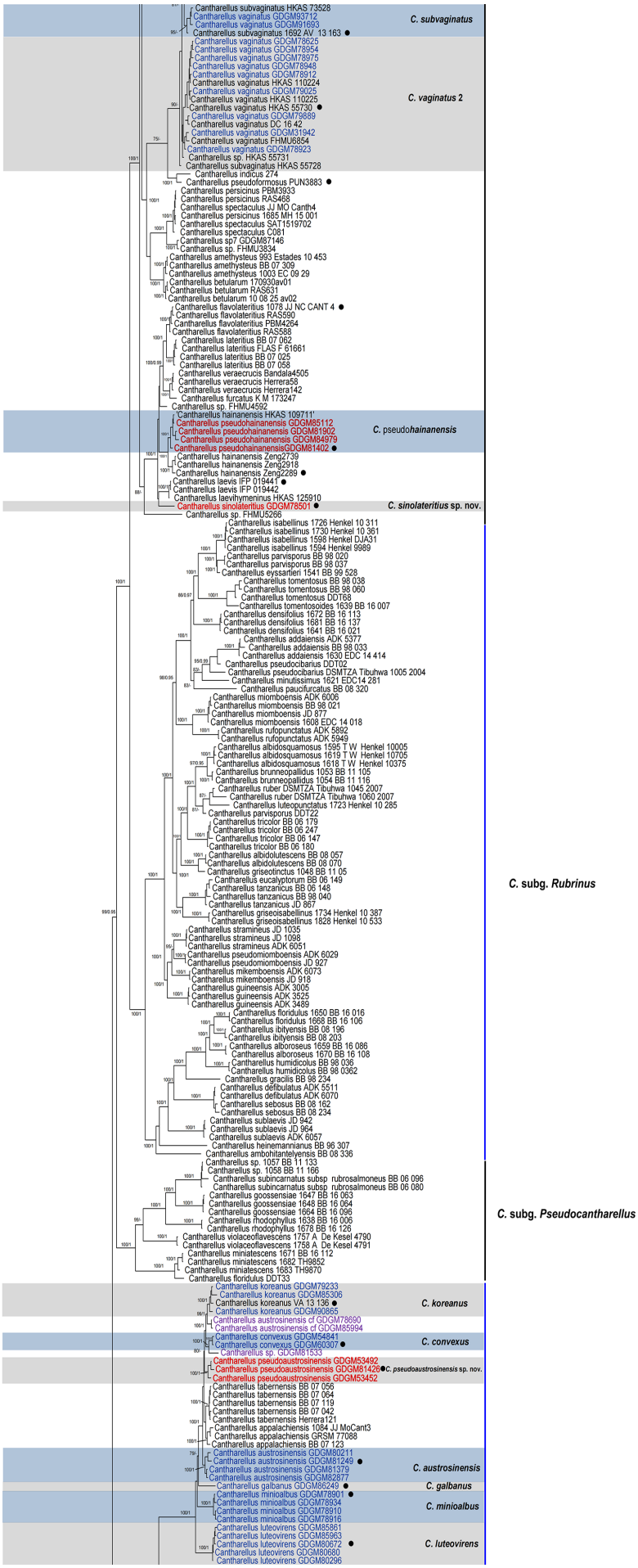


Figure 2 - Continued

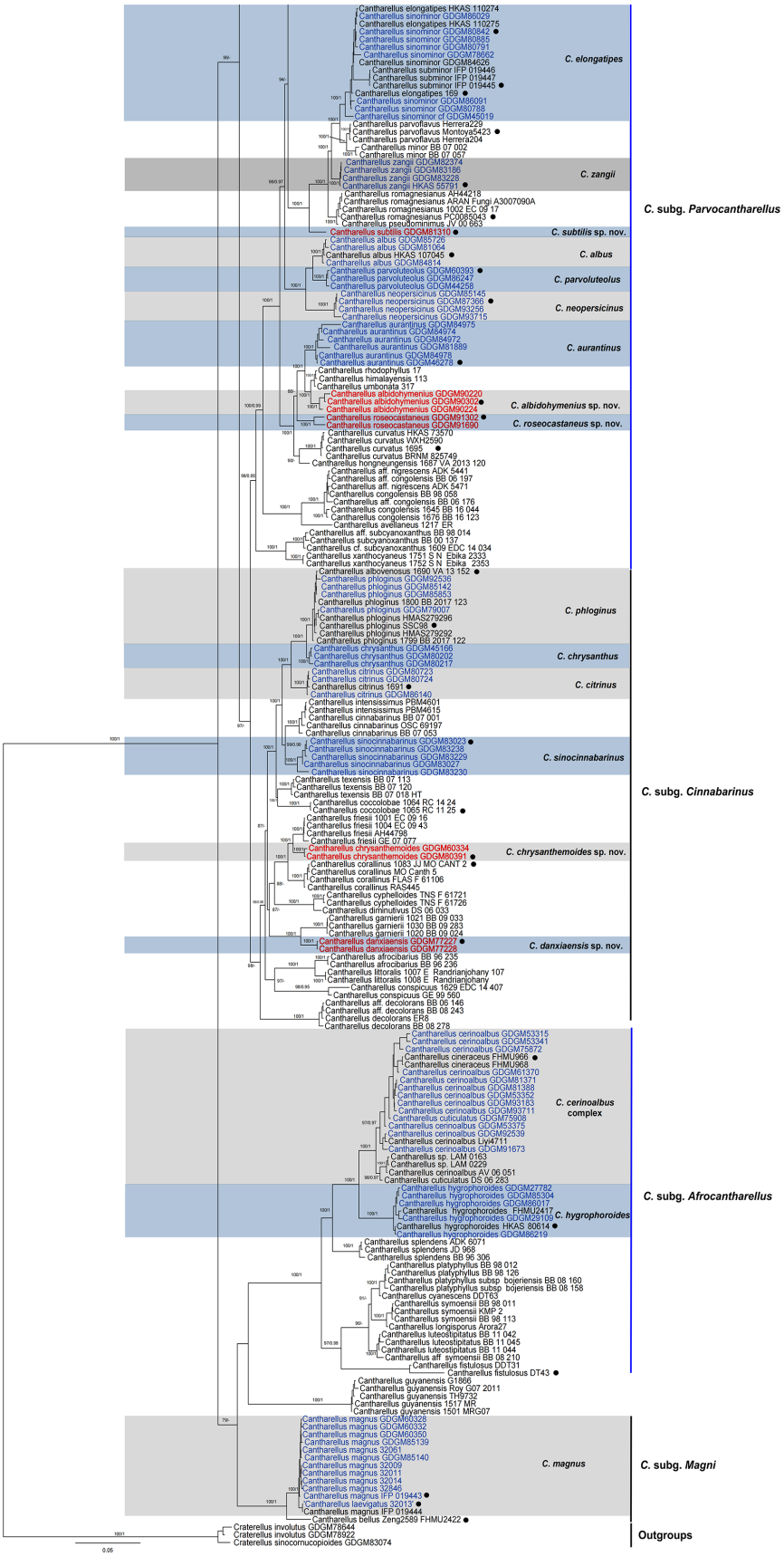


Figure 2 – Phylogram of *Cantharellus* species obtained from Bayesian analyses based on the combined dataset of LSU+*tef1*+*rpb2*+mtSSU. New taxa are marked in red and bold. The known species with newly obtained collections in this study are marked in blue colour. The type specimens are marked with "●". Branches are labelled with maximum likelihood bootstrap ≥ 75 % and Bayesian posterior probabilities ≥ 0.95.

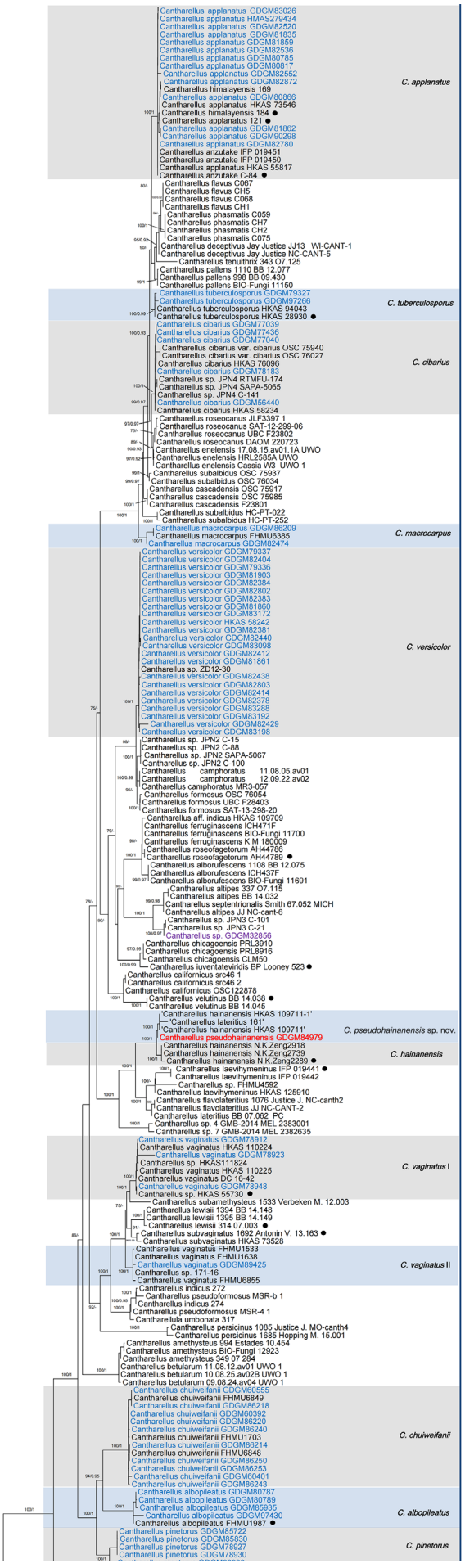


Figure 3- Continued

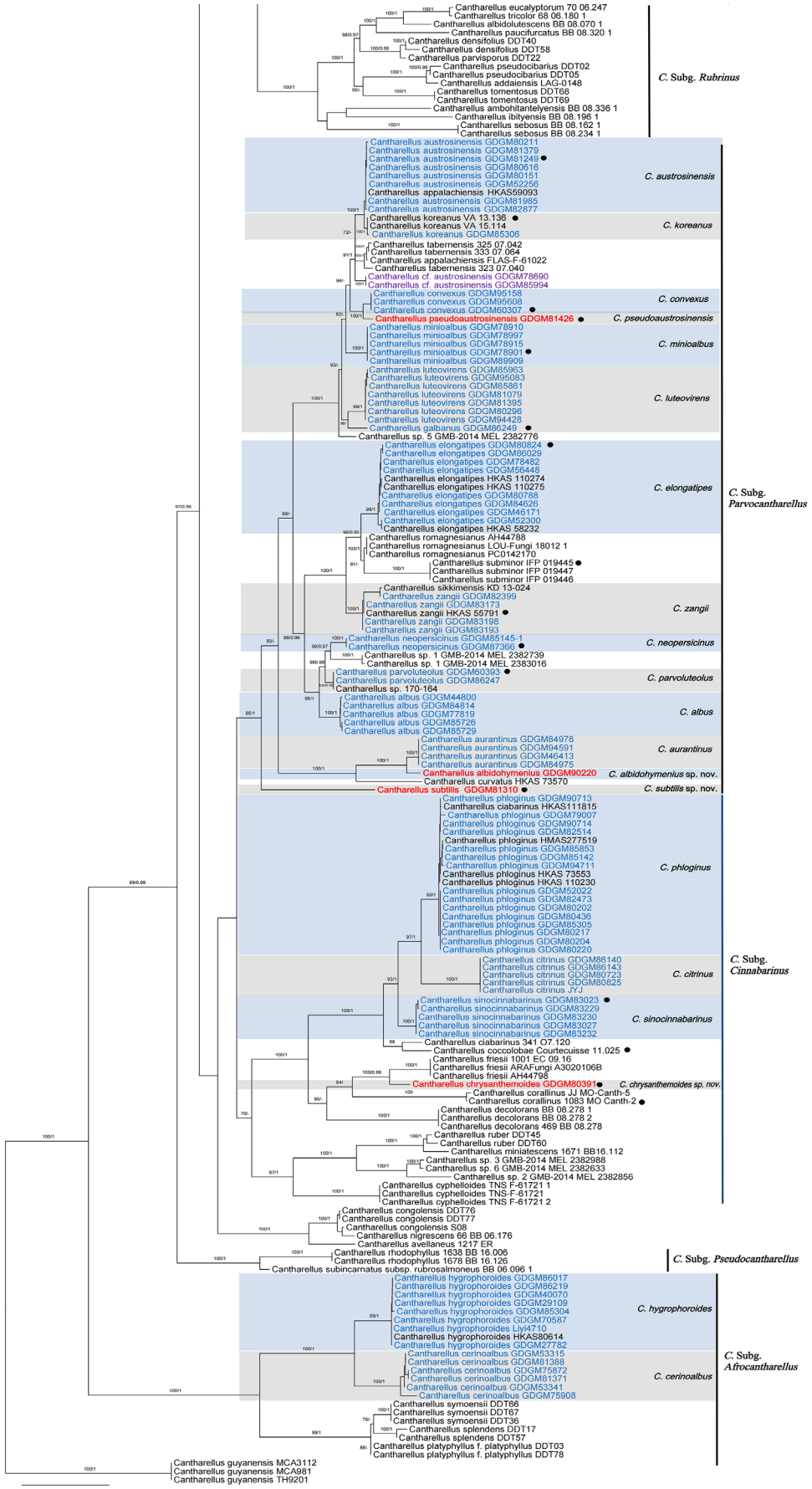


Figure 3 – Phylogram of *Cantharellus* species obtained from Bayesian analyses based on the ITS sequence dataset. New taxa are marked in red and bold. Branches are labelled with maximum Likelihood bootstrap ≥ 75 % and Bayesian posterior probabilities ≥ 0.95.

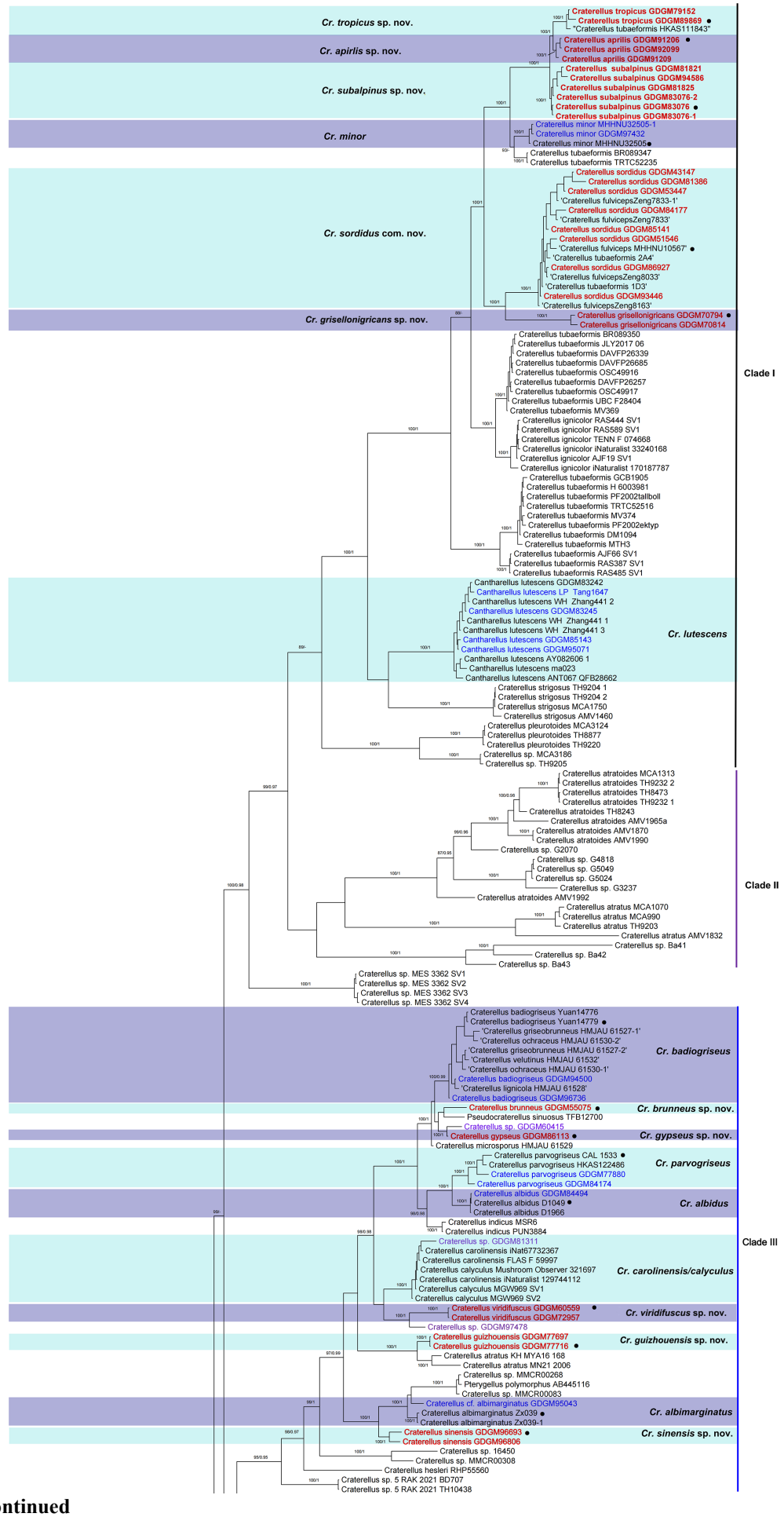


Figure 4 - Continued

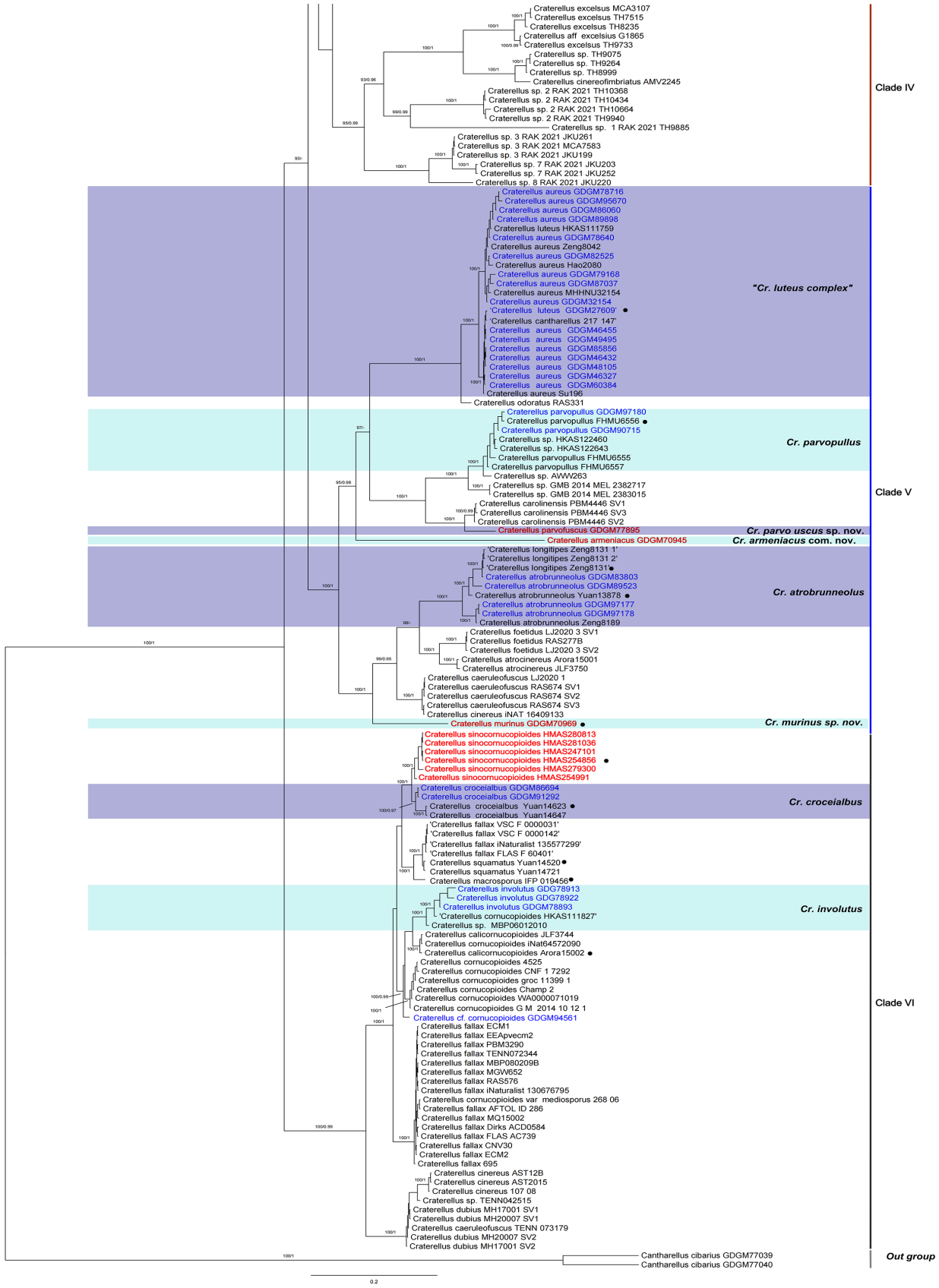


Figure 4 – Phylogram of *Craterellus* species obtained from Bayesian analyses based on the ITS sequence dataset. The new and newly combined taxa are marked in red and bold. The known species with newly obtained collections in this study are marked in blue colour. The type specimens are marked with "●". Branches are labelled with maximum likelihood bootstrap ≥ 75 % and Bayesian Posterior Probabilities ≥ 0.95.

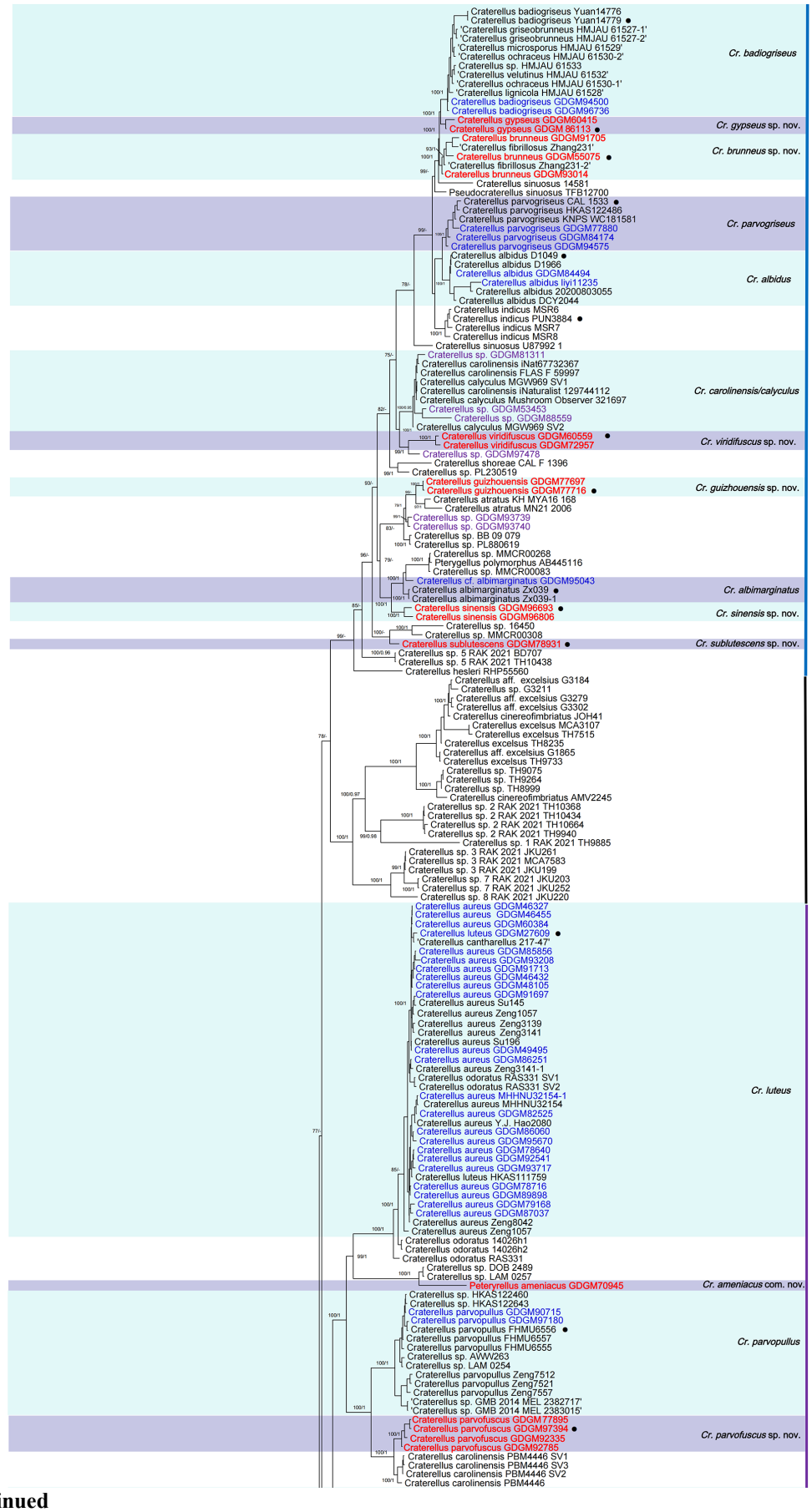


Figure 5 - Continued

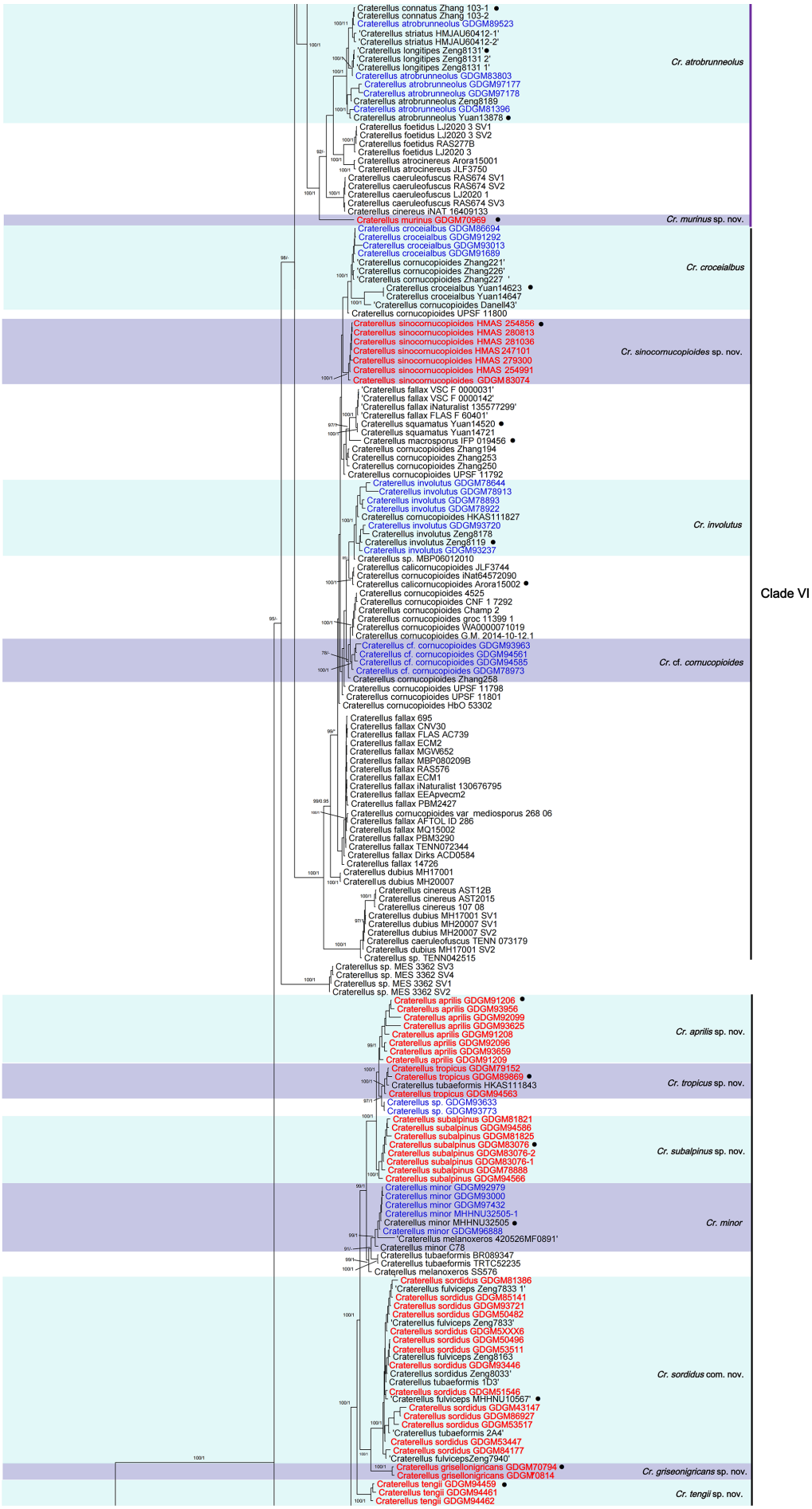


Figure 5 - Continued

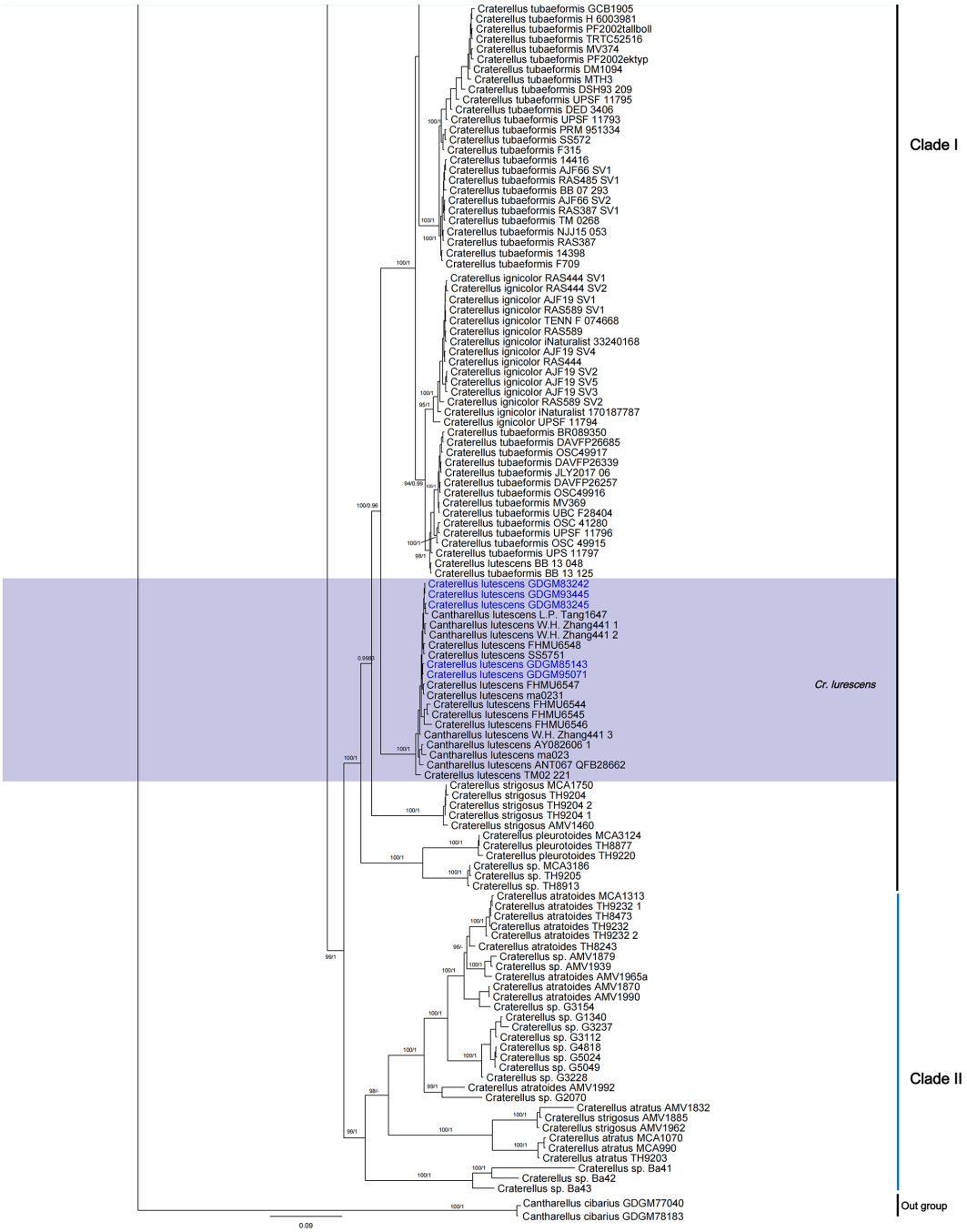


Figure 5 – Phylogram of *Craterellus* species obtained from Bayesian analyses based on the combined dataset of ITS+LSU+*tef1*+*rpb2*+mtSSU. New taxa are marked in red and bold. The known species with newly obtained collections in this study are marked in blue colour. The type specimens are marked with "●". Branches are labelled with maximum likelihood bootstrap ≥ 75 % and Bayesian posterior probabilities ≥ 0.95.

Due to the *tef1* sequence having been proven to be an effective fragment for distinguishing species within *Cantharellus* (Buyck & Hofstetter 2011), a phylogenetic analysis based on the *tef1* fragment was firstly conducted. The *tef1* matrix included 778 sequences, with *Cr. involutus* and *Cr. sinocornucopioides* serving as the outgroups. The length of alignment matrix was 887 nucleotide sites, including gaps. TIM2e+R4 and SYM+I+G were selected as the best models for ML and BI analyses, respectively. The tree topology obtained by Bayesian analyses is shown in Figure 1.

In the *tef1* tree (Fig. 1), *Cantharellus* was divided into seven main branches, which basically corresponded to those former studies (Buyck et al. 2014; Cao et al. 2021a). Forty distinct lineages were uncovered from Chinese samples, containing 8 new lineages, namely, *C. albidohymenius*, *C. chrysanthemoides, C. danxiashanensis*, *C. pseudoaustrosinensis*, *C. pseudohainanensis*, *C. roseocastaneus*, C. *sinolateritius* and *C. subtilis*, separately, which are shown in red bold in the tree.

Among those new lineages, *C. chrysanthemoides* and *C. danxiashanensis* nested into the *C.* subg. *Cinnabarinus*; *C. chrysanthemoides* shows close relationship to *C. friesii* and *C. corallinus*; while *C. danxiashanensis* was closely related to *C. garnierii. Cantharellus albidohymenius*, *C. roseocastaneus* and *C. pseudoaustrosinensis* were grouped under the *C.* subg. *Parvocantharellus*; *C. albidohymenius* and *C. roseocastaneus* formed two closely related lineages, and were close to *C. aurantinus* and *C. curvatus*; *C. pseudoaustrosinensis* formed a well supported monophyletic lineage, which was close to *C. appalachiensis*, *C. tabernensis*, *C. austrosinensis*, *C. koreanus* and *C. convexus. Cantharellus sinolateritius* and *C. pseudohainanensis* nested into the *C.* subg. *Cantharellus*, and were closely related to *C. hainanensis, C. lateritius*, *C. flavolateritius* and *C. laevihymeninus*.

Additionally, three unnamed lineages were discovered in the tree and labelled in purple colour. HMAS10298 and MHHNU32852 formed a well supported lineage in the *C.* subg. *Cantharellus*, which were closely related to *C. altipes*. GDGM95090 was clustered together with a sample named as *C.* aff. *indicus* HKAS109709. GDGM81533 nested into the *C.* subg. *Parvocantharellus*, and was close to the new lineage *C. pseudoaustrosinensis*.

Furthermore, *C. versicolor* was well supported as a monophyletic group, and closely related to *C. formosus* and *C. camphoratus*; and *C. chuiweifanii* was closely related to *C. pinetorus* and *C. albopileatus*. The sequence from the type specimen of *C. anzutake* well nested into the *C. applanatus* clade. Specimens of *C. cibarius, C. roseocanus, C. enelensis* and *C. tubercluosporus* clustered together and formed a well supported major clade, labelled as "*C. cibarius* complex" in the tree. Samples of *C. macrocarpus* were well supported as a distinct lineage. The smooth hymenophore species formed a distinct subclade in *C.* subg. *Cantharellus*; *C. laevihymeninus* is sister to *C. hainanensis* and *C. pseudohainanensis*. Specimens named as "*C. vaginatus*" formed a distinct major clade, namely "*C. vaginatus* complex", which is distinct from *C. subvaginatus*.

Besides, all those recognized species in the *C.* subg. *Parvocantharellus* and *C.* subg. *Cinnabarinus* in this study were well supported, and the two sequences from type specimens of *C. sinominor* and *C. subminor* nested into the *C. elongatipes* clade. In the *C.* subg. *Afrocantharellus*, specimens of *C. cineraceus* and *C. cerinoalbus* from China clustered together with significant support (ML/BPP = 100/1). Additionally, in the *C.* subg. *Magni*, samples labelled as *C. laevigatus* well nested into the *C. magnus* clade (ML/BPP = 100/1).

In the multi-gene datasets (nrLSU+*tef1*+*rpb*2+mtSSU) of *Cantharellus*, 559 samples were included, with two serving as outgroups. The combined data matrix has an aligned length of 3224 nucleotide sites, (1–1040 characters for LSU; 1041–1816 characters for *tef1*; 1817–2682 characters for *rpb*2; 2683–3224 characters for mtSSU). For the maximum likelihood analyses, TIM3e+R8, TIMe+R4, TIM3e+R4, and GTR+F+I+G4 were selected as the best models for LSU, *tef*1, *rpb*2 and mtSSU, respectively. For the BI analyses, SYM+I+G4, K2P+I+G4, SYM+I+G4 and GTR+F+I+G4 were selected as the best models for LSU, *tef*1, *rpb*2 and mtSSU, respectively, with the generation set as 40 million. The BI topology is shown in Figure 2. The tree topologies were similar to the above analysis of *tef*1 tree, seven main clades were supported, and 41 distinct lineages including seven new lineages were further supported. In the multi-gene tree, species in the "*C. cibarius* complex" were clearly separated from each other, but without support values. In the "*C. vaginatus* complex", specimens of *C. vaginatus* formed two distinct clades, labelled as *C. vaginatus* 1 and *C. vaginatus* 2, but without significant supports. Four samples labelled as *C. subvaginatus* form a distinct lineage, which were close to *C. lewisii*, *C. violaceovinosus* and *C. subamethysteus*. Specimens labelled as *C. cerinoalbus* and *C. cineraceus* from China clustered together with

C. cerinoalbus, *C. cuticulatus* and two unnamed samples (*C.* sp. LAM 0163 and *C.* sp. LAM 0229) with significant supports.

In the ITS datasets, 384 sequences were included, covering all the known species with ITS sequence. The alignment length was 2798 characters, including gaps. JC+R3+F and GTR+I+G were selected as the best models for ML and BI analyses, respectively. The BI topology is shown in Figure 3. From our studied collections, 30 distinct lineages were identified, including five new lineages, namely, *C. pseudoaustrosinensis*, *C. pseudohainanensis, C. albidohymenius*, *C. subtillis* and *C. chrysanthemoides*. In the ITS tree (Fig. 3), species in the "*C. cibarius* complex" were clearly separated from each other, and *C. tuberculosporus* was well supported as a monophyletic lineage. Specimens named as "*C. vaginatus*" formed two distinct well supported clades (*C. vaginatus* 1 and *C. vaginatus* 2).

In the phylogenetic analyses of *Craterellus*, *C. cibarius* was selected as the outgroup based on recent studies (Cao et al. 2021a). A total of 253 sequences were included in the ITS datasets matrix, with an aligned length of 1907 nucleotide sites, including gaps. TIM+R4+F and SYM+I+G4 were selected as the best models for ML and BI phylogenies. In the ITS tree (Fig. 4), sequences of *Craterellus* formed six main clades (named Clade I, Clade II, Clade III, Clade IV, Clade V and Clade VI). Specimens from the present study formed 25 well-supported lineages, marked with pale blue and light violet colour blocks (Fig. 4), including 11 new lineages (shown in red bold colour) discovered in this study. Samples labelled as *Pterygellus armeniacus* and *P. polymorphus* well nested into the *Craterellus* clade.

In Clade I, seven species lineages were discovered from China, including four new species *Cr. tropicus*, *Cr. aprilis*, *Cr. grisellonigricans* and *Cr. subalpinus*, a new combined species *Cr. sordidus* and two known species *Cr. lutescens* and *Cr. minor. Craterellus tropicus* closely related to *Cr. aprilis* and *Cr. subalpinus*, and forming a subclade in the tree, which is sister to *Cr. minor* and two sequences labelled as "*Cr. tubaeformis*". In the *Cr. sordidus* lineage, the type specimen of *Cr. fulviceps* and two samples named as *Cr. tubaeformis* from Japan were well included (BS/BPP=100/1). Samples named as "*Cr. tubaeformis*" formed four distinct clades, and represented a species complex. In the *Cr. lutescens* lineage, samples from Asia, North America and Europe clustered together and well supported (BS/BPP=100/1).

In Clade II, specimens were all from tropical Africa in the southern hemisphere, and no sequence from China or Asia nested into this clade.

Clade III, contained five new monophyletic lineages which were discovered in this study, named as *Cr. brunneus, Cr. gypseus, Cr. viridifuscus, Cr. guizhouensis* and *Cr. sinensis*. Several samples labelled as *Cr. griseobrunneus*, *Cr. ochraceus*, *Cr. velutinus*, *Cr. lignicola*, and *Cr. microsporus*, along with two new samples obtained in the present study, clustered together with samples of *Cr. badiogriseus*, formed a well supported major clade, and were close to *Cr. brunneus*, *Cr. gypseus* and *Cr. sinuosus*. Two samples GDGM77880 and GDGM84174 nested into *Cr. parvogriseus* lineage. An unnamed sample GDGM81311 nested into the *Cr. carolinensis*/*Cr. calyculus* lineage, and sister to the new species *Cr. viridifuscus* and an unnamed sample GDGM97478. *Craterellus guizhouensis* is closely related to *Cr. atratus*. *Cr. albimarginatus* was close to *Cr. polymorphus* and *Cr. sinensis*.

In Clade IV, all samples are from Africa and South America, *Cr. excelsius*, *Cr. cinereofimbriatus* and several unnamed samples were included, and no sample from China nested into this clade.

In Clade V, two new lineages named as *Cr. murinus* and *Cr. parvofuscus* were uncovered in the present study. *Cr. murinus* formed a distinct monophyletic clade and close to *Cr. atrobrunneolus*, *Cr. foetidus*, *Cr. atrocinereus* and *Cr. caeruleofuscus*; and *Cr. parvofuscus* is sister to *Cr. carolinensis.* Additionally, a sample named as *Cr. armeniacus* (= *Pterygellus armeniacus*) nested into Clade V, and formed a distinct monophyletic lineage, which was close to two unnamed samples (*Cr.* sp. DOB 2489 and *Cr.* sp. LAM 0257). Samples of *Cr. aureus* nested together and were closely related to *Cr. odoratus*. Three species *Cr. connatus*, *Cr. longitipes* and *Cr. striatus* clustered together with *Cr. atrobrunneolus* with significant supports (BS/BPP=100/1).

In Clade VI, one new lineage and four known species from China were uncovered, namely, *Cr. sinocornucopioides* sp. nov., *Cr. croceialbus*, *Cr. involutus*, *Cr. macrosporus* and *Cr. squamatus*. The new species *Cr. sinocornucopioides* formed a distinct monophyletic lineage in the phylogenetic tree and was close to *Cr. croceialbus.*

In the multi-locus dataset (ITS+nrLSU+*tef*1+*rpb*2+mtSSU) of *Craterellus*, 979 sequences from 467 fungal collections were included. The alignment length was 6134 characters (1–1917 characters for ITS, 1918–3452 characters for LSU, 3453–4518 characters for *tef*1, 4519–5597 characters for *rpb*2 and 5597–6134 characters for mtSSU) including 4207 distinct patterns, 2668 parsimony-informative, 679 singleton sites and 2787 constant sites. The best models for the concatenated dataset for the BI analysis were HKY+F+I+G4 for ITS, GTR+F+I+G4 for LSU, K2P+G4 for *tef*1, K2P+I+G4 for *rpb*2 and HKY+F+I+G4 for mtSSU. The BI topology is depicted in Figure 5. In the multi-gene tree, specimens from the present study formed 30 distinct lineages (Fig. 5, shown in colour blocks), including 13 new ones, which is similar to the ITS analysis result and two new lineages, named as *Cr. tengii* and *Cr. sublutescens*, which were not included in the ITS analysis. *Craterellus tengii* consisting of three samples, nested into clade I, and formed a distinct monophyletic group; while, *Cr. sublutescens* nested into clade III, and formed a unique lineage with significant bootstrap.

Taxonomy

A total of 619 samples were collected, including 610 specimens from China, five samples from Vietnam, and four samples from Finland. Based on the phylogenetic inference of ITS, nrLSU, *tef*1, *rpb*2 and mtSSU combined with morphological observations, 68 species were identified, of which 66 species are from China, including 44 known species, 20 novel species, 2 species firstly recorded in China, and one new combination species. In addition, two new species discovered from Vietnam are also described in the present study, and five new combination species names are proposed. Definitions of the genera *Cantharellus* and *Craterellus* are re-summarized separately below. Species in *Cantharellus* are treated alphabetically based on their respective subgenera, and species in *Craterellus* are treated alphabetically.

Cantharellus Adans. ex Fr., Syst. Mycol. (Lundae) 1: 316 (1821)

Type species: *Cantharellus cibarius* Fr., Syst. Mycol. (Lundae) 1:318. 1821.

Basidiomata solitary, scattered to gregarious, rarely caespitose, gymnocarpic, growing on soil. Pileus very variable in size (1–30 cm broad), glabrous to strongly squamulose, very variable in colour. Hymenophore varying from nearly smooth, veined or ridged to distinctly lamellate, with gills or pseudolamellae mostly distinctly forked in varying degrees, concolorous or not with the rest of the basidiomata. Stipe central to excentric, glabrous to strongly squamulose, solid, although in some smaller species often rapidly fistulose, not perforating from the pileus center as in *Craterellus*, concolorous or not with pileus and/or hymenophore. Context variable in thickness, usually fleshy to sometimes subceraceous, often fragile, often concolorous with pileus or paler, when exposed unchanged to characteristically discoloring, including yellowing, browning, bluing or blackening, entirely or only in certain parts. Odour mostly distinctly fruity (apricots-like). Taste slightly acrid to mild. Spore print white to yellow or salmon pink. Pileipellis poorly differentiated, a cutis or trichocutis, rarely a trichoderm, hyphal terminations thin- to thick-walled. Basidia stichic, very variable in length between species, mostly (2–)4–6(–8)-spored, exceptionally regularly 2- or 8-spored. Cystidia of a particular form not differentiated. Basidiospores ovoid, ellipsoid, reniform to short cylindrical, inamyloid, smooth, thin-walled. Clamp connections absent or present.

Phylogenetic analyses proved that *Cantharellus* is a monophyletic group in family Hydnaceae, and sister to *Craterellus*. Seven subgenera have been recognised, viz. *C.* subg. *Afrocantharellus* Buyck & V. Hofstetter, subg. *Cantharellus*, subg. *Cinnabarinus* Buyck & V. Hofstetter, subg. *Magni* T. Cao & H.S. Yuan, subg. *Parvocantharellus*, subg. *Pseudocantharellus* Buyck & V. Hofstetter, and subg. *Rubrinus* Buyck & V. Hofstetter.

Infrageneric classification system

Cantharellus* subg. *Afrocantharellus Buyck & V. Hofst., Docums Mycol. 31: 55 (2001)

Type species: *C. symoensii* Heinem., Bull. Jard. bot. État Brux. 36: 343 (1966)

Basidiomata medium to large in size. Hymenophore relatively well-developed. Flesh fragile, changing or unchanging in colour when exposed. Basidia mostly 4–6-spored, Pileipellis with poorly differentiated thin-walled hyphae. Clamp connections absent.

Notes – Members of this subgenus are mainly distributed in tropical and subtropical regions of Africa, Madagascar, Malaysia and China. In China, three species have been reported, *C. cerinoalbus*, *C. cineraceus* and *C. hygrophoroides*.

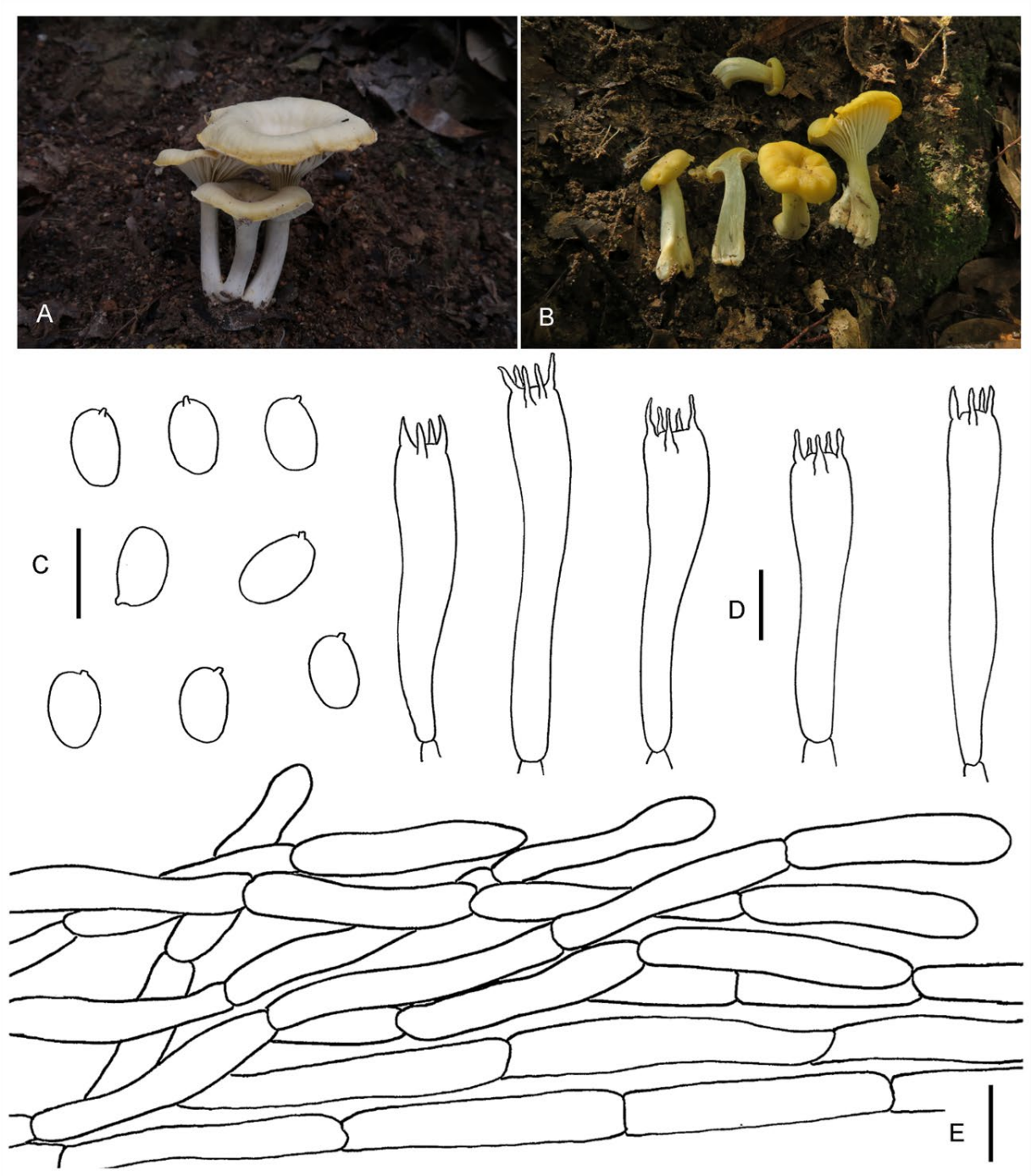


Figure 6 – Morphology of *Cantharellus cineraceus*. A, B. Basidiomata. C. Basidispores. D. Basidia. E. Pileipellis. Scale bars: C–E = 10 µm.

Cantharellus cineraceus N.K. Zeng, Y.Z. Zhang & Zhi Q. Liang, Frontiers Microbiol. 14(no. 1109831): 9 (2023)

Chinese name:灰肉鸡油菌 Fig. 6

Basidiomata small to medium in size. Pileus 30–80 mm broad, hemispherical to convex at first, then slightly applanate with a concave center at maturity; surface dry, ceraceous, fragile, glabrous or with faintly fibrillose, hygrophanous, yellow to light yellow (1A6–4A6), mixed with light green to yellowish green (28A7–30A7) tinge at first, then gradually fading to yellowish green to grayish green (29A6–30A6, 29B6–30B6) at mature, sometimes yellowish orange; margin incurved when young, usually wavy and slimsy lobed when mature. Context 2–3 mm thick at pileus center, sharply attenuate towards margin, greenish white, with pale orange tinge under pileipellis, unchanging when exposed. Hymenophore decurrent, gill-like, well-developed, sometimes wrinkly or very ill-defined veined at pileus margin, yellowish white, greenish white to pale green, unchanging in colour when injured. Stipe 3–5 × 0.5–15 cm, central, cylindrical to subcylindrical, solid; surface dry, ceraceous, fragile, glabrous or with faintly fibrils, yellowish white to greenish white, usually with yellowish orange tinge at upper part in some specimens. Odour of faint almond flavor, pleasant. Taste mild.

Basidiospores 8.5–9.6(10.5) × 5–5.9(6.3) μm, elliptical to elongate elliptical, smooth, thin-walled, hyaline in KOH. Basidia 48–74 × 9–11 μm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, 4–6-spored, sterigmata 3–5 μm long. Hymenophoral trama composed of cylindrical interwoven hyphae 4–6.5 μm in diam. Pileipellis composed of long, repent, branched, interwoven and thin-walled hyphae 4–6 μm wide, rarely inflated to 10 μm wide, colourless in KOH. Stipitipellis a cutis, composed of cylindrical hyphae measuring 4–6 μm in diam., not secondarily septate. Cystidia absent. Clamp connections absent.

Habitat and distribution – Solitary, scattered or gregarious under *Castanopsis eyrei* (Champ. ex Benth.) Tutch. and *Castanopsis* spp. mixed with other broadleaved trees in subtropical broadleaved forests. Known from Guangdong and Hunan Provinces, Southern China.

Specimens examined – China, Hunan Province, Chenzhou City, Rucheng Town, Jiulongjiang National Forest Park, alt. 330 m, 3 Sep 2016, M. Zhang (GDGM53315, GDGM53341, GDGM53352, GDGM53375); Same location, 11 Jun 2020, M. Zhang (GDGM81388, GDGM81371); Guangdong Province, Shaoguan City, Renhua County, Danxiashan National Nature Reserve, alt. 210 m, 27 Sep 2018, Y. He (GDGM75872); Huizhou, City, Xiangtoushan National Nature Reserve, alt. 590 m, 27 Sep 2017, T. Li (GDGM71370).

Notes – *Cantharellus cineraceus* is characterized by its *Hygrophorus*-like basidiomata, with a highly variable pileus colour, a well-developed hymenophore, greenish white context unchanging when bruised, and absence of clamp connections. These characteristics seamlessly integrate it within the *C*. subg. *Afrocantharellus*. Among the known species, *C. cerinoalbus* resembles *C. cineraceus* in the variable pileus colour and similar sizes of basidiospores, make them almost indistinguishable morphologically. However, *C. cerinoalbus* is distinguished by its association with trees of Dipterocarpaceae (Eyssartier et al. 2009), whereas *C. cineraceus* grows under Fagaceae forests. *Cantharellus platyphyllus* Heinem. also shares certain similarities with *C. cineraceus*, but it can be distinguished by its more brightly colored (orange-red) pileus and broader basidiospores measuring 6–7.5 μm in width (Eyssartier & Buyck 1998). Furthermore, *C. platyphyllus* is only known in tropical Africa and associated with trees of the families Caesalpinioideae, Caesalpinioideae and Euphorbiaceae.

Phylogenetic analyses have shown that samples labelled as *C. cineraceus* and *C. cerinoalbus* from China are well clustered with specimens of *C. cerinoalbus* and *C. cuticulatus* from Malaysia, forming a well-supported "*C. cerinoalbus* complex" clade (Fig. 2). Previously, samples of *C. cineraceus* from China were identified as the morphologically similar and molecularly related species *C. cerinoalbus* (Song et al. 2017). Recent phylogenetic analyses of the combined genes LSU+*tef*1 have confirmed that *C. cineraceus* is a separate species, distinct from *C. cerinoalbus* (Zhang et al. 2023). However, in the present multi-gene trees (Fig. 2), samples from China formed two subclades within the "*C. cerinoalbus* complex" clade, and closely related to *C. cerinoalbus* and

C. cuticulatus. Nevertheless, only LSU sequences for *C. cerinoalbus* and *C. cuticulatus* are available in the GenBank dataset, and a BLASTn search revealed only 98.78% identity with our samples. Therefore, they might represent several different species, and hence are treated as "*C. cerinoalbus* complex" in present study. More comprehensive genetic data, including ITS, *tef*1, and other sequences, are needed to accurately delineate their evolutionary positions and resolve the taxonomic ambiguity.

Cantharellus hygrophoroides S.C. Shao, Buyck & F.Q. Yu, Cryptog. Mycol. 35(3): 287 (2014)Fig. 7

Chinese name:蜡伞状鸡油菌

Basidiomata medium to large sized. Pileus 40–150 mm broad, dry, glabrous, light yellow, light orange, pastel red, reddish orange to vivid red (3A5–10A5,7A8–10A8). Hymenophore decurrent, with well-developed gill-like folds; folds up to 8 mm in height, non-forking to forking, anastomosing only near pileus margin, white, pale yellow to pale orange (3A3–5A3), sometimes with pale orange tint at fold or gill edge. Stipe 58–120 × 11–18 mm, usually concolorous with pileus, sometimes paler to white or orange white. Basidiospores (9.5)10–12(12.5) × (6)6.5–8(8.5) µm, ellipsoid to narrowly ellipsoid, thin-walled. Basidia 65–100 × 8–11 µm, narrowly clavate to subcylindrical, 2–6-spored. Pileipellis a loose tissue of intermixed, ascending, subcylindrical hyphae 3–8 µm wide, thin-walled. Clamp connections absent.

Habitat and distribution – Solitary or scattered under broad-leaved forests in subtropical to tropical regions of China. Known from southern and southwestern China.

Specimens examined – China, Guangdong Province, Huizhou City, Luofushan National Forest Part, alt. 450 m, 13 Jul 2021, M. Zhang (GDGM86017); Shaoguan City, Chebaling National Nature Reserve, alt. 700 m, 25 Jun 2010, Y.J. Li (GDGM26919); Same location, 25 Aug 2010, Y.J. Li (GDGM27782, GDGM28013); Hainan Province, Changjiang City, Bawangling National Nature Reserve, alt. 800 m, 8 Jul 2013, M. Zhang (GDGM29109, GDGM40070); Ledong County, Jianfengling National Nature Reserve, alt. 800 m, 17 Jun 2017, M. Zhang (GDGM70599); Same location, 19 Jun 2017, M. Zhang (GDGM70587); same location,13 Jul 2021, M. Zhang (GDGM86219); Zhejiang Province, Hangzhou City, Laohu Mountain, alt. 350 m, 14 Sep 2018, B.J. Ling (GDGM75329); same location, 15 Jul 2021, B.J. Ling (GDGM85304).

Notes – *Cantharellus hygrophoroides* is characterized by its large basidiomata, light yellow to vivid red pileus, well developed gill-like hymenophore, and absence of clamp connections (Shao et al. 2014, Jiang et al. 2025). Morphologically, *C. luteostipitatus*, *C. platyphyllus*, *C. splendens* and *C. symoensii* are similar to *C. hygrophoroides.* However, *C. luteostipitatus* differs by its smaller basidiomata (30–60 mm broad), reddish pink to yellowish orange pileus, shorter stipe and relatively narrower gills changing to yellowish when handled, pileus context changing to bluish when cut, and smaller basidiospores measuring 7.5–8.5 × 5.2–6.3 µm (Liu et al. 2015); *C. platyphyllus* can be easily distinguished by its smaller basidiospores (7.5–11 × 6–7.5 µm), shorter basidia 60–70 µm long (Eyssartier & Buyck 1998, Buyck 2012, Tibuhwa et al. 2012); *C. splendens* differs by its narrower basidiospores (8.1−12 × 3.7−4.7 µm), shorter basidia 60–70 µm long, and trichoderm pileipellis (Buyck 2012); *C. symoensii* differs in having smaller basidiomata, shorter basidia 50–70 µm long, smaller basidiospores measuring 8−10 × 4.5−5.5 µm (Buyck 2012, Tibuhwa et al. 2012). Additonally, the above four species are currently only known from tropical regions of Africa (Tibuhwa et al. 2012, Buyck et al. 2014), while *C. hygrophoroides* is only known from China.

Phylogenetic analyses revealed that samples of *C. hygrophoroides* formed a well-supported monophyletic clade (ML/BPP = 100%/1) in the *C.* subg. *Afrocantharellus* (Figs. 1, 2), and can be easily separated from other *Cantharellus* species with known sequences. The three Asian species, *C. cerinoalbus*, *C. cineraceus* and *C. cuticulatus* were closely related to *C. hygrophoroides* in the multi-gene trees (Fig. 2). However, *C. cerinoalbus* differs by its smaller basidiomata, pale olive green to straw yellow pileus, light cream to very pale orange stipe, smaller basidiospores measuring 7.5−9(10) × 5−5.75(6) µm, and shorter basidia 65−80 µm long (Eyssartier et al. 2009);
C. cineraceus differs by its smaller basidiomata, yellowish orange pileus, grayish white stipe, smaller basidiospores 8.5–9.6(10.5) × 5–5.9(6.3) µm (Zhang et al. 2023, present study);

C. cuticulatus differs by its smaller pileus (35–40 mm broad), pale yellow stipe, smaller basidiospore (7–9.5 × 5–6.5 µm) and shorter basidia 54–75 µm long (Eyssartier et al. 2009).

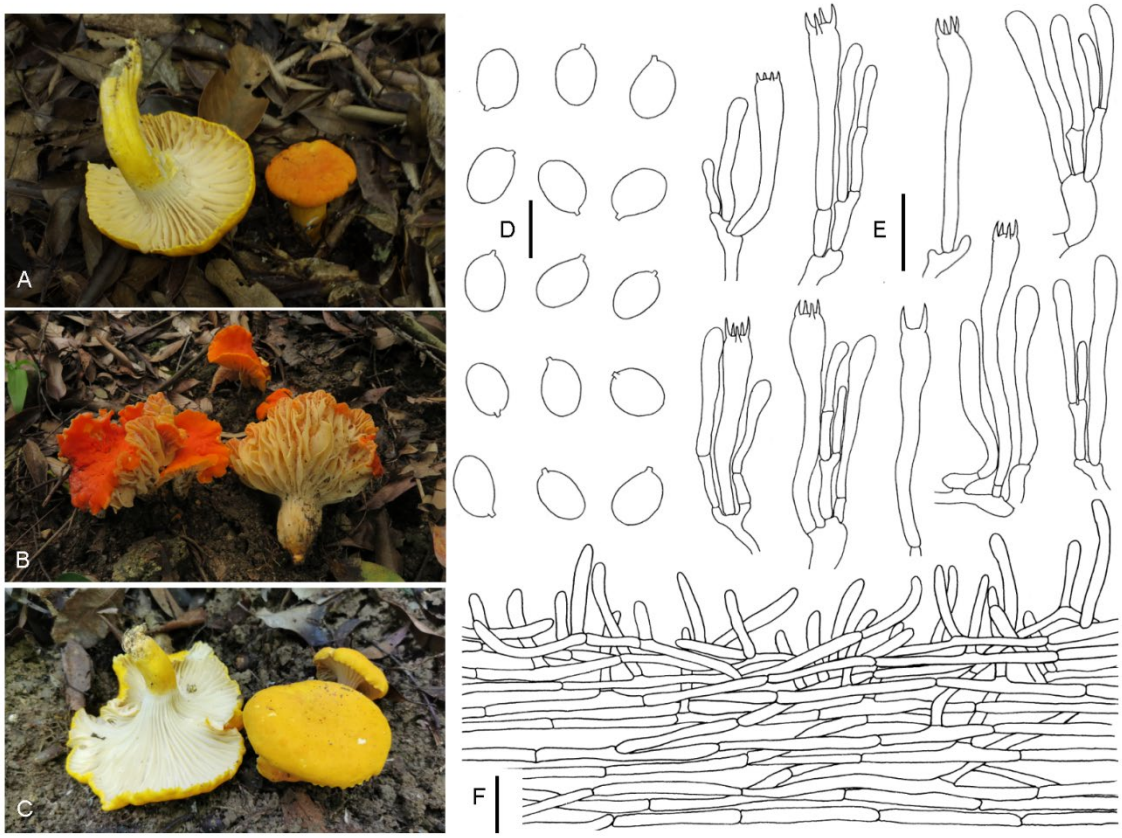


Figure 7 – Morphology of *Cantharellus hygrophoroides*. A–C. Basidiomata. D. Basidiospores. E. Basidia. F. Pileipellis. Scale bars: D = 10 µm; E, F = 20 µm.

Previously, *C. hygrophoroides* was only known from tropical regions of Hainan and Yunnan Provinces. The present study expands its distribution to subtropical regions of Guangdong, Hunan, Jiangsu, and Zhejiang Provinces.

It is worth noting that the pileus colour of *C. hygrophoroides* is very diverse, ranging from light yellow to vivid red in different ecological conditions, and the gills sometimes exhibit pale orange tinge at edge.

Cantharellus* subg. *Cantharellus Adans. ex Fr.

Type species: *C. cibarius* Fr., Syst. mycol. (Lundae) 1: 318 (1821)

Basidiomata relatively large in size, fleshy. Pileus mainly white or with orange tinge, glabrous, sometimes with appressed squamules. Hymenophore smooth or veined with blunt, mostly strongly forking-anastomosing ridges. Stipe central, solid. Pileipellis a cutis, with thin or thick walled hyphae. Clamp connections abundant.

Notes – Taxa of this subgenus are currently only known in Northern Hemisphere. In the present study, 15 species were found in China, containing 12 known species, i.e. *C. albopileatus*, *C. applanatus*, *C. chuiweifanii*, *C. cibarius*, *C. hainanensis*, *C. laevihymeninus*, *C. macrocarpus*, *C. pinetorus*, *C. ravus*, *C. vaginatus*, *C. versicolor*, *C. tuberculosporus*, one new record for China *C. subvaginatus,* and two new species *C. pseudohainanensis* and *C. sinolateritius*.

Cantharellus albopileatus N.K. Zeng, Y.Z. Zhang & W.F. Lin, Frontiers in Microbiology 13: 3 (2022) Fig. 8

Chinese name: 白盖鸡油菌

Pileus 30–60 mm broad, dry, white, yellowish white to yellowish, with brownish orange scales. Hymenophore with well-defined gill-like folds strongly forking and anastomosing at pileus margin, white or yellowish white to yellowish, unchanging or slightly changing to yellowish when bruised. Stipe 50–100 × 8–10 mm, solid, concolorous with pileus, glabrous to pubescent. Basidiospores 7–8 × 5–6 µm, $L_m \times W_m$ = 7.3(±0.4) × 5.46(±0.39) µm, Q = (1.16)1.25–1.4(1.5), Q_m = 1.34±0.08, broadly ellipsoid or oval, thin-walled. Basidia 57–90 × 7–10 µm, narrowly clavate to subcylindrical, 4–6-spored. Pileipellis a cutis, composed of repent to slightly interwoven, branched and thin- or slightly thick-walled hyphae (less than 1 µm thick). Clamp connections present.

Habitat and distribution – Solitary or scattered in subtropical mixed forest. Known from eastern and southwestern China.

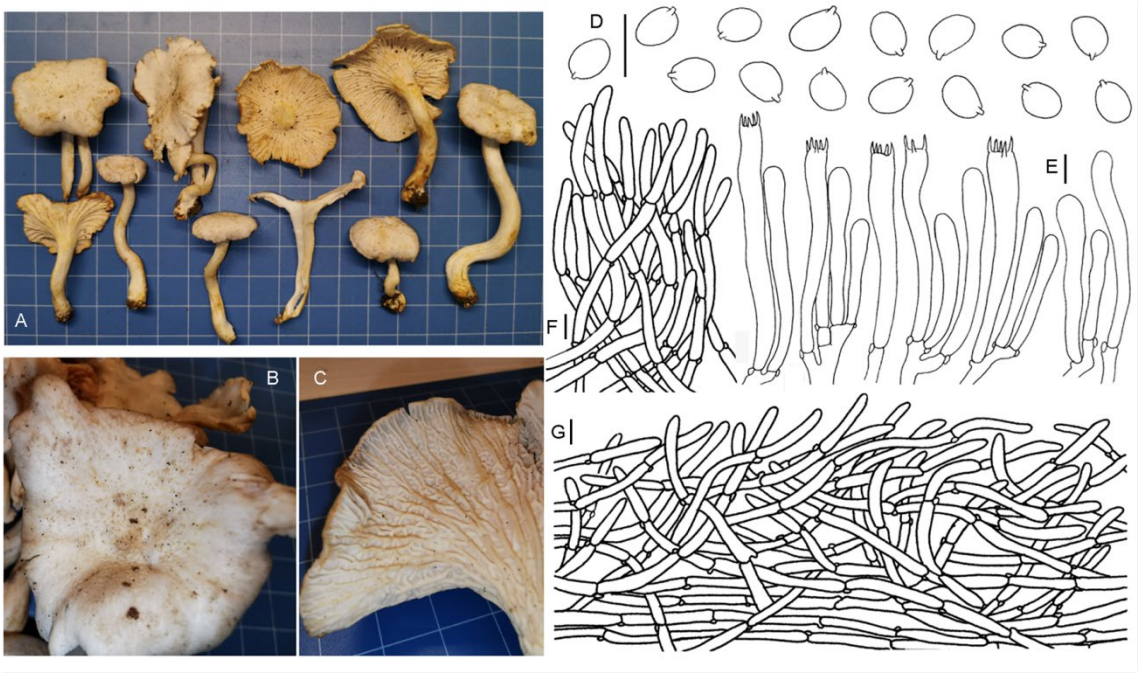


Figure 8 – Morphology of *Cantharellus albopileatus*. A–C. Basidiomata. D. Basidispores. E. Basidia. F, G. Pileipellis. Scale bars: D, E = 10 µm; F, G = 20 µm.

Specimens examined – China, Guizhou Province, Qiannan Buyi and Miao Autonomous Prefecture, Longli County, bought from a mushroom market, alt. 1080, 1 Jul 2020, M. Zhang (GDGM80787, GDGM80789). Guizhou Province, Qiannan Buyi and Miao Autonomous Prefecture, Longli County, 10 Jul 2021, M. Zhang (GDGM85935).

Notes – *Cantharellus albopileatus*, recently reported from southern and eastern China, is mainly characterized by its white to yellowish-white basidiomata that typically turn yellowish when bruised, a relatively poorly-developed gill-like hymenophore, broadly ellipsoid or oval basidiospores, and the presence of clamp connections. *Cantharellus albus* is similar to *C. albopileatus* in the whitish basidiomata which is slightly changing to yellowish when bruised, but the former can be distinguished by its smaller basidiomata (pileus ≤ 42 mm broad), and smaller basidiospores measuring 5.5–7.5 × 4.5–6 µm (Jian et al. 2020; Zhang et al. 2021a).

Phylogenetic analyses showed that *C. albopileatus* belongs to *C.* subg. *Cantharellus* and was close to *C. pinetorus* and *C. chuiweifanii*, but the latter two species can be easily distinguished by their light yellow to light orange pileus colour (Zhang et al. 2021b).

Cantharellus applanatus D. Kumari, Ram. Upadhyay & Mod.S. Reddy, Mycology 4(4): 211 (2014) Fig. 9

Chinese name: 平盖鸡油菌

Pileus 30–100 mm broad, convex to applanate, usually depressed at center, surface dry, covered with white minute pubescence, yellow, light yellow to yellowish orange (2A5–4A5, 2A6–4A6). Hymenophore decurrent, relatively well-developed, with well-defined gill-like folds, forking and anastomosing toward pileus margin, yellowish white, pale yellow to light yellow (3A2–3A4); Context yellowish white (3A2), 5–12 mm thick at centre, unchanging when bruised. Stipe 20–60 × 5–15 mm, solid, subcylindrical, concolorous with hymenophore or paler. Basidiospores 7–8.5 × 4.5–6 µm, broadly ellipsoid or ellipsoid, thin-walled. Basidia 56–95 × 7.5–10 µm, narrowly clavate to subcylindrical, 4–6-spored. Pileipellis mainly as a cutis, partially with erect terminal hyphae or with clustered hyphae, forming an intricate trichoderm, terminal elements 3–10 µm broad, thin to slightly thick-walled (<0.5 µm thick). Clamp connections present in all tissues.

Habitat and distribution – Solitary or scattered in subtropical mixed forests. Known from southwestern China.

Specimens examined – China, Guizhou Province, Qiannan Buyi and Miao Autonomous Prefecture, Longli County, bought from a mushroom market, alt. 1080 m, 18 Jul 2019, Y. He (GDGM56523); Same location, 1 Jul 2020, M. Zhang (GDGM81405, GDGM80785, GDGM80786, GDGM80816).

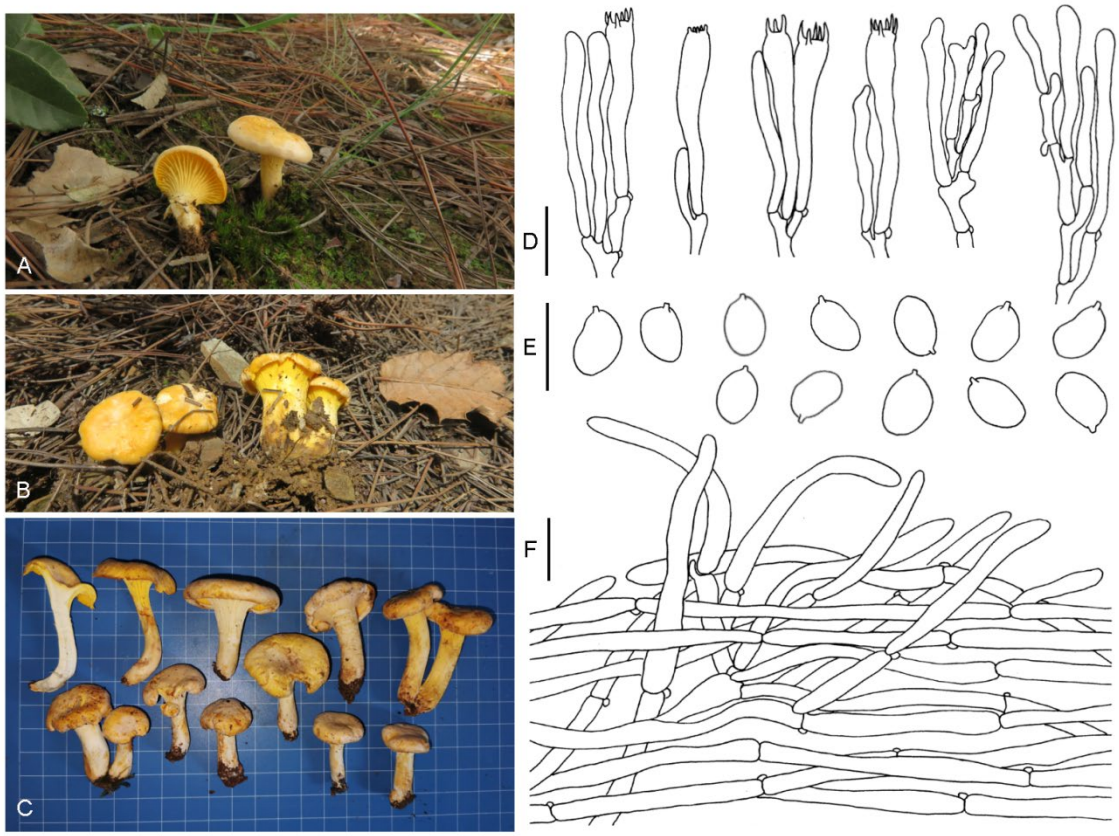


Figure 9 – Morphology of *Cantharellus applanatus*. A–C. Basidiomata. D. Basidia. E. Basidiospores. F. Pileipellis. Scale bars: D, F = 20 µm; E = 10 µm.

Notes – *Cantharellus applanatus*, originally reported from India, was once misidentified as *C. cibarius* and *C. yunnanensis* in China. It is sold in large quantities in wild mushroom markets, particularly in Yunnan and Guizhou Provinces (Shao et al. 2021, Wang et al. 2023a).

Shao et al. (2021) previously identified the common golden yellow *Cantharellus* species in southwest China as *C. yunnanensis*, and designated an epitype for *C. yunnanensis*. Subsequently, Cao et al. (2021a) considered that *C. tuberculosporus* and *C. anzutake* were later synonyms of *C. yunnanensis*. However, Wang et al. (2023a) demonstrated that *C. yunnanensis* is actually a member of *Craterellus* based on study of the type specimen; they also proved that the common

species samples labelled as "*C. yunnanensis*" from southern China were identical to *C. applanatus*, and so was the species *C. anzutake* which was originally reported from Japan (Ogawa et al. 2018); while *C. tuberculosporus*, originally described from China, was a species distinct from *C. applanatus* (Wang et al. 2023a).

Cantharellus chuiweifanii N.K. Zeng, Y.Z. Zhang & Zhi Q. Liang, Frontiers in Microbiology 13(no. 900329): 6 (2022) Fig. 10

Chinese name: 裘维蕃鸡油菌

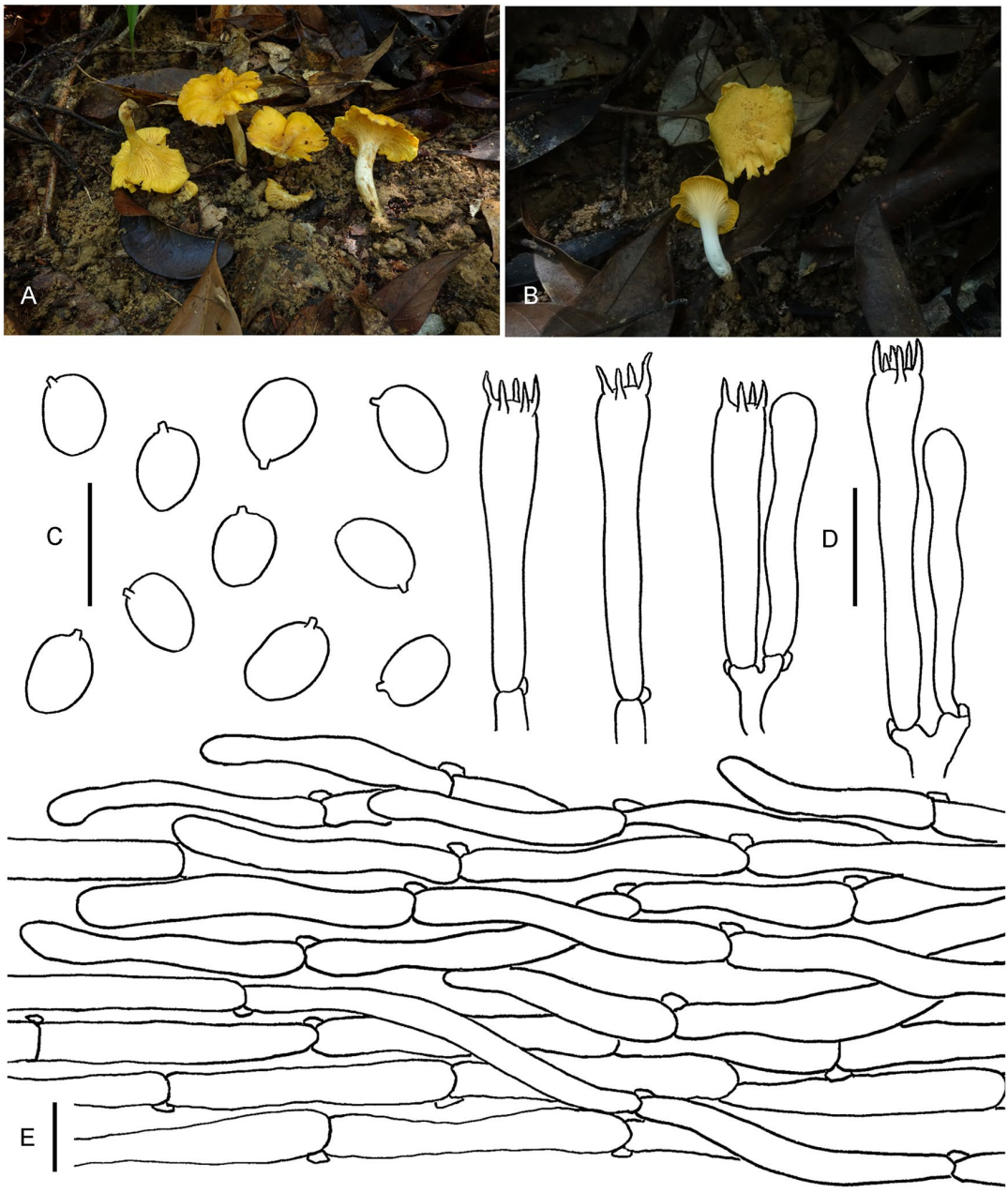


Figure 10 – Morphology of *Cantharellus chuiweifanii*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Pileus 20–50 mm broad, convex to nearly applanate with a depressed center, surface dry, glabrous, light yellow, yellow to yellowish orange (2A5–4A5, 2A6–4A6), sometimes tinged with brownish at centre; context yellowish white, unchanging when injured. Hymenophore decurrent, with poorly developed gill-like folds strongly forking and anastomosing at margin, pastel yellow to light yellow (2A4–4A4). Stipe 20–50 × 4–8 mm, central, cylindrical, surface dry, yellowish white

(3A2). Basidiospores 6–8 × 4.5–5.5(6) µm, ellipsoid, smooth, thin-walled, yellowish in KOH. Basidia 55–70 × 8–10 µm, narrow, subcylindric, thin-walled, 4-6-spored. Pileipellis a cutis, composed of cylindrical repent hyphae, 4–10 µm wide, slightly thick-walled (≤ 0.5 µm thick), sometimes slightly interwoven in some specimens. Clamp connections present in all tissues.

Habitat and distribution – Solitary or scattered under mixed or broad-leaved forest in subtropical regions. Known from South China.

Specimens examined – China, Hainan Province, Wanning City, Jianfengling National Nature Reserved, 17 Jun 2017, M. Zhang (GDGM60555, GDGM60567, GDGM60392); Same location, 13 Jul 2017, M. Zhang (GDGM86183, GDGM86214, GDGM86218, GDGM86240, GDGM86243, GDGM86250, GDGM86253); 14 Jul 2017, M. Zhang (GDGM86184, GDGM86258, GDGM86220). Guangdong Province, Shaoguan City, Renhua County, Danxiashan National Nature Reserve, 11 Sep 2018, M. Zhang (GDGM75272); Same location, 2 Jun 2017, M. Zhang (GDGM49825); Same location, 23 Jun 2021, M. Zhang (GDGM85737); Nanling National Nature Reserve, 28 Aug 2023, G.R. Zhong (GDGM93194). Zhejiang Province, Hangzhou City, Hangzhou Botanical Garden, 18 Jun 2023, Q.Q. Huang (GDGM91702); Huzhou City, 28 Sep 2023, Z.L. Zhou (GDGM92535).

Notes – *Cantharellus chuiweifanii*, recently reported from the tropical regions of southern China, forms symbiotic relationships with Fagaceae trees (Zhang et al. 2022b). The morphologically similar and phylogenetically related species, *C. pinetorus*, can be distinguished by its bright yellow to orange-yellow pileus, a relatively well-developed hymenophore, broader basidiospores, and its association with coniferous trees (Zhang et al. 2022b).

Cantharellus cibarius Fr., Syst. Mycol. (Lundae) 1: 318 (1821) Fig. 11

Chinese name: 欧洲鸡油菌

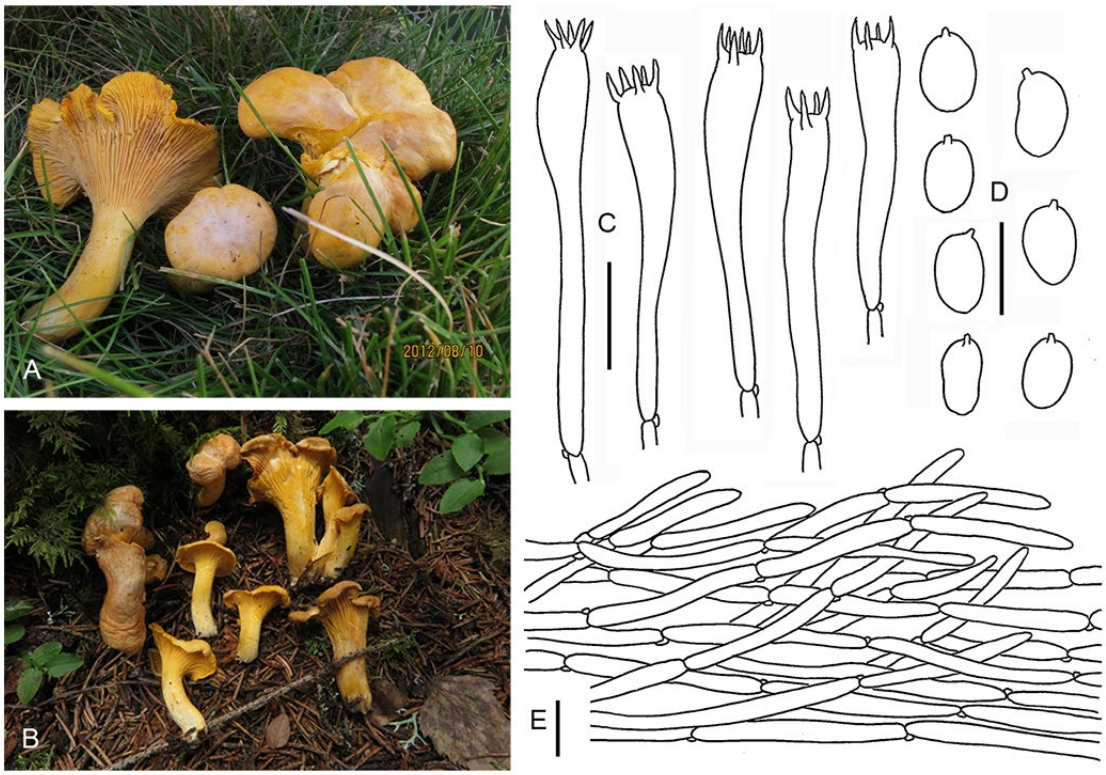


Figure 11 – Morphology of *Cantharellus cibarius*. A, B. Basidiomata. C. Basidia. D. Basidiospores. E. Pileipellis. Scale bars: C = 20 µm; D, E = 10 µm.

Pileus 40–90 mm broad, convex to nearly applanate with a shallow depressed center, surface dry, glabrous or covered with white tomentum when young, pale yellow, pale orange, light yellow to light orange (3A3–5A3, 3A5–5A5); context white, unchanging when injured. Hymenophore decurrent, with poorly developed gill-like folds strongly forking and anastomosing at margin, concolorous with pileus. Stipe 20–50 × 5–15 mm, central, cylindrical, surface dry, pale yellow to pale orange (3A3–5A3). Basidiospores 7.5–9 × 5–6 μm, ellipsoid, smooth, thin-walled, yellowish in KOH. Basidia 70–90 × 7–9 μm, narrowly subcylindrical, thin-walled, 4-6-spored. Pileipellis a cutis, composed of mostly interwoven, cylindrical hyphae in 4–8 μm wide. Clamp connections present in all tissues.

Habitat and distribution – Solitary or scattered under mixed or broad-leaved forests in temperate regions. Known from northeastern China.

Specimens examined – China, Inner Mongolia Autonomous Region, Hulunbuir City, 7 Aug 2022, L.L. Zhang (GDGM92017); Yakeshi County, bought from a market, 10 Aug 2012, M. Zhang (GDGM42636). Heilongjiang Province, Yichun City, Fenglin Nation Nature Reserve, alt. 600 m,16 Jul 2016, R.L. Zhao ZRL20160194 (HMAS0271173). Finland, Orivesi, Juupajoki, 10 Aug 2019, M. Zhang (GDGM77039); Same location, 12 Aug 2019, M. Zhang (GDGM78183); 16 Aug 2019, M. Zhang (GDGM56440, GDGM77034, GDGM77040).

Notes – Traditionally, identification of *Cantharellus* species was rather difficult mainly relying on the morphological characters of basidiomata and basidiospores. Thus, *C. cibarius* was widely reported in most regions of China, even worldwide (Wang et al. 2023a). However, recent studies based on DNA sequences have proved that *C. cibarius* is only distributed in Europe, northeastern China and Japan (Swenie & Matheny, 2023; Wang et al. 2023a).

Phylogenetic analyses showed that only three specimens (XHW2580, HMAS0271173 and GDGM92017) with related sequences have been confirmed as *C. cibarius* from northeast China. Besides, two unnamed samples (JPN4 C-141 and JPN4 C-142) from Japan clustered into the *C. cibarius* clade, which indicated that they were conspecific with *C. cibarius* based on Genealogical Concordance Phylogenetic Species Recognition (GCPSR).

Cantharellus hainanensis N.K. Zeng, Zhi Q. Liang & S. Jiang, Mycoscience 58(6): 439 (2017)

Chinese name: 海南鸡油菌

Notes – *Cantharellus hainanensis*, originally reported from the tropical region of China, is easily separated from other *Cantharellus* species in China by its smooth hymenophore (An et al. 2017). However, *C. laevihumeninus* and *C. magnus*, recently described from China, are similar to *C. hainanensis* in sharing a smooth hymenophore. *Cantharellus laevihumeninus* differs by its larger basidiomata (up to 65 mm broad), discolored stipe when bruised, broader basidiospores measuring 7–8.8 × 5–6.1 μm, and different DNA sequences (Cao et al. 2021a); *C. magnus* differs by its larger basidiomata (up to 200 mm broad), larger basidiospores measuring (8.5)9–11(11.5) × (6.5)6.8–7.5(8) μm, and longer basidia up to 120 μm (Cao et al. 2021a). Additionally, phylogenetic analyses showed that *C. magnus* belongs to the C. subg. *Magnii*, while *C. hainanensis* belongs to the *C.* subg. *Cantharellus*.

Cantharellus hainanensis is also similar to *C. flavolateritius* Buyck & V. Hofstetter and *C. lateritius* in morphology. However, *C. flavolateritius* differs by its discolored stipe when injured, bright yellow hymenophore composed of radially oriented low anastomosing veins and developing pinkish hues with age, and different of DNA sequences (Buyck et al. 2016d); *C. lateritius* differs in having relatively larger basidiomata (up to 12 cm high and 9 cm broad), variable pileus colour ranging from pale yellow to bright orange or pinkish orange, discolored stipe when handled, smaller basidiospores measuring 7.09–7.82 × 4.57–4.99 μm and slightly thick-walled terminal cells of pileipellis (Petersen 1979, Buyck & Hofstetter 2011, Buyck et al. 2014).

Cantharellus pseudohainanensis Ming Zhang & Z.H. Zhang, sp. nov. Fig. 12

Chinese name:假海南鸡油菌

Fungal Name: FN573120; Facesoffungi number: FoF 19024

Etymology – "*pseudo-*" means false; "*pseudohainanensis*" refers to the species similar to *C. hainanensis*.

Diagnosis – Differs from *C. hainanensis* in its much larger basidiomata and basidiospores, subtropical distribution and different DNA sequences.

Type – China. Jiangsu Province, Nanjing City, Zijinshan National Forest Park, under broad-leaved forests, alt. 380 m, 4 Jun 2021, Z.H. Zhang (GDGM84979).

Pileus 5–12 cm broad, applanate when young, with a depressed center, concave to subinfundibuliform with age, surface dry, subglabrous to subtomentose, pastel yellow, light yellow to light orange (3A4–5A4); margin incurved, usually wavy and lobed, thin. Context 2–3 mm thick at pileus center, sharply attenuate towards margin, white to yellowish white, unchanging when exposed. Hymenophore deeply decurrent, smooth to wrinkled or faintly veined, concolorous with pileus or paler, grayish yellow to grayish orange (3B3–5B3), unchanging when injured. Stipe 4–8 × 0.5–1.5 cm, central, subcylindrical, solid, never hollow, smooth or with tiny yellow to pale yellow squamules, slightly deeper to orange downwards; basal mycelium white. Odour faintly fruity or with milk fragrance, pleasant.

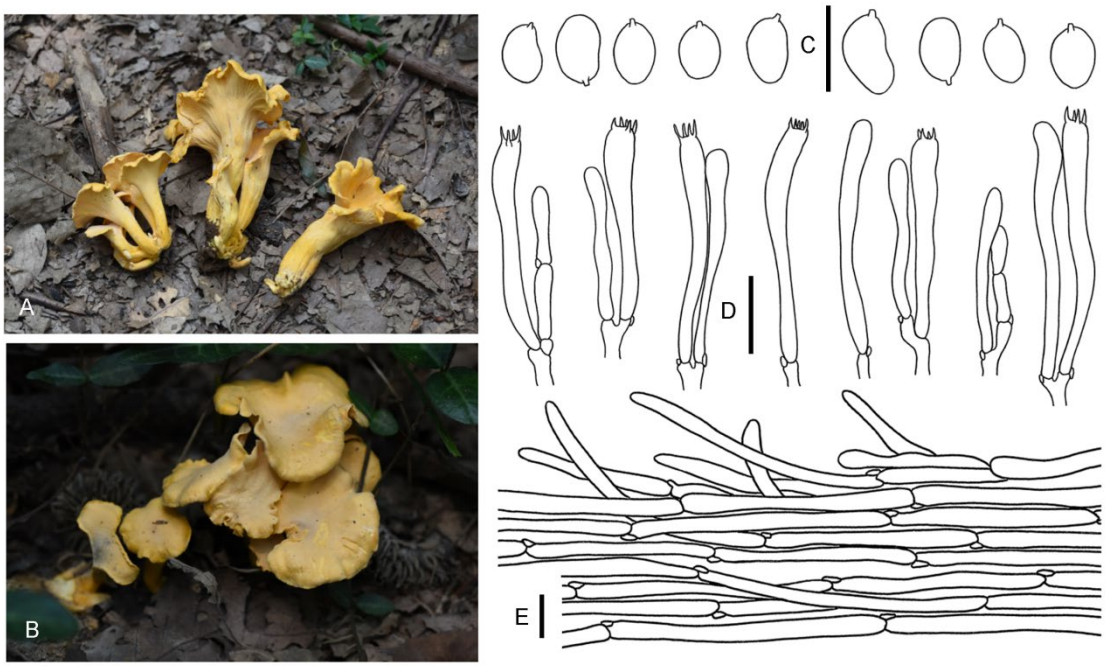


Figure 12 – Morphology of *Cantharellus pseudohainanensis*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C, E = 10 µm; D = 20 µm.

Basidiospores 7–9(10) × 5–6 µm, $L_m \times W_m$ = 7.97(±0.74) × 5.45(±0.37) µm, Q = (1.25)1.27–1.6(1.8), Q_m = 1.46±0.13, elliptical to elongate, thin-walled, colourless in KOH. Basidia 60–87 × 6–8 µm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, 4–6-spored, sterigmata 4–8 µm long. Hymenophoral trama composed of slightly interwoven hyphae 4–7 µm in diam., thin-walled. Pileipellis a cutis, composed of long, repent, thin-walled hyphae 4–9 µm wide, colourless in KOH, terminal cells narrowly clavate or subcylindrical, thin-walled, with obtuse apex. Stipitipellis a cutis, composed of cylindrical hyphae 5–11 µm in diam. Clamp connections present in all tissues.

Habitat and distribution – Solitary or scattered under broad-leaved forests. Known from Henan and Jiangsu Provinces, China.

Specimens examined – China, Jiangsu Province, Nanjing City, Zijinshan, alt. 200 m, 17 Aug 2021, Z.H. Zhang (GDGM85112); Same location, 4 Jun 2021, Z.H. Zhang (GDGM84979) 20 Sep 2020 Z.H. Zhang (GDGM81902). Henan Province, Xinyang City, Zhutang Township, bought from a market, 15 Jul 2020, W. Zhou (GDGM81402). Hubei Province, Jingmen City, Guanjiadu, 27 Jul

2024, C.Y. Li (GDGM97152); Same location, Yaoerping, 8 Jul 2024, C.Y. Li (GDGM97157, GDGM97153).

Notes – *Cantharellus pseudohainanensis* and *C. hainenensis* exhibit similarity in both morphological and molecular phylogenetic analyses. However, *C. pseudohainanensis* can be distinguished by its larger basidiomata and basidiospores; it grows in subtropical board-leaved forests, while *C. hainenensis* is only known from tropical forests in southern China.

Additionally, the two species have quite different DNA sequences. A BLAST search on the ITS sequence revealed that *C. pseudohainanensis* (GDGM84979) shares only 96.6% identity with *C. hainanensis* (Zeng 2289), and only 94.88% identity on the *tef*1 sequence. Therefore, morphological features and molecular evidence showed that they are two independent species.

A specimen HKAS109711 from Henan Province was once identified as *C. hainanensis* based on phylogenetic analysis, and indicated a wider geographical distribution for *C. hainanensis* (Wang et al. 2023a). In the present study, however, HKAS109711 nested into the *C. pseudohainanensis* clade, and the sequences are exactly the same as specimen GDGM81402. Both specimens were bought from the same local market in Xinyang, Henan Province, at the same time.

Cantharellus laevihymeninus T. Cao & H.S. Yuan, Stud. Mycol. 99 (no. 100121): 35 (2021)

Chinese name:光褶鸡油菌

Notes – *Cantharellus laevihymeninus*, recently reported from China, is mainly characterized by its pale orange to orange pileus, smooth to faintly veined hymenophore, orange-white stipe changing to darker colour when injured and elliptical basidiospores measuring (6.8)7–8.8(9) × (4.8)5–6.1(6.2) µm. Morphological features and phylogenetic analyses results support that it is a member of *C.* subg. *Cantharellus*, and belongs to section *Sublaeves*.

Three chanterelles species with a "smooth" hymenophore, namely *C. hainanensis*, *C. magnus* and *C. pseudohainanensis* from China, resemble *C. laevihymeninus* in morphology. Among them, *C. hainanensis* differs in its pastel yellow to light orange pileus, longer stipe (up to 8 cm long) usually with tiny squamules, slightly larger basidiospores measuring 7–9(10) × 5–6 µm, and thin-walled hyphae of pileipellis (An et al. 2017; present study); *C. magnus* differs in having larger basidiomata up to 14 cm broad, reddish yellow to orange red pileus, yellow to vivid yellow hymenophore changing to pale yellow when mature, and larger basidiospores measuring (8)8.5–10.2(15) × (4.8)5.2–6.5(7) µm (Cao et al. 2021a); and *C. pseudohainanensis* described in the present study, differs in having larger basidiomata (up to 12 cm broad), pastel yellow to light orange pileus, grayish yellow to grayish orange hymenophore and relatively larger basidiospores with size of 7–9(10) × 5–6 µm. Additionally, phylogenetic analyses distinguishes them from each other, such as *C. magnus* belongs to *C.* subg. *Magni*, and *C. hainanensis* and *C. pseudohainanensis* can be separated from *C. laevihymeninus* by genetic distance.

Cantharellus macrocarpus N.K. Zeng, Y.Z. Zhang & Zhi Q. Liang, Phytotaxa 482(2): 174 (2021) Fig. 13

Chinese name:大盖鸡油菌

Pileus 10–16 cm broad, dry, subtomentose to nearly glabrous, light yellow, light orange to orange (3A5–6A5, 6A6). Hymenophore decurrent, composed of relatively well-developed branched to furcate gill folds, yellow-orange (2A7) to deep brownish yellow (3A7). Stipe 5.2–6.5 × 1.7–2.2 cm, solid, cream to pale yellow (2A2–4). Basidiospores 6.5–8 × 4–5(5.5) µm, ellipsoid, smooth, thin to slightly thick-walled (up to 0.5 µm). Basidia 53–76.5 × 7.5–9 µm, narrowly clavate, thin to slightly thick-walled (up to 0.5 µm), 4–6-spored. Pileipellis a cutis composed of interwoven, filamentous hyphae 4–9 µm wide, slightly thick-walled (0.5–1 µm thick). Clamp connections present in all tissues.

Habitat and distribution – Scattered to gregarious on the ground under Fagaceae trees in tropical broadleaved forests. Known from Hainan and Guangxi Provinces, southern China.

Specimens examined – China, Hainan Province, Ledong County, Jianfenglin National Nature Reserve, alt. 950 m, 17 Jun 2017, M Zhang (GDGM60539); same location, 13 Jul 2021, M. Zhang (GDGM86209). Guangxi Province, Yulin City, 31 Aug 2022, H. Jun (GDGM87103).

Notes – *Cantharellus macrocarpus* is recently reported from the tropical region in southern China. The combination of large basidiomata, a bright yellow to orange pileus, a yellow-orange to deep brownish yellow hymenophore, a cream to pale yellow stipe, slightly thick-walled hyphae of the pileipellis, and the presence of clamp connections, makes it distinguishable from other species. *Cantharellus magnus* resembles *C. macrocarpus* in the large basidiomata, but *C. magnus* belongs to *C*. subg. *Magni*, can be distinguished by its smooth hymenophore and larger basidiospores measuring 9.0–11.0× 6.8–7.5 µm (Cao et al. 2021a, present study).

Phylogenetic analyses showed that *C. macrocarpus* formed a distinct monophyletic lineage, which nested into *C.* subg. *Cantharellus*, and can be easily separated from other *Cantharellus* species.

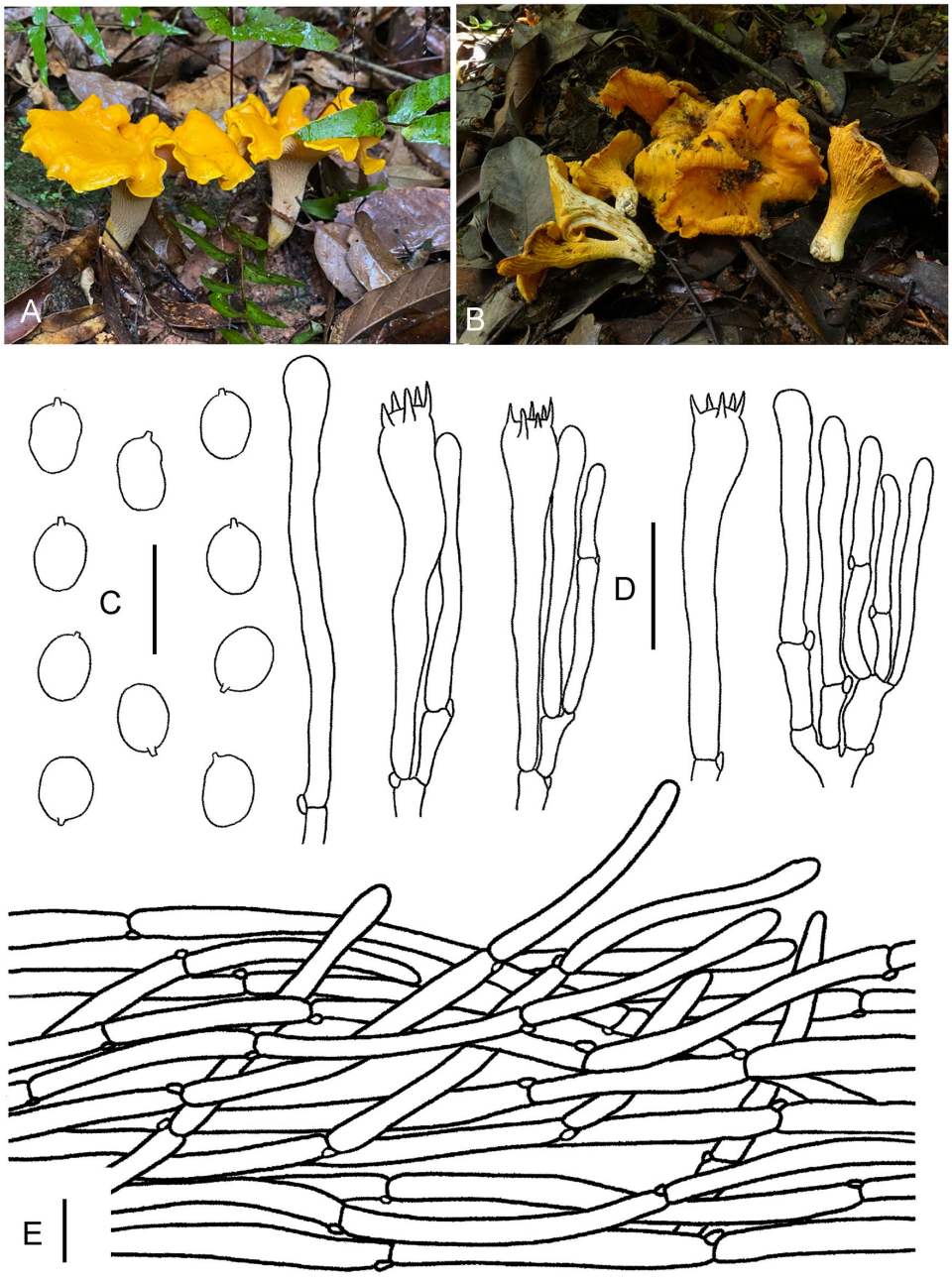


Figure 13 – Morphology of *Cantharellus macrocarpus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C, E = 20 µm; D = 10 µm.

Cantharellus pinetorus N.K. Zeng, Y.Z. Zhang & Zhi Q. Liang, Frontiers in Microbiology 13 (no. 900329): 9 (2022) Fig. 14

Chinese name:松林鸡油菌

Pileus 20–50 mm broad, convex to nearly applanate with a depressed center, surface dry, glabrous or subtomentose, light yellow to light orange (3A5–5A5); context white to yellowish white, unchanging when exposed. Hymenophore decurrent, smooth or poorly developed gill-like folds strongly forking and anastomosing at margin, pale yellow to pastel yellow (2A3–4A3, 2A4–3A4). Stipe 30–60 × 4–8 mm, cylindrical, central, surface dry, white to yellowish white (2A2). Basidiospores 6–9.5 × 4.5–6 µm, elliptical to elongate elliptical, thin-walled. Basidia 50–76 × 8–10 µm, clavate to subcylindrical, 4–6-spored. Pileipellis a cutis, composed of repent to slightly interwoven thin-walled hyphae 4–9 µm wide. Clamp connections present in all tissues.

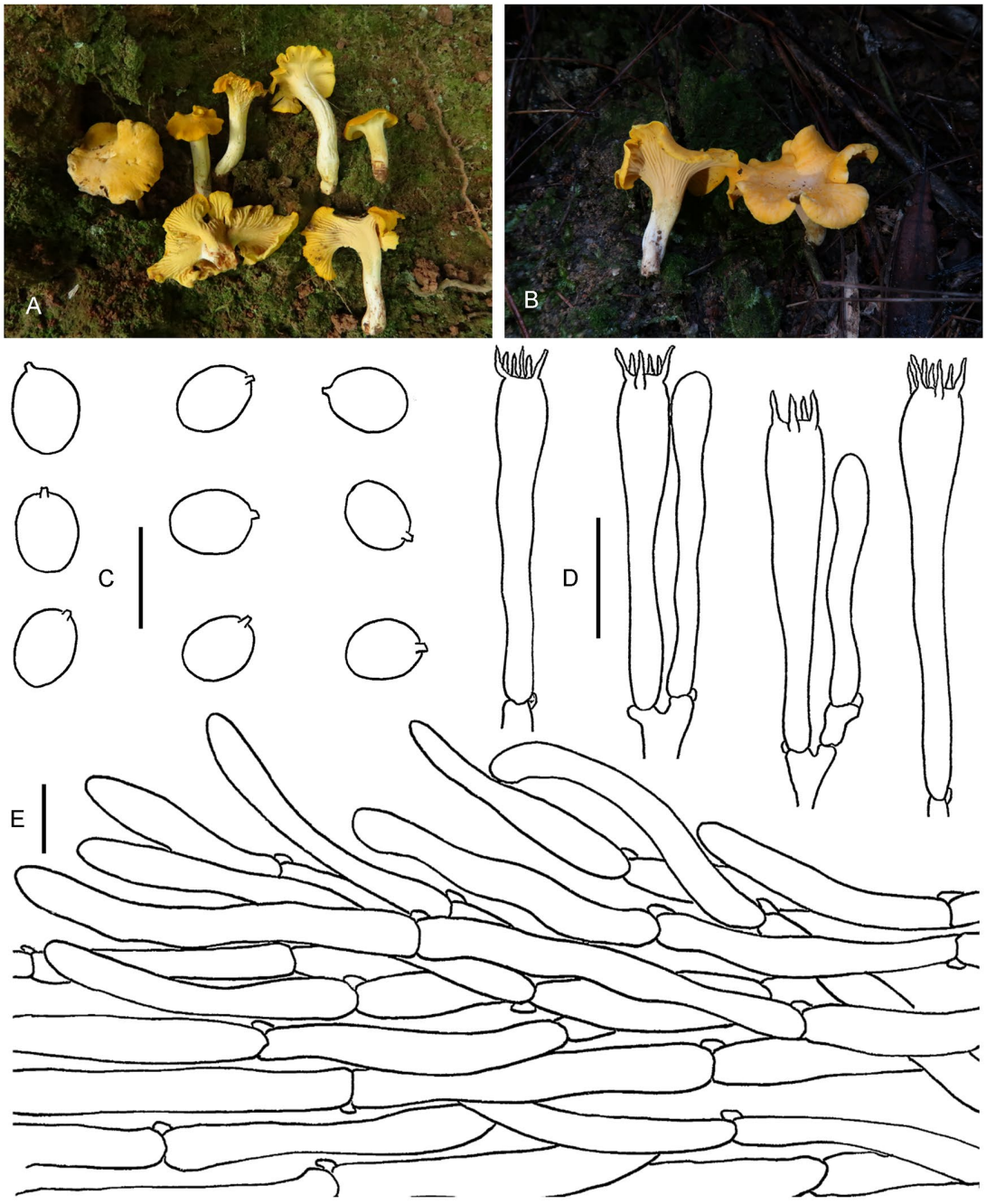


Figure 14 – Morphology of *Cantharellus pinetorus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Habitat and distribution – Solitary or scattered under mixed forests in subtropical regions. Known from South China.

Specimens examined – China, Guangdong Province, Shaoguan City, Renhua County, Danxiashan National Nature Reserve, 151 m, 3 Jun 2020, M. Zhang (GDGM80626); same location, alt.151 m, 7 Jun 2017, M. Zhang (GDGM49628); Same location, 23 Jun. 2021, M. Zhang (GDGM85722, GDGM85830); Same location 14 Aug 2019, M. Zhang (GDGM77219); Nanling National Nature Reserve, 29 Aug 2023, G.R. Zhong (GDGM93135, GDGM93203). Yunnan Province, Puer City, Taiyanghe National Forest Park, 22 Sep 2019, M. Zhang (GDGM78930, GDGM78927); Same location, 24 Sep 2019, M. Zhang (GDGM78935); Zhejiang Province, Shaoxing City, Zhuji County, 12 Sep 2022, S.Z. Wang (GDGM90996).

Notes – *Cantharellus pinetorus*, primarily found in the subtropical regions of southern China, has been reported to be symbiotic with *Pinus massoniana* (Zhang et al. 2022b). Morphologically, *C. pinetorus* is similar to *C. chuiweifanii*, but the latter is mainly distributed in the tropical region of southern China and may form a symbiotic relationship with broad-leaved trees (Zhang et al. 2022b, present study). Phylogenetic analyses showed that the two species formed two distinct lineages in *C.* subg. *Cantharellus* (Figs. 1–3), and can be easily separated from each other.

It is worth noting that the hymenophore surface varies significantly in some specimens of *C. pinetorus*, ranging from with gill-like folds to smooth. Therefore, it is necessary to pay attention to distinguish it from those *Cantharellus* species with smooth hymenophores.

Cantharellus ravus N.K. Zeng, Y.Z. Zhang & Zhi Q. Liang, Frontiers in Microbiology 13 (no. 900329): [10] (2022)

Chinese name:灰黄鸡油菌

Notes – *Cantharellus ravus*, recently reported from Hunan Province of China, fit well with the characters defining *C.* subg. *Cantharellus,* sharing yellowish to grayish yellow pileus, veined and decurrent hymenophore, elliptical basidiospores measuring (6)6.5–7.04–7.5 × 4.5–5.24–5.5 µm, and the presence of clamp connections (Zhang et al. 2023). It is difficult morphologically to distinguish *C. ravus* from those species in subg. *Cantharellus* with yellow tinted pileus, such as *C. pinetorus*, *C. chuiweifanii*, *C. cibarius* and *C. applanatus*. However, *C. ravus* can be easily separated from those species by its forming a distinct lineage in the phylogenetic trees.

No morphological description for the species was given here, as the authors have not collected any specimens of this fungus. For detailed morphological descriptions, comparisons with similar species, and illustrations of *C. ravus*, refer to Zhang et al. (2023).

Cantharellus sinolateritius Ming Zhang & T.H. Li, sp. nov. Fig. 15

Chinese name:中华无褶鸡油菌

Fungal Name: FN573121; Facesoffungi number: FoF 19025

Etymology – "*sino*-" means China or Chinese, "*sinolateritius*" refers to this Chinese species similar to *C. lateritius*.

Diagnosis – Similar to *C. lateritius* in the smooth hymenophore, but differs in light yellow to light orange pileus, smaller basidiospores, and the different *tef*1 sequences.

Type – China. Yunan Province, Xishuangbanna Dai Autonomous Prefecture, Jinghong City, Dadugang Village, bought from a market, 21 Sep 2019, M. Zhang (GDGM78501).

Basidiomata medium to large sized. Pileus 30–120 mm broad, applanate when young, concave to subinfundibuliform at maturity; surface dry, nearly glabrous to subtomentose, light yellow to light orange (3A5–5A5); margin incurved when young, decurved to slightly upturned at maturity, usually wavy and lobed. Context 2–4 mm thick in center of pileus, sharply attenuate towards margin, white to yellowish white, unchanging when exposed. Hymenophore deeply decurrent, smooth, sometimes wrinkly or very ill-defined veins, yellow (2A6–3A6) when young, slightly changing to pale yellow (2A3–3A3) when mature, unchanging in colour when injured. Stipe 30–120 × 3–8 mm, central, subcylindrical, slightly tapering toward the base, solid, never

hollow; surface glabrous or covered with tiny, pale yellow to yellow scales, unchanging when handled; basal mycelium white. Odour fruity, pleasant.

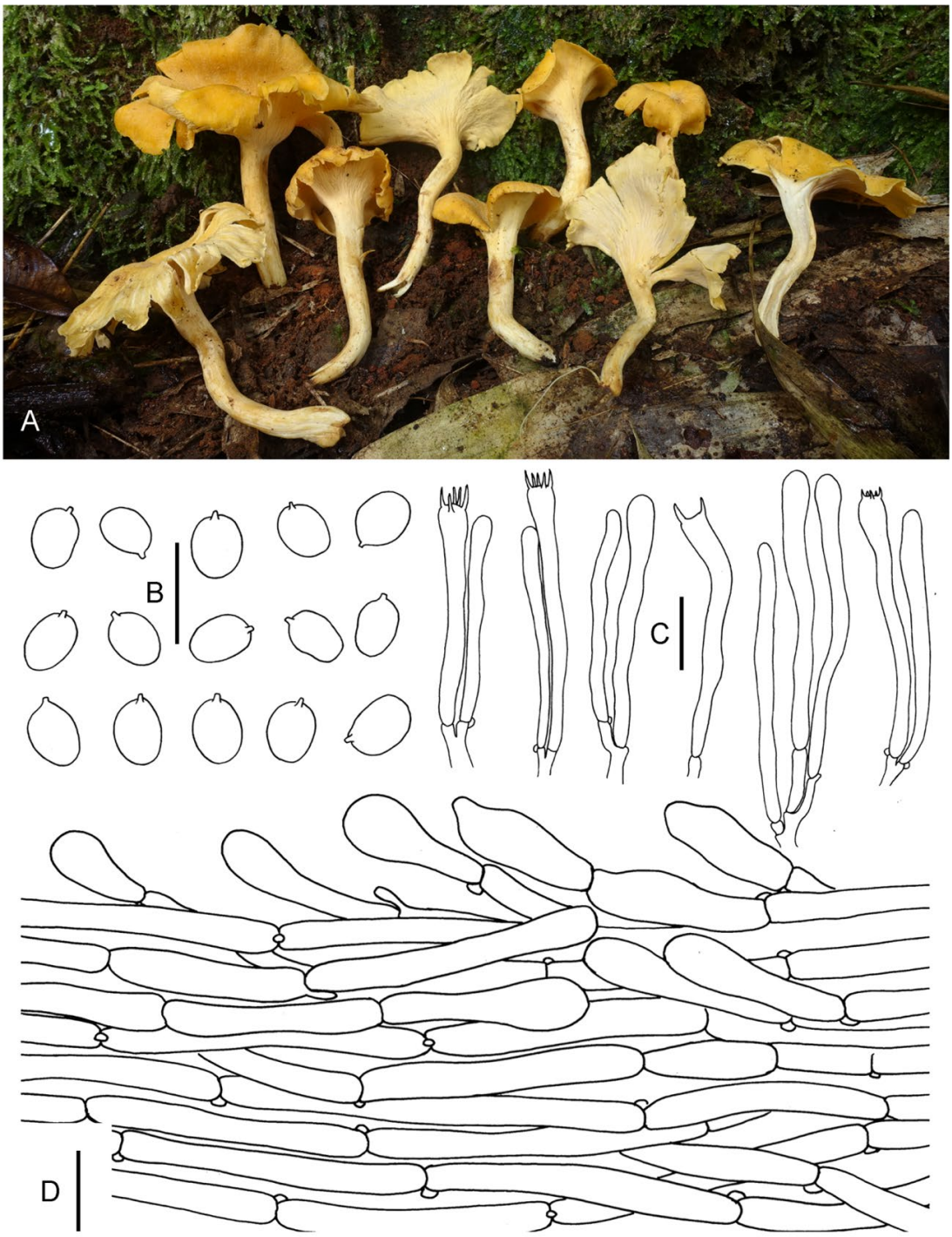


Figure 15 – Morphology of *Cantharellus sinolateritius*. A. Basidiomata. B. Basidiospores. C. Basidia. D. Pileipellis. Scale bars: B = 10 µm; C, D = 20 µm.

Basidiospores 6–7.8 × 4.3–5.5 µm, $L_m \times W_m$ = 6.7(±0.48) × 4.8(±0.44) µm, Q = (1.15)1.27–1.47(1.56), Q_m = 1.27±0.08, smooth, elliptical to elongate elliptical, thin-walled, colourless in KOH. Basidia 45–80 × 8–9 µm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, 2–6-spored; sterigmata 4–7 µm long. Hymenophoral trama composed of branched, subparallel to interwoven hyphae 3–7 µm in diam. Pileipellis a cutis, composed of long, repent, branched, interwoven and thin-walled hyphae measuring 4–9 µm wide, sometimes inflating to 20 µm,

colourless in KOH; terminal cells 25–90 × 8–20 μm, narrowly clavate or subcylindrical, thin-walled, with an obtuse apex. Stipitipellis a cutis, composed of thin-walled, hyaline, cylindrical hyphae measuring 3–5 μm in diam. Cystidia absent. Clamp connections present in all tissues.

Habitat and distribution – Solitary or scattered in tropical broad-leaved forests. Only known from Yunnan Province, southwestern China.

Specimen examined – China, Yunnan Province, Xishuangbanna Dai Autonomous Prefecture, Jinghong City, Dadugang Village, bought from an open fair, alt. 1357 m, 3 Aug 2022, M. Zhang (GDGM92984).

Notes – *Cantharellus sinolateritius* was collected from the tropical region of southwest China, and grows under broad-leaved forest. Phylogenetic analyses showed that the species formed a distinct monophyletic clade, closely related to *C. laevihymenius* in the multi-gene tree (Fig. 2). However, *C. laevihymenius* can be distinguished by its smaller basidiomata, and larger basidiospores measuring (6.8)7–8.8(9) × (4.8)5–6.1(6.2) μm (Cao et al. 2021). *C. hainanensis* and *C. pseudohainanensis* also resemble *C. sinolateritius* in morphology. *C. hainanensis* differs by its smaller basidiomata, larger basidiospores of 7–9(10) × 5–6 μm, and different DNA sequences (An et al. 2017); *C. pseudohainanensis* differs by its grayish yellow to grayish orange hymenophore, more robust stipe, larger basidiospores measuring 7–9(10) × 5–6 μm, different DNA sequences, and subtropical distribution.

Cantharellus subvaginatus Buyck, Antonín & V. Hofst., Mycol. Progr. 17(8): 921 (2018) Fig. 16

Chinese name: 近翘鳞鸡油菌

Basidiomata small sized. Pileus 2–4 cm broad, convex to broadly-convex when young, applanate, often shallowly depressed at centre when old, surface dry, yellowish white, pale yellow to orange white (2A2–5A2, 2A3–4A3) in mass, light brown (6D5–7D5), brown (6E5–7E5), reddish brown to violet brown (8E5–11E5) at centre, covered with light brown, reddish brown to violet brown tomentous, especially at centre; margin incurved, entire, undulate or irregular, rarely lobed, not striated. Context white to yellowish white, 2–3 mm thick at pileus centre, unchanging when bruised. Hymenophore decurrent, poorly developed, with sinuous or irregular gill-like folds up to 1 mm in height, frequently forking, with lower irregular anastomosis amongst the folds, yellowish white (2A2–4A2), pale yellow (2A3–4A3) to light yellow (2A5–4A5), unchanging when bruised. Stipe 20–40 × 4–6 mm, equal and slightly tapering downward, solid, yellowish white to pale yellow, glabrous or covered with faintly subtomentous or scales. Odour fruity. Taste mild.

Basidiospores (6.5)7–8(8.5) × 4.5–5.5(6) μm, $L_m \times W_m = 7.71(\pm0.54) \times 5.0(\pm0.36)$ μm, Q = (1.33)1.4–1.66(1.7), $Q_m = 1.54\pm0.12$, smooth, elliptical to elongate elliptical, thin-walled, colourless in KOH. Basidia 55–75 × 8–10 μm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, 4–6-spored; sterigmata 6–8 μm long. Hymenophoral trama composed of interwoven hyphae 4–12 μm in diam., hyphae often inflating towards septa. Pileipellis a cutis, composed of long, repent, thin-walled hyphae 5–15 μm wide, colourless in KOH; terminal cell narrowly clavate or subcylindrical, thin-walled. Stipitipellis a cutis, composed of parallel cylindrical hyphae 5–12 μm in diam. Clamp connections present in all tissues.

Habitat and distribution – Solitary or scattered in subtropical broad-leaved forests mainly dominated by Fagaceae trees (such as *Castanopsis sclerophylla* and *Castanopsis* spp.). Known from Zhejiang and Jiangsu Provinces, eastern China.

Specimens examined – China, Zhejiang Province, Ningbo City, Fenghua County, alt. 280 m, 1 Jul 2023, B. Chen (GDGM91693); Quzhou City, Jinwang County, 24 Jun 2023, B. Chen (GDGM91679); Jiangsu Province, Nanjing City, Jiangjunshan, 7 Sep 2023, M. Zhang (GDGM93712).

Notes – *Cantharellus subvaginatus* originally reported from South Korea (Buyck et al. 2018), is recorded for the first time in China. Morphologically, *C. subvaginatus* is similar to *C. vaginatus*, however, the later differs by its relatively smaller basidiomata, pale yellow to light yellow pileus, and smaller basidiospores measuring 6–7 × 5–5.5 μm.

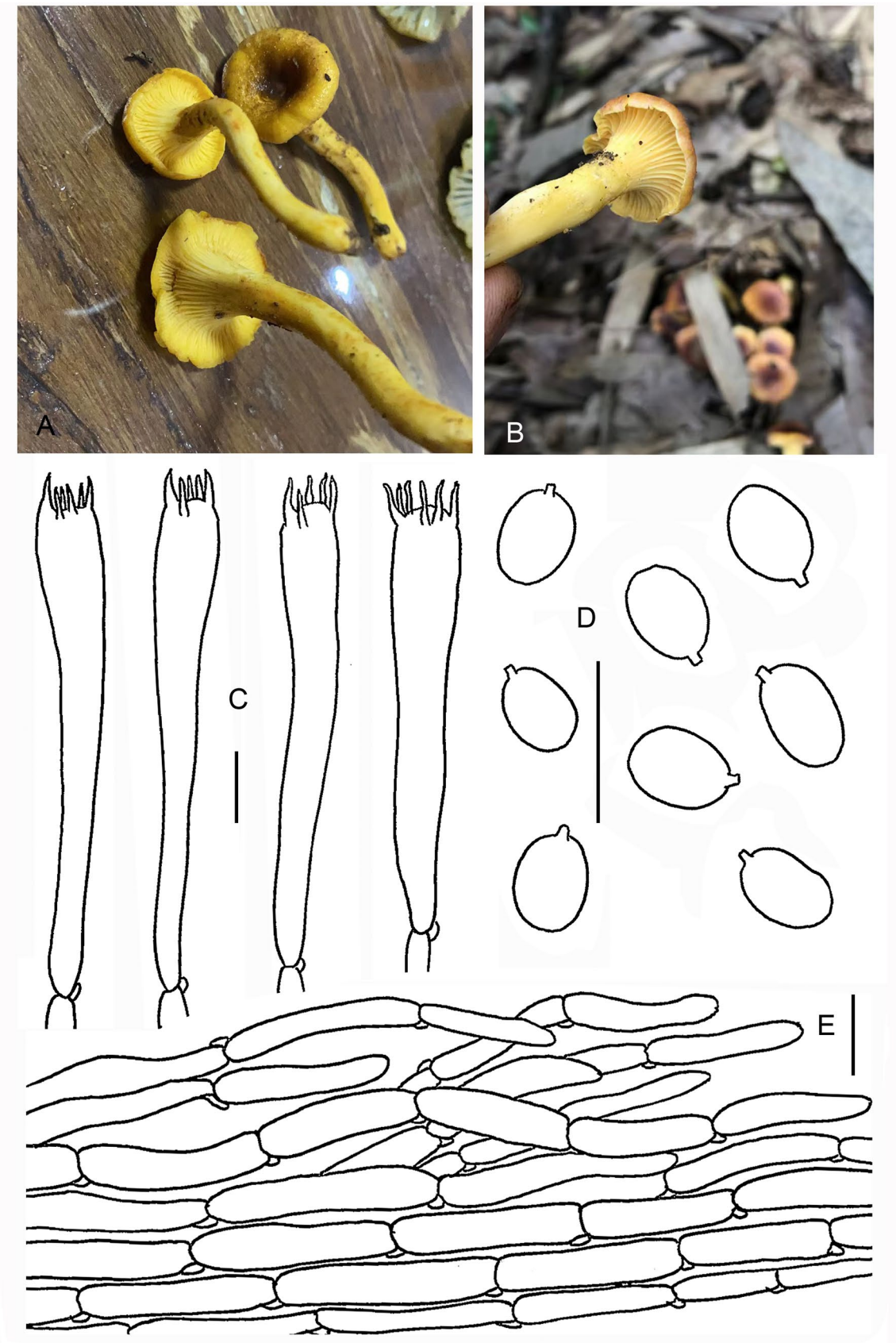


Figure 16 – Morphology of *Cantharellus subvaginatus*. A, B. Basidiomata. C. Basidia. D. Basidiospores. E. Pileipellis. Scale bars: C, D = 10 µm; E = 20 µm.

Phylogenetic analyses proved that *C. subvaginatus* is a member of *C.* subg. *Cantharellus*, belongs to section *Amethystini*, and is closely related to *C. lewisii* and *C. violaceovinosus*. However,

C. lewisii originally reported from North America, differs in its pale yellow to pale brownish orange pileus covered with dark purplish-lilac appressed fibrils, and pileipellis composed of very conspicuously thick-walled (wall mostly 1–1.5 μm) hyphae 4–6 μm wide (Buyck et al. 2011); while *C. violaceovinosus*, originally reported from Mexico, differs in having medium to large size basidiomata, dark violet to violet reddish pileus usually breaking in faintly tesselate-rimose-like pattern, appressed fibrillose on pileus surface, relatively larger basidiospores measuring 7–10(11) × (4.5) 5– 6.5 (7) μm, larger basidia up to 125 μm long, and slightly thick-walled (<1 μm thick) and narrower (4–6 μm diam) terminal elements of pileipellis (Herrera et al. 2018).

Cantharellus vaginatus S.C. Shao, X.F. Tian & P.G. Liu, Mycotaxon 116: 438 (2011) Fig. 17

Chinese name:翘鳞鸡油菌

Pileus 2–7 cm broad, applanate with center depressed, not perforate, margin incurved when young, applanate or slightly reflexed with age, sometimes irregularly split at margin, surface dry, pale yellow, pastel yellow to light yellow (2A2–3A2, 2A4–3A4), covered with olive brown, brown, reddish brown (4E6–10E6) minute fibrils or squamules, especially at center. Context thin, 1.5–3.5 mm thick, fibrous, yellowish white, unchanging when bruised. Hymenophore gill-like, decurrent, composed of relatively well-developed, decurrent, branched to furcate gill folds, rugulose, strongly anastomose due to conspicuous transversal veins with age, 1–1.5 mm high, yellowish white, pale yellow to pastel yellow (2A2–2A4). Stipe 3–7 mm long, 3–8 mm thick, subcylindrical, tapering downward, glabrous or minutely fibrillose, concolorous with hymenophore or gill-like folds. Odour none. Taste mild.

Basidiospores 6–7 × 5–5.5 μm, broadly elliptical to oval. Basidia 60–80 × 9–11 μm, clavate, 4–6-spored, sterigmata 3–6 μm long. Pileipellis a cutis, composed of horizontal to ascending, subparallel, cylindrical parallel hyphae, 5–12 μm wide, colourless, thin-walled. Hymenophoral trama composed of cylindrical hyphae 3–7 μm in diam. Stipitipellis a cutis, composed of parallel cylindrical hyphae 3–9 μm in diam. Cystidia absent. Clamp connections present in all tissues.

Habitat and distribution – Solitary or scattered in broad-leaved forests (dominated by Fagaceae trees) in tropical regions of China. Known from southwestern China.

Specimens examined – China, Yunnan Province, Puer City, Simao District, Taiyanghe National Forest Park, alt. 1623 m, 20 Sep 2019, M. Zhang (GDGM78625); Same location, alt. 1581 m, 24 Sep 2019, M. Zhang (GDGM78912); alt. 1590 m, 25 Sep 2019, M. Zhang (GDGM78954, GDGM79025, GDGM78923), T. Li (GDGM78948), J.Y. Xu (GDGM78975). Anhui Province, Huangshan City, Huangshan Scenic Spot, 11 July 2022, R.G. Wang (GDGM88621); Same location, 11 Aug 2020, M. Zhang (GDGM82492). Zhejiang Province, Quzhou City, Jinwang town, 24 Jun 2023, B. Chen (GDGM91680, GDGM91675); Huzhou City, Moshan, Z.L. Zhou (GDGM92540); Same location 10 Oct 2024, Z.L. Zhou (GDGM97481). Jiangxi Province, Congyi County, Yangling National Forest Park, 28 Jul 2020, M. Zhang (GDGM80775, GDGM80779); Nanchang City, 16 Jun 2024, Y.Y. Hu (GDGM95539). Guangxi Province, Yulin City, 3 Jun 2023, H. Jun (GDGM91295). Hunan Province, Zhangjiajie City, Shichangxi, 16 Jul 2022, W.Q. Qin (GDGM90866). Fujian Province, Nanping City, B. Ben (GDGM93719).

Notes – *Cantharellus vaginatus* originally reported from the tropical region of southwestern China, is characterized by its small basidiomata (2–3.5 cm broad), light yellow pileus covered with grayish brown to dark brown squamules at center, rugulose hymenophore and elliptical to elongate elliptical basidiospores measuring 6–7 × 5–5.5 μm (7–9 × 5–7 μm in Shao et al. 2011).

Phylogenetic analyses have shown that samples named as *C. vaginatus* formed two distinct clades, which were well supported in the ITS phylogenetic tree (Fig. 3), and the type specimen was included in the "*C. vaginatus* II" clade (Figs. 2, 3). However, in the *tef*1 and multi-gene phylogenetic trees (Fig. 1, 2), the two clades '*C. vaginatus* I' and "*C. vaginatus* II" were not well supported. In the "*C. vaginatus* I" clade, specimens were mainly from southern and eastern China, while in the "*C. vaginatus* II" clade, specimens were mainly from the adjacent region of the type location in southwestern China.

The morphological examination indicated that specimens from the two clades exhibited nearly consistent morphological features with *C. vaginatus*, with the exception of slight variations in the size of basidiospores. Consequently, in the present study, specimens from the two clades are provisionally classified as *C. vaginatus*, and further studies are required to identify more distinct morphological features to differentiate the two clades.



Figure 17 – Morphology of *Cantharellus vaginatus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C, E = 20 µm; D = 10 µm.

Cantharellus versicolor S.C. Shao & P.G.Liu, Phytotaxa 252(4): 276 (2016) Fig. 18

Chinese name:多色鸡油菌

Pileus 3.5–10 mm broad, convex when young, then gradually to nearly applanate with a central shallow depression at maturity; surface dry, glabrous or tomentous to floccose in some specimens, yellow, yellowish orange, orange to grayish orange (3A6–6A6, 3B6–6B6), sometimes with brownish tinge, margin even, incurved when young, decurved to slightly upturned at maturity, unchanging when handled. Context yellowish white, 3–6 mm thick in the center of the pileus, sharply attenuate towards margin, unchanging when exposed. Hymenophore decurrent, poorly-developed, composed of bifurcate and interconnected low veins, in particular toward the cap margin, 0.5–2 mm high, usually less than 1 mm high, yellow, light yellow to yellowish orange (2A5–4A5; 2A6–4A6), unchanging when bruised. Stipe 40–100 × 5–12 mm, central, cylindrical or slightly tapering towards base, solid, smooth or faintly scaly, concolorous with pileus or slightly paler. Odour milk fragrance, pleasant. Taste mild.

Basidiospores (8)9–11(12) × (5.5)6–7(7.5) µm, $L_m \times W_m = 9.87(\pm0.92) \times 6.35(\pm0.54)$ µm, Q = (1.42)1.45–1.69(1.75), $Q_m = 1.55\pm0.09$, broadly ellipsoid, smooth, guttulate. Basidia 65–105 × 8–12 µm, narrowly clavate, colourless in KOH, 4–6-spored, sterigmata 8–10 µm long. Pileipellis a cutis with long, repent and occasionally interwoven subcylindrical hyphae, 5–15(21) µm wide, slightly thick-walled. Stipipellis a cutis of cylindrical, parallel hyphae, 5–14 µm wide. Clamp connections abundant in all tissues.

Habitat and distribution – Solitary or scattered in subalpine mixed forests. Known from Yunnan, Sichuan and Xizang Provinces, southwestern China.

Specimens examined – CHINA. Yunnan Province, Shangrila, Bitahai National Nature Reserve, alt. 3500 m, 2 Sep 2020, M. Zhang (GDGM82440); Same location, alt. 3830 m, 3 Sep 2020, M. Zhang (GDGM82384, GDGM82388, GDGM82400, GDGM82414, GDGM82429, GDGM82438); 4 September 2020, Ming Zhang (GDGM82370, GDGM82371, GDGM82373, GDGM82378, GDGM82381, GDGM82383, GDGM83277, GDGM83185, GDGM83172, GDGM83174, GDGM83177, GDGM83192); 4 Aug 2022, M. Zhang (GDGM90151); 26 Aug 2022, X.L. Gao (GDGM89617, GDGM89616); Sichuan Province, Kangding City, bought from a wild mushrooms market, 7 Aug 2020, C.Q. Wang (GDGM79332, GDGM79336, GDGM79339, GDGM79337, GDGM82803, GDGM82806); Xiaojin County, Siguniang Mountain Scenic Area, alt. 3800 m, 31 Jul 2020, C.Q. Wang (GDGM81860, GDGM81828, GDGM81862, GDGM81865, GDGM82805, GDGM82811); Xizang Province, Linzhi City, Milin County, Nanyigou Scenic Area, alt. 3000 m, 22 Aug 2024, M. Zhang (GDGM96922, GDGM96612, GDGM96847, GDGM96857, GDGM96861, GDGM96870, GDGM96874, GDGM96909, GDGM96957, GDGM96530), Lulang Town, alt. 3950 m, 22 Aug 2024, M. Zhang (GDGM96870, GDGM96874, GDGM96909, GDGM96957, GDGM96530).



Figure 18 – Morphology of *Cantharellus versicolor*. A, B. Basidiomata. C. Basidia. D. Basidiospores. E. Pileipellis. Scale bars: C, E = 20 µm; D = 10 µm.

Notes – *Cantharellus versicolor* is a subalpine species primarily found in high-elevation regions above 3800 meters in the Himalayan-Hengduan mountains of southwestern China, within mixed forests dominated by *Abies* trees. It is commonly encountered in wild mushroom markets in western Sichuan, northwestern Yunnan, and southeastern Xizang, and was historically identified as *C. cibarius*, *C. cibarius* var. *squamosus* and *C. formosus* (Wei et al. 2008, Shao et al. 2012, Li et al. 2015). *Cantharellus versicolor* is mainly characterized by the small basidiomata, a sandy brown to dark brown pileus that turns gray upon handling, and a pale yellow context changing to brown when exposed (Shao et al. 2016b). However, the discolored feature was not observed in our studied specimens, and the studied specimens have larger basidiospores than those described by Shao et al. (2016) (9–11 × 6–7 µm vs. 9−10 × 5−6 µm).

In the phylogenetic analyses, specimens of *C. versicolor* formed a well supported monophyletic clade in *C.* subg. *Cantharellus*, and was closely related to *C. formosus* and *C. camphoratus*. However, *C. camphoratus* originally reported from Canada, differs in having a deep yellow pileus densely covered with brownish scales, a light yellow to whitish hymenophore, all tissues stain reddish-brown when injured or exposed, and smaller basidiospores (9.1 × 5.0 μm) (Petersen 1979, Thorn et al. 2017); *C. formosus* distributed in North America, differs by its bright to dull orange-yellow pileus typically covered with tiny darker scales, which change to yellowish when bruised, smaller basidiospores (6.5–10 × 5–7 μm) and basidia (45–75 μm long) (Corner 1966, Thiers 1985, Redhead et al. 1997, Pilz et al. 2003, Kuo 2019).

Ecologically, *C. versicolor* usually grows together with *C. zangii* under mixed forests dominated by *Abies* spp. with a small number of broad-leaved trees (such as Fagaceae) in subalpine regions of southwest China. However, *C. zangii* can be easily distinguished by its relatively smaller basidiomata, brown to dark brown pileus with longer and hollow stipe, and thin-walled pileipellis. Besides, *C. zangii* belongs to *C.* subg. *Parvocantharellus*, while *C. versicolor* is a member of *C.* subg. *Cantharellus*.

Cantharellus tuberculosporus M. Zang, Acta microbiol. sin. 20(1): 31 (1980) Fig. 19

Chinese name:疣孢鸡油菌

Pileus 40–80 mm broad, convex to applanate with depressed center, broadly infundibuliform, surface dry, pastel yellow, light yellow to light orange (3A4–5A4, 3A5–5A5), glabrous or with brownish floccose at center, margin even, incurved when young, decurved to slightly upturned at maturity, unchanging when handled. Context yellowish white, 3–8 mm thick in the center of the pileus, unchanging when exposed. Hymenophore decurrent, composed of poorly developed gill like folds**,** bifurcate and interconnected, in particular toward the pileus margin**,** pale yellow, light yellow to yellowish orange (3A3–3A6; 4A3–4A6), unchanging when bruised. Stipe 40–80 × 8–15 mm, central, cylindrical, solid, glabrous or faintly scaly, concolorous with hymenophore or slightly paler to white in some specimens. Odor fruity. Taste mild.

Basidiospores (8)8.5–10(10.5) × (4.5)5–6(6.5) μm, broadly ellipsoid, smooth, thin-walled. Basidia 65–95 × 7–12 μm, narrowly clavate, colourless in KOH, 4–6-spored, sterigmata 8–10 μm long. Pileipellis a cutis with long, repent and occasionally interwoven subcylindrical hyphae 5–15(21) μm wide, slightly thick-walled. Stipipellis a cutis of cylindrical, parallel hyphae, 5–14 μm wide. Clamp connections abundant in all tissues.

Habitat and distribution – Solitary or scattered in subalpine mixed forests with *Pinus densata* and oak. Known from Yunnan, Sichuan and Xizang Provinces, southwestern China.

Specimens examined – China. Yunnan Province, Diqing Prefecture,Weixi County, Tacheng town, alt. 3100 m, 31 Jul 2024, X.L. Gao (GDGM94580); Sichuan Province, Kangding City, bought from a mushroom market, 7 Aug 2020, C.Q. Wang (GDGM79327). Xizang Province, Changdu City, Basu Town, 25 Jul 2024, S.M. Tang & K.Y. Niu (GDGM97266).

Notes – *Cantharellus tuberculosporus* is a rare species that has not been reported since its publication (Zang 1980). Wang et al. (2023a) obtained the ITS sequence from the type specimen through genome skimming technology, and confirmed that *C. tuberculosporus* is a distinct and valid species. Phylogenetic analyses shown that *C. tuberculosporus* nested within the *C. cibarius* core clade and was closely related to *C. cibarius*. However, *C. cibarius* can be easily distinguished by its smaller basidiospores (7–11 × 4–6 μm), and it is distributed in the temperate regions of northeast China. In contrast, *C. tuberculosporus* occurs in the transition band from subtropical *Pinus* forests to subalpine *Abies* forests in southwest China (Wang et al. 2023a).

It is worth noting that in the distribution areas of *C. tuberculosporus*, there is a common species, *C. versicolor*, which is very similar to *C. tuberculosporus* in macro-morphology. However, *C. versicolor* can be distinguished by its larger basidiomata (up to 10 cm broad) and basidiospores measuring (8)9–11(12) × (5.5)6–7(7.5) μm. Additionally, *C. versicolor* is only found in *Abies* forests above 3800 m, whereas *C. tuberculosporus* grows in mixed forests with *Pinus densata* and oak, typically below 3500 m.

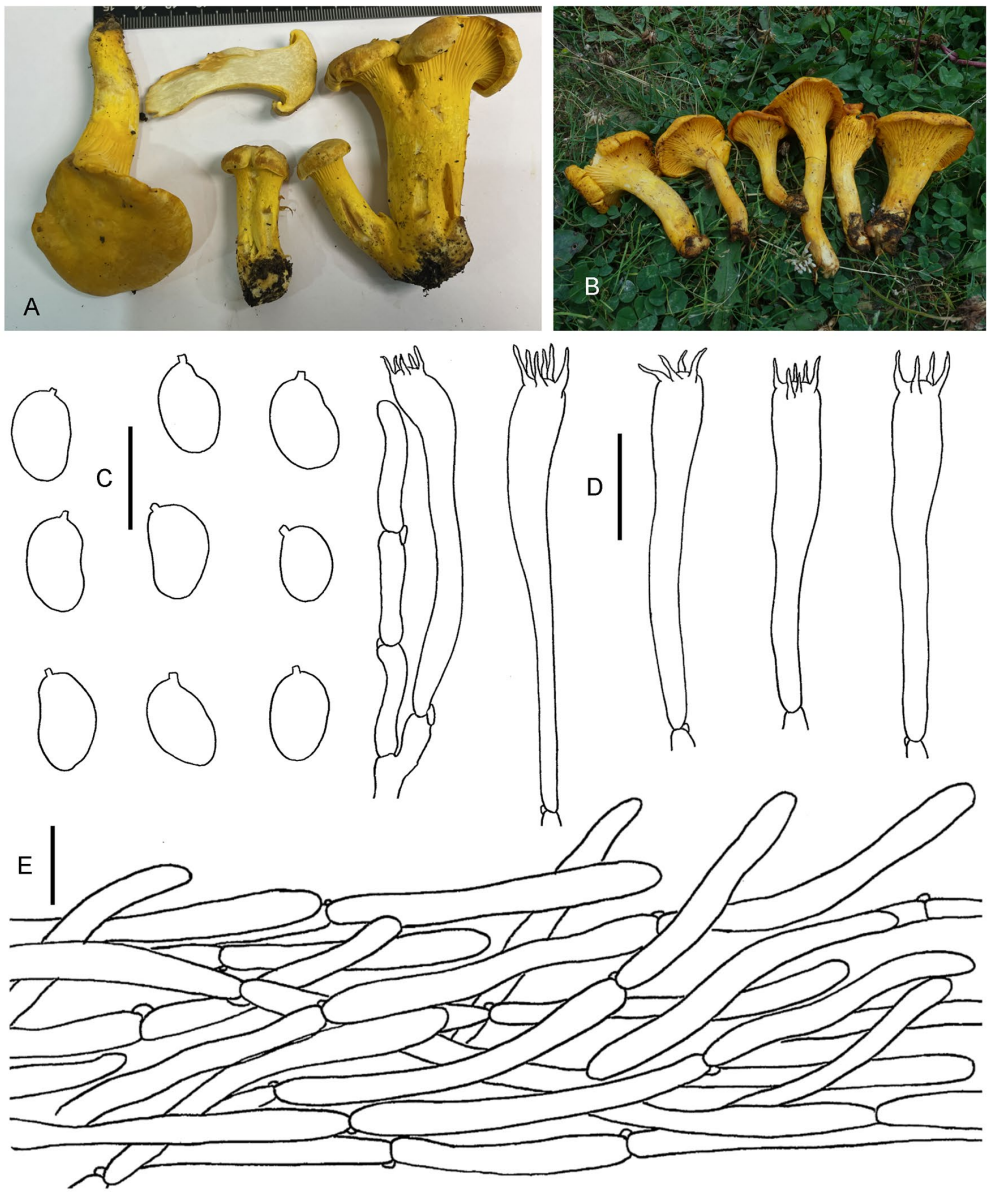


Figure 19 – Morphology of *Cantharellus tuberculosporus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Cantharellus* subg. *Cinnabarinus Buyck & V. Hofstetter

Type species: *C. cinnabarinus* (Schwein.) Schwein., Trans. Am. phil. Soc., New Series 4(2): 153 (1832) [1834]

Baisidomata small to quite small, pileus yellow, orange, pink to red, sometimes with lilac-purple or brownish tones, particularly at disc, glabrous or with appressed squamules. Hymenophore strongly veined to lamellate. Pileipellis with thin-walled hyphae. Clamp connections abundant.

Notes – Phylogenetic analyses well supported subg. *Cinnabarinus* as a monophyletic clade, and six species of the subgenus have been uncovered from China, containing four known species: *C. chrysanthus*, *C. citrinus*, *C. phloginus* and *C. sinocinnabarinus*, as well as two new species described in the present study: *C. chrysanthemoides* and *C. danxiashanensis*.

Cantharellus chrysanthemoides Ming Zhang, sp. nov. Fig. 20

Chinese name:拟菊黄鸡油菌

Fungal Name: FN573122; Facesoffungi number: FoF 19026

Etymology – "*-oides*" means "-like"; "*chrysanthemoides*" refers to the species similar to *C. chrysanthus*.

Diagnosis – Similar to *C. chrysanthus*, but different in smaller basidiomata, slightly more orange or reddish pileus, smaller basdiospores and basidia.

Type – China. Guangdong Province, Shaoguan City, Ruyuan County, Nanling National Nature Reserve, alt. 500 m, 9 Jun 2020, M. Zhang (GDGM80391).

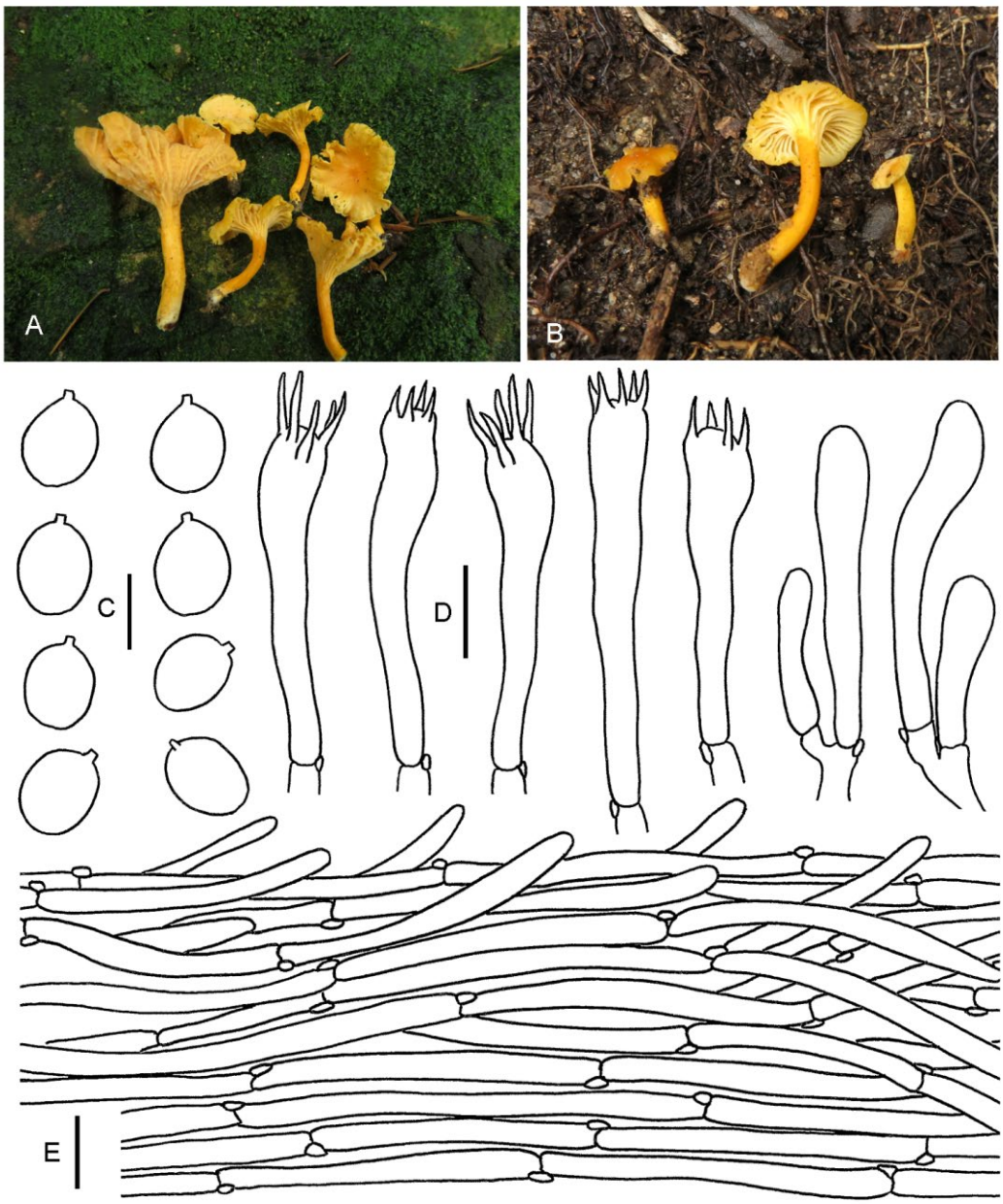


Figure 20 – Morphology of *Cantharellus chrysanthemoides*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Basidiomata small sized. Pileus 15–35 mm broad, convex, with involute margin when young, then gradually to nearly applanate or broadly infundibuliform with depressed center and inflexed to straight, irregularly undulate or slightly cracked at maturity; surface dry or hygrophanous, glabrous or finely subtomentose, orange, reddish orange to deep orange (5A7–7A7, 5A8–7A8) when young, slightly fading to light yellow to light orange (3A4–5A4) when mature. Context yellowish white to orange white (4A2–6A2), 1–1.5 mm thick in the center of the pileus, sharply attenuate towards margin, unchanging when exposed. Hymenophore decurrent, subdistant, composed of bifurcate, 1–

2 mm high vein-like folds, particularly towards pileus margin, pale yellow, light yellow, pale orange to light orange (3A3–6A3, 3A4–6A4), unchanging when bruised. Stipe 20–40 × 2–5 mm, central, cylindrical, solid, glabrous or finely pubescent, concolorous with pileus or paler, unchanging when handled. Odour fruity and pleasant. Taste mild.

Basidiospores 7–8 × 5–6 μm, Lm × Wm = 7.34(±0.42) × 5.5(±0.35) μm, Q = (1.25)1.27–1.4(1.45), Q_m = 1.33 ± 0.06; broadly elliptical to subglobose, smooth, guttulate, thin-walled. Basidia 50–70 × 7–10 μm, narrowly clavate, colourless in KOH, 2–6-spored, sterigmata 6–10 μm long. Pileipellis a cutis with long, repent and occasionally interwoven subcylindrical hyphae 6–15 μm wide, thin-walled. Stipitipellis a cutis of cylindrical, parallel hyphae, 2–7 μm wide. Clamp connections abundant in all tissues.

Habitat and distribution – Solitary or scattered under Fagaceae trees mixed with other broad-leaved trees in subtropical forests. Known from Guangdong and Hunan Provinces, southern China.

Additional specimen examined – China, Hunan Province, Chenzhou City, Yizhang town, Mangshan National Nature Reserve, alt. 1100 m, 30 Jul 2017, M. Zhang (GDGM60334).

Notes – *Cantharellus chrysanthemoides* is similar to *C. chrysanthus* in morphology. However, *C. chrysanthus* differs in having larger basidiomata (pileus up to 60 mm) with an orange to orange-yellow pileus, a pinkish white to orange white hymenophore, relatively larger basidiospores (7.5–9 × 5–6.5 μm), and longer basidia up to 100 μm long (Zhang et al. 2022a).

Phylogenetic analyses showed that *C. chrysanthemoides* formed a sister clade to *C. friesii* and was closely related to *C. corallinus*. *Cantharellus friesii*, originally described from France, differs by its larger basidiomata (pileus up to 50 mm broad), pinkish orange to orange-red pileus, very pale pinkish orange to pale ochre orange hymenophore, pale pinkish orange stipe surface sometimes with pinkish orange patches, and larger basidiospores measuring (7.5)8.5–11.5(13) × 4.5–5.5(6) μm (Olariaga et al. 2016); *C. corallinus,* originally described from North America, differs in having pinkish red to orange-reddish basidiomata with pinkish red hymenophore, longer and narrower basidiospores (7.3–9.2 × 3.7–5 μm) (Buyck et al. 2016c).

Cantharellus chrysanthus Ming Zhang, C.Q. Wang & T.H. Li, Journal of Fungi 8 (5, no. 483): 7 (2022) Fig. 21

Chinese name:菊黄鸡油菌

Pileus 20–60 mm broad, glabrous or finely subtomentose, orange (5A7–6A7) to deep orange (5A8–6A8) when young, slightly fading to orange yellow to yellow (3A7–4A7) when mature, usually with pale red to reddish orange in some specimens. Hymenophore decurrent, composed of bifurcate, 2–3 mm high vein-like folds, yellowish white to orange white, pinkish white (7A2–10A2). Stipe 20–60 × 3–14 mm, solid, glabrous or finely pubescent, concolorous with pileus or paler. Basidiospores 7.5–9 × 5–6.5 μm. Basidia 55–100 × 7–11 μm, 2–6-spored, narrowly clavate. Pileipellis a cutis with long, repent and occasionally interwoven hyphae 6–12 μm wide, thin-walled. Clamp connections abundant in all tissues.

Habitat and distribution – Solitary or scattered under broad-leaved forests mainly dominated by Fagaceae trees in subtropical forest. Known from southern China.

Specimens examined – China. Anhui Province, Huangshan City, Huangshan scenic spot, 11 Aug 2020, M. Zhang (GDGM82511), Same location, 13 Aug 2020, M. Zhang (GDGM82516). Guangdong Province, Shaoguan City, Ruyuan County, Nanling National Nature Reserve, alt. 500 m, 7 Jun 2017, M. Zhang (GDGM49628); Same location, 21 Jul 2017, M. Zhang (GDGM60524); 9 Jun 2020, M. Zhang (GDGM80436, GDGM80438); 10 Jun 2020, M. Zhang (GDGM80202, GDGM80204, GDGM80217, GDGM80220); 6 Sep 2022,B. Song (GDGM89326); Huizhou City, Xiangtoushan National Nature Reserve, alt. 550 m, 17 May 2016, T. Li (GDGM45937). Guizhou Province, Guiyang City, Longli County, Guanyin Village, bought from a wild mushroom market, 2 Augt 2019, alt. 1000 m, Y. He (GDGM77035). Hunan Province, Rucheng town, Jiulongjiang National Forest Park, alt. 300 m, 4 Sep 2016, M. Zhang (GDGM53485). Zhejiang Province, Jinhua city, Wuyi Town, 23 Aug 2015, T.H. Li (GDGM45166); Hangzhou City, Laohushan, 15 Jul 2021, B.J. Ling (GDGM85298, GDGM85305); Qingyuan Town, Baishanzu National Nature Reserve, alt.

29 Jul 2020, T.H. Li (GDGM82473); Longquan City, Fengyangshan National Nature Reserve, 25 Aug 2016, R.L. Zhao (ZRL20161616, HMAS279434); Quzhou City, Kaihua County, Hetian township, Chikeng village, 24 May 2021, Y. Li (GDGM87950); Shengtanggou Scenic Spot, 30 May 2021, Y. Li (GDGM87951).

Notes – *Cantharellus chrysanthus*, recently reported from subtropical regions of southern China, is widely distributed in Guangdong, Guizhou, Anhui and Zhejiang Provinces, in symbiosis with broad-leaved trees such as Fagaceae (*Castanopsis concinna*, *Lithocarpus glaber*, *Castanopsis* spp., etc.). The orange to deep orange tinged basidiomata usually with reddish tint fits well with *C*. subg. *Cinnabarinus*, and it can be easily distinguished from the other species in morphology and DNA sequences.

Phylogenetic analyses showed that it was closely related to *C. phloginus*. However, the latter can be easily distinguished by its pastel red to pastel pink basidiomata with white to yellowish orange hymenophore, and relatively larger basidiospores measuring 6.8–9.5 (12) × 5–7 μm (Zhang et al. 2022a).



Figure 21 – Morphology of *Cantharellus chrysanthus*. A, B. Basidiomata. C. Basidia. D. Basidiospores. E. Pileipellis. Scale bars: C, E = 20 μm; D = 10 μm.

Cantharellus citrinus Buyck, R. Ryoo & Antonín, MycoKeys 76: 35 (2020) Fig. 22

Chinese name:橘黄鸡油菌

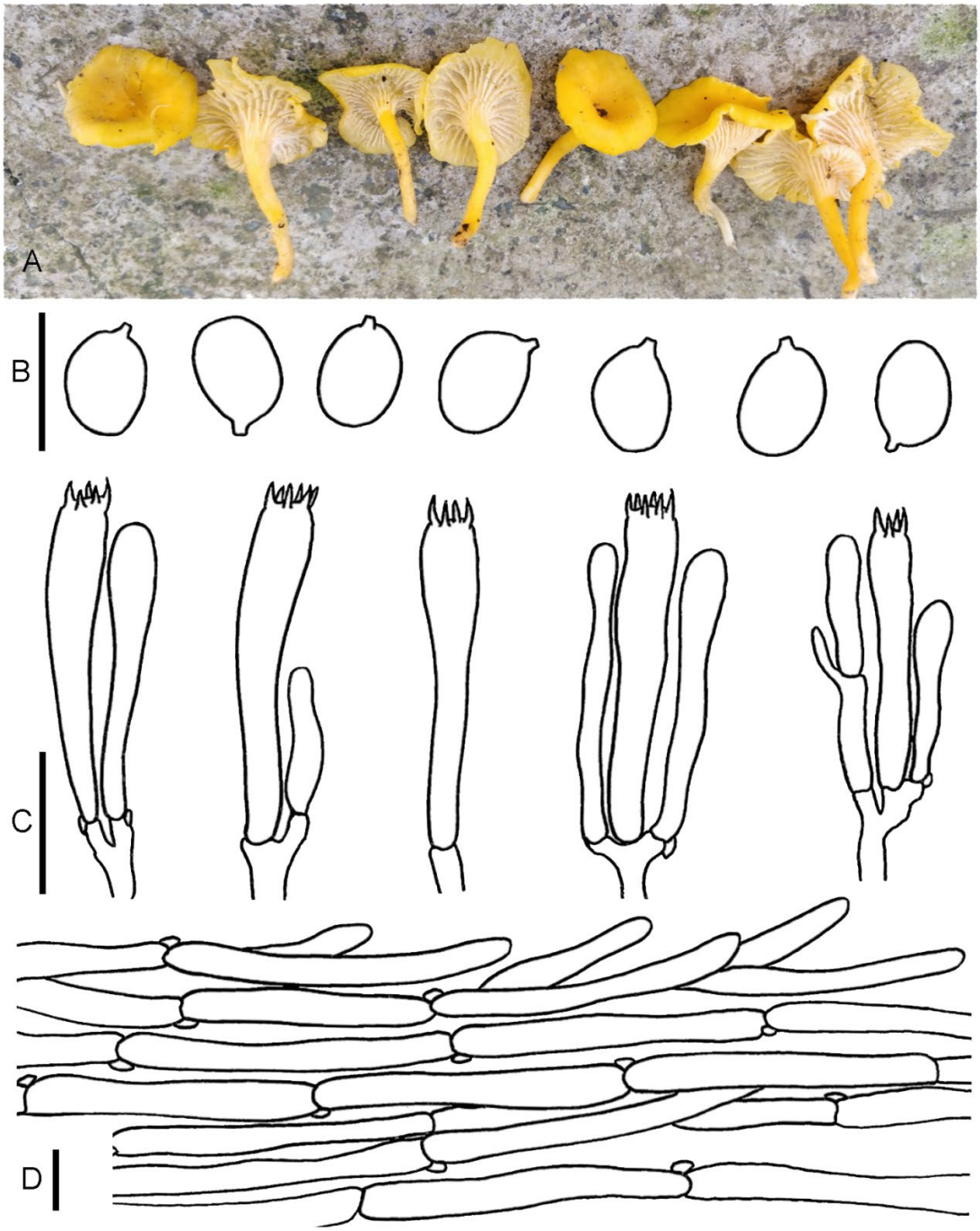


Figure 22 Morphology of *Cantharellus citrinus* (GDGM80825). **A**. Basidiomata. **B.** Basidiospores. **C.** Basidia. **D**. Pileipellis. Scale bars: **B** = 10 µm; **C, D** = 20 µm.

Pileus 15–45 mm broad, glabrous or finely subtomentose, greenish yellow, light yellow, yellow to yellowish orange (1A4–4A4, 1A7–4A7). Hymenophore decurrent, composed of bifurcate, less than 1 mm high vein-like folds, white to yellowish white (1A2–3A2). Stipe 15–30 × 3–5 mm, hollow, glabrous, concolorous with pileus or paler. Basidiospores 7–9 × 5–6(6.5) µm, broad elliptical. Basidia 55–65 × 7–8 µm, 4–6-spored, narrowly clavate. Pileipellis a cutis with

long, repent and occasionally interwoven hyphae 5–15 μm wide, thin-walled. Clamp connections abundant in all tissues.

Habitat and distribution – Growing in groups or gregariously on soil under mixed forest in southwest China. Known from southwest China and Korea.

Specimens examined – China. Guizhou Province, Guiyang City, Longli County, Guanyin Village, bought from a wild mushroom market, 1 Jul 2020, alt. 1000 m, M. Zhang (GDGM80825); Same location, 16 Jun 2020, T. Li (GDGM80724); 7 July 2021, Ming Zhang (GDGM86142).

Notes – *Cantharellus citrinus*, originally described from South Korea, was recently reported from southwest China (Buyck et al. 2020, Zhang et al. 2022). It can be distinguished by its small basidiomata with greenish yellow to yellowish orange pileus, white to yellowish white hymenophore, and hollow stipe. In China, *C. citrinus* can be commonly seen in wild mushroom markets in Guizhou Province (called "small huang si jun 小黄丝菌"), often sold mixed together with other small *Cantharellus* species such as *C. sinominor* and *Cantharellus* spp.

Geographically, *C. citrinus* might be a narrowly distributed species, which is currently only found in Guizhou Province, and associated with conifers. However, Buyck et al. (2020) reported that it grew under Fagaceae or *Abies koreana*.

Cantharellus danxiashanensis Ming Zhang & T.H. Li, sp. nov. Fig. 23

Chinese name:丹霞山鸡油菌

Fungal Name: FN573123; Facesoffungi number: FoF 19027

Etymology – "*danxiashanensis*" refers to the type locality, Danxiashan National Nature Reserve.

Diagnosis – Similar to *C. chrysanthus*, but differs in smaller basidiomata and narrower basidiospores; also close to *C. citrinus*, but has less greenish tinge, smaller basidiomata and basidiospores.

Type – China. Guangdong Province, Shaoguan City, Renhua County, Danxiashan National Nature Reserve, under broad-leaved forests, alt. 500 m, 14 Aug 2019, J.P. Li (GDGM77227)

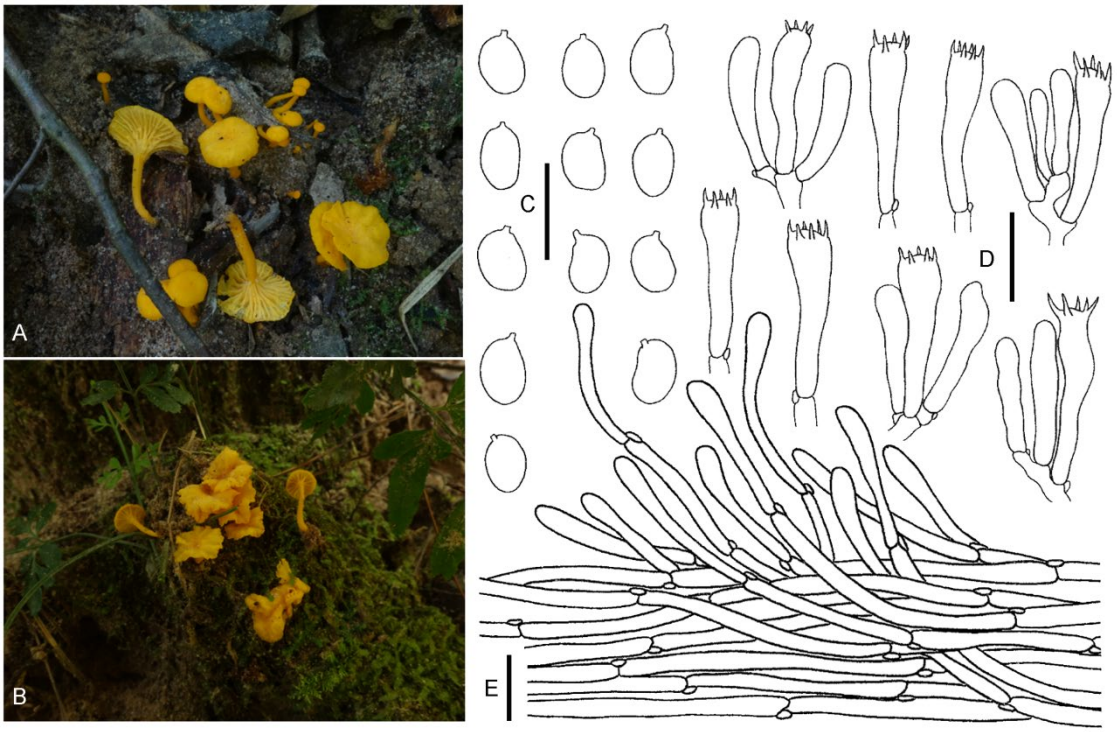


Figure 23 Morphology of *Cantharellus danxiashanensis*. **A, B**. Basidiomata. **C.** Basidiospores. **D.** Basidia. **E**. Pileipellis. Scale bars: **C** = 10 μm; **D, E** = 20 μm.

Basidiomata small-sized. Pileus 5–15 mm broad, convex, with involute margin when young, then gradually to nearly applanate with a slightly depressed center, margin straight, irregularly undulate or slightly cracked at maturity; surface dry, glabrous or finely subtomentose, yellow, yellowish orange to orange (3A6–5A6). Context yellowish white to orange white (4A2–6A2), thin, 1 mm thick in the center of the pileus, sharply attenuate towards margin, unchanging when exposed. Hymenophore decurrent, distant to subdistant, as relatively well-developed gill-like ridges, 1–1.5 mm high, composed of appropriately bifurcate and interconnected low vein-like folds, particularly towards pileus margin, light yellow to grayish yellow (2A5–4A5, 2B5–4B5), unchanging when bruised. Stipe 7–20 × 1–2 mm, central, cylindrical, solid, glabrous or finely pubescent, concolorous with pileus, unchanging when handled. Odour fruity and pleasant. Taste mild.

Basidiospores 7–8 × 4.5–5 μm, Lm × Wm = 7.45(±0.42) × 4.75(±0.25) μm, Q = 1.4–1.77, Q_m = 1.57± 0.13; broadly elliptical to subglobose, smooth, guttulate, thin-walled. Basidia 35–50 × 7–10 μm, 4–6-spored, narrowly clavate, colourless in KOH; sterigmata 3–6 μm long. Pileipellis a cutis, composed of long, repent and occasionally interwoven hyphae, subcylindrical cells that are 5–13 μm wide, thin-walled. Stipitipellis a cutis of cylindrical, parallel hyphae, 3–8 μm wide. Clamp connections abundant in all tissues.

Habitat and distribution – Solitary or scattered under broad-leaved forests mainly dominated by Fagaceae trees in subtropical regions of China. Only known from Guangdong Province, southern China.

Specimens examined – China, Guangdong Province, Shaoguan City, Renhua County, Danxiashan National Nature Reserve, alt. 500 m, 14 August 2019, J.P. Li (GDGM77227); Same location, alt. 350 m, 14 Aug 2019, J.Y. Xu (GDGM77228).

Notes – *Cantharellus danxiashanensis* is characterized by its small basidiomata, yellow to orange pileus, subdistant gill-like hymenophore relatively well-developed, and association with broad-leaved trees in subtropical regions of southern China. The distinct morphological characters fit it well into *C.* subg. *Cinnabarinus*.

Two Asian species *C. chrysanthus* and *C. citrinus* in subg. *Cinnabarinus* are similar to the new species. However, *C. chrysanthus* can be distinguished by its larger basidiomata (pileus up to 60 mm broad), orange to deep orange pileus, yellowish white to pinkish white hymenophore, and broader basidiospores (7.5–9 × 5–6.5 μm); *C. citrinus* differs by its greenish yellow to yellowish orange pileus, white to yellowish white hymenophore, hollow stipe, and broader basidiospores (7–9 × 5–6.5 μm) and larger basidia (55–65 × 7–8 μm) (Buyck et al. 2020; Zhang et al. 2022a).

Phylogenetic analyses (Figs. 1 and 2) showed that *C. danxiashanensis* well nested into *C.* subg. *Cinnabarinus,* and sister to *C. garnierii* with significant support value (BS/BPP=100/1). However, *C. garnierii,* originally reported from New Caledonia, differs by its relatively larger basidiomata (pileus up to 40 mm broad), strongly interveined hymenophore, larger and broader basidiospores (up to 10 μm long, 6 μm wide) (Ducousso et al. 2004, Buyck et al. 2016c).

Cantharellus phloginus S.C. Shao & P.G. Liu, Mycoscience 57(2): 146 (2016) Fig. 24

= *Cantharellus albovenosus* Buyck, Antonín & Ryoo, Mycol. Progr. 16(8): 757 (2017)

Chinese name:桃红鸡油菌

Pileus 20–60 mm broad, glabrous to tomentose, orange, deep orange, reddish orange, pastel red to pastel pink (5A6–7A6, 5A8–7A8, 7A4–11A4), pallescent toward margin; Hymenophore decurrent, gill-liked ridges with bifurcate and interconnected low vein-like folds, white, orange white, pale yellow to light yellow (3A3–4A3, 5A2–6A2). Stipe 20–50 × 2.5–9 mm, glabrous or with finely longitudinally fibrillose, concolorous with pileus. Basidiospores 7–9 × 5–6 μm, broadly ellipsoid to subglobose, guttulate. Basidia 48–95 × 7–10 μm, 2–6-spored, narrowly clavate. Pileipellis a cutis, composed of repent, cylindrical, thin-walled hyphae, 3–13 μm wide. Clamp connections abundant.

Habitat and distribution – Scattered or gregarious on soil under broad-leaved forests dominated by Fagaceae trees. Known from south China and South Korea.

Specimens examined – China, Yunnan Province, Puer City, bought from a mushroom market, 28 Sep 2019, M. Zhang (GDGM79007). Jiangsu Province, Nanjing City, Purple Mountain, 19 Jun 2021, alt. 150 m, Z.H. Zhang (GDGM85846); same location, 28 Jun 2021, Z.H. Zhang (GDGM85852, GDGM85853), 20 Jul 2023, Y.Y. Zhang (GDGM91695). Anhui Province, Huangshan National Scenic Area, 26 Aug 2021, alt. 1400 m, C.J. Jiang (GDGM85142). Zhejiang Province, Lishui City, Jingning Town, Wangdongyang Alpine Wetland Nature Reserve 22 Sep 2016, R.L. Zhao (HMAS279296, HMAS279292); Same location, 23 Sep 2016, R.L. Zhao (HMAS279262, HMAS279284). Huzhou City, 28 Sep 2023, Z.L. Zhou (GDGM92536).

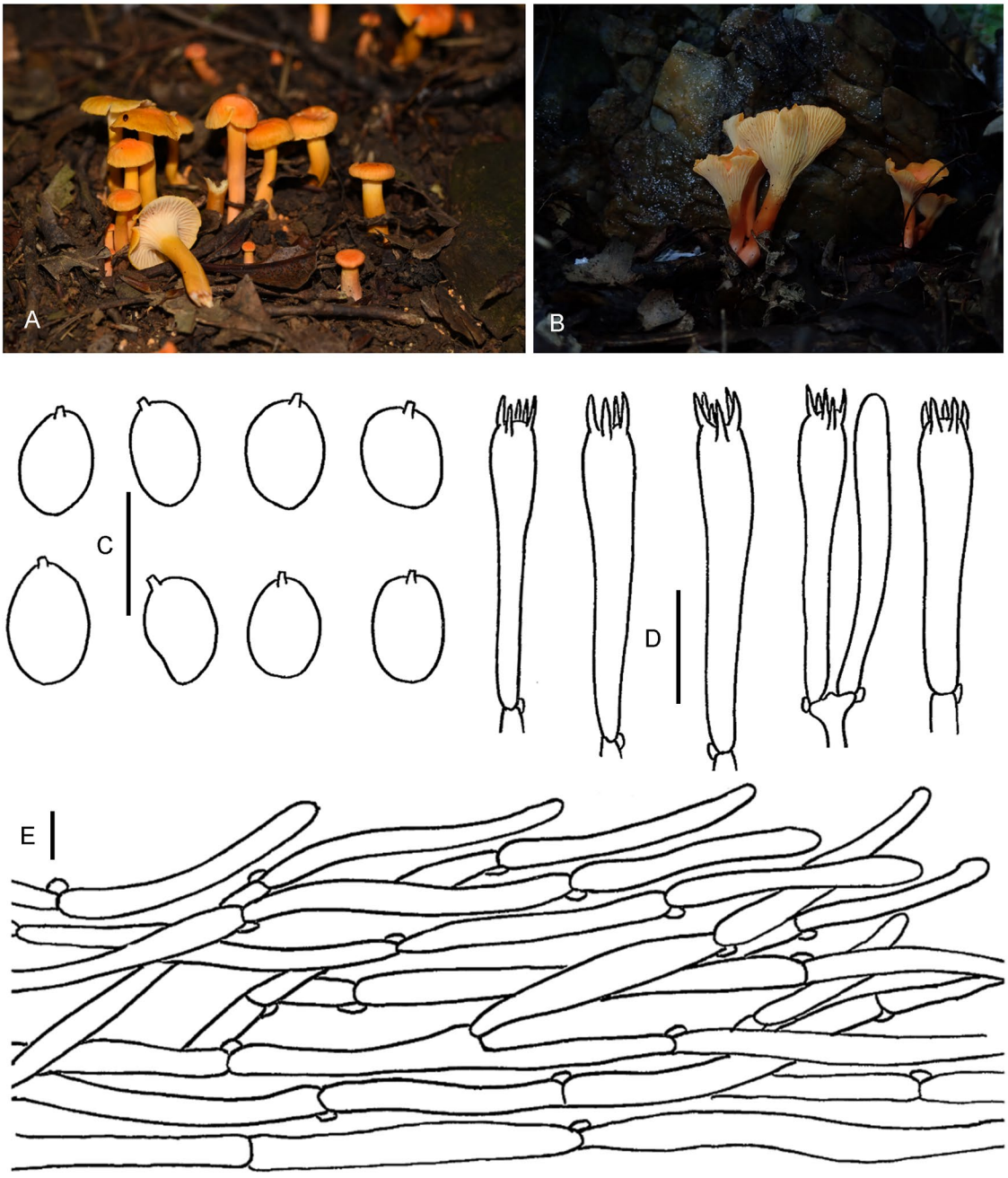


Figure 24 – Morphology of *Cantharellus phloginus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Notes – *Cantharellus phloginus*, originally reported from southwest China, is characterized by its pastel red to pastel pink pileus and stipe, pale yellow to yellowish-orange hymenophore, and

ellipsoid basidiospores (7–9 × 5–6 µm) (Shao et al. 2016a). Recent studies have proven that this species is widely distributed in subtropical to tropical regions of southern China, including the provinces of Yunnan, Guangdong, Zhejiang, Anhui, and Jiangsu (Zhang et al. 2022a, Wang et al. 2023a). The basidiomata colour of *C. phloginus* is highly variable, pileus can be yellowish orange, reddish orange, pastel red, pastel pink, vivid pinkish, light pink, or red, while the hymenophore can be white, orange-white to light yellow.

Phylogenetic analyses showed that samples of *C. phloginus* formed a well supported lineage in *C.* subg. *Cinnabarinus* with significant support value (BS/BPP=100/1). The type specimen of *C. albovenosus* also nested into this lineage (Fig. 2), and the latter is a synonym of *C. phloginus*.



Figure 25 – Morphology of *Cantharellus sinocinnabarinus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Cantharellus sinocinnabarinus Ming Zhang, S.C. Shao & T.H. Li, Journal of Fungi 8 (5, no. 483): 10 (2022) Fig. 25

Chinese name:中华小红鸡油菌

Pileus 5–15 mm broad, applanate with center depressed, not perforate, surface dry, orange, reddish orange to yellowish red (6A7–8A7), locally with white minute fibrils. Hymenophore subdecurrent, yellowish orange to orange (4A7–6A7). Stipe 10–15 mm long, 1–2.5 mm thick, smooth or with obscure white minute fibrils, hollow, concolorous with pileus. Basidiospores (6.5–)7–8(9) × (4.5)5–6 μm, elliptical to elongate elliptical. Basidia 50–75 × 10–12 μm, clavate, 4–8-spored. Pileipellis a cutis, composed of procumbent hyphae 4–13 μm in diam., thin-walled. Clamp connections common.

Habitat and distribution – Gregarious on soil in subalpine mixed forest dominated by *Cyclobalanopsis delavayi* and *Pinus yunnanensis*. Known from southwest China.

Specimens examined – China, Yunnan Province, Lijiang City, Yulong County, Jiuhe Village, 1 Sep 2020, alt. 2400 m, M. Zhang (GDGM83023, GDGM83027, GDGM83229, GDGM83230, GDGM83232); Same location and data, L.Q. Wu (GDGM83238); Chuxiong Prefecture, Lufeng County, Guangtong Town, alt. 2400 m, 17 Sep 2022, X.L. Gao 32 (GDGM97194); Jianchuan County, Qianshi Mountain, 7 Sep 2009, alt. 2491 m, Yu23 (HKAS58243).

Notes – *Cantharellus sinocinnabarinus* can be distinguished by its small basidiomata with a reddish orange to yellowish red pileus, orange hymenophore, and elliptical to elongate elliptical basidiospores measuring (6.5–)7–8(9) × (4.5)5–6 μm. In the past, *C. sinocinnabarinus* was identified as *C. cinnabarinus* in China (Shao et al. 2012). However, recent phylogenetic studies proved that they are two different species, and formed two distinct lineages in phylogenetic trees (Zhang et al. 2022a, present study). *C. cinnabarinus* can be distinguished by its larger basidiomata, smaller basidiospores (6.7–7.57 × 3.82–4.68 μm), and thick-walled hyphae of pileipellis terminal cells (Buyck et al. 2011, Zhang et al. 2022a). *C. sinocinnabarinus* is only known from mixed forests of subalpine regions of southwest China.

Cantharellus* subgen. *Magni T. Cao & H.S. Yuan, Stud. Mycol. 99: 30 (2021)

Type species: *C. magnus* Ting Cao & H.S. Yuan, in Cao et al., Stud. Mycol. 99(no. 100121): 35 (2021)

Basidiomata large in size. Pileus deep yellow to deep orange. Hymenophore smooth or poorly developed. Basidiospores broadly ellipsoid. Pileipellis with thin- to slightly thick-walled terminal cells of hyphae. Clamp connections present.

Notes – This subgenus was established by Cao et al. in 2021 on the base of the type species *C. magnus* T. Cao & H.S. Yuan. Three species, *C. bellus* N.K. Zeng, Y.Z. Zhang & Zhi Q. Liang, *C. laevigatus* N.K. Zeng, Y.Z. Zhang, Z.H. Chen & W.F. Lin and *C. magnus* have been reported from China. However, phylogenetic analyses in this study proved that *C. laevigatus* is synonymous with *C. magnus*.

Cantharellus bellus N.K. Zeng, Y.Z. Zhang & Zhi Q. Liang, Frontiers in Microbiology 14: 8 (2023)

Chinese name:美丽鸡油菌

Notes – *Cantharellus bellus*, recently described from Hainan Province of China, is characterized by the bright orange-yellow pileus, pale yellow and well-developed gill-like hymenophore, grayish yellow to fulvous stipe, slightly thick-walled basidiospores measuring (7)7.5–9.5(10) × 5.5–6.5(7) μm and the intricate trichodermal pileipellis (Zhang et al. 2023). In morphology, *C. bellus* is more similar to those species in *C.* subg. *Cantharellus* with bright orange-yellow pileus, relatively well-developed gill-like hymenophore strongly forked and anastomotic. However, phylogenetic analyses proved that *C. bellus* is a member of *C.* subg. *Magni* and closely related to *C. magnus*, which distinguishes it from other species in *Cantharellus*.

No morphological description for the species is given here, as the authors have not collected this species. For detailed morphological descriptions, comparisons with similar species, and illustrations of *C. bellus*, refer to Zhang et al. (2023).

Cantharellus magnus T. Cao & H.S. Yuan, Stud. Mycol. 99 (no. 100121): 35 (2021) Fig. 26

= *Cantharellus laevigatus* N.K. Zeng, Y.Z. Zhang, Z.H. Chen & W.F. Lin, Frontiers in Microbiology 14 (no. 1109831): 12 (2023)

Chinese name:巨盖鸡油菌

Pileus 3–14 cm broad, nearly glabrous to subtomentous, yellow, reddish yellow, orange, reddish orange to orange red (3A6–8A6). Hymenophore deeply decurrent, smooth, sometimes wrinkly or very ill-defined veined, yellow to vivid yellow (2A6–3A6, 2A8–3A8) when young, slightly changing to pale yellow (2A3–4A3) when mature. Stipe 4–10 × 0.8–1.5 cm, surface covered with tiny, yellow to pale yellow scales, slightly deeper to orange toward base. Basidiospores (8)8.5–10.2(15) × (4.8)5.2–6.5(7) µm, thin-walled. Basidia 45–82 × 8–9 µm, clavate to subcylindrical, thin-walled, 2–5-spored. Pileipellis a cutis, composed of long, repent, branched, interwoven and thin-walled hyphae, 4–9 µm wide, terminal cells narrowly clavate or subcylindrical, thin-walled. Clamp connections present in all tissues.

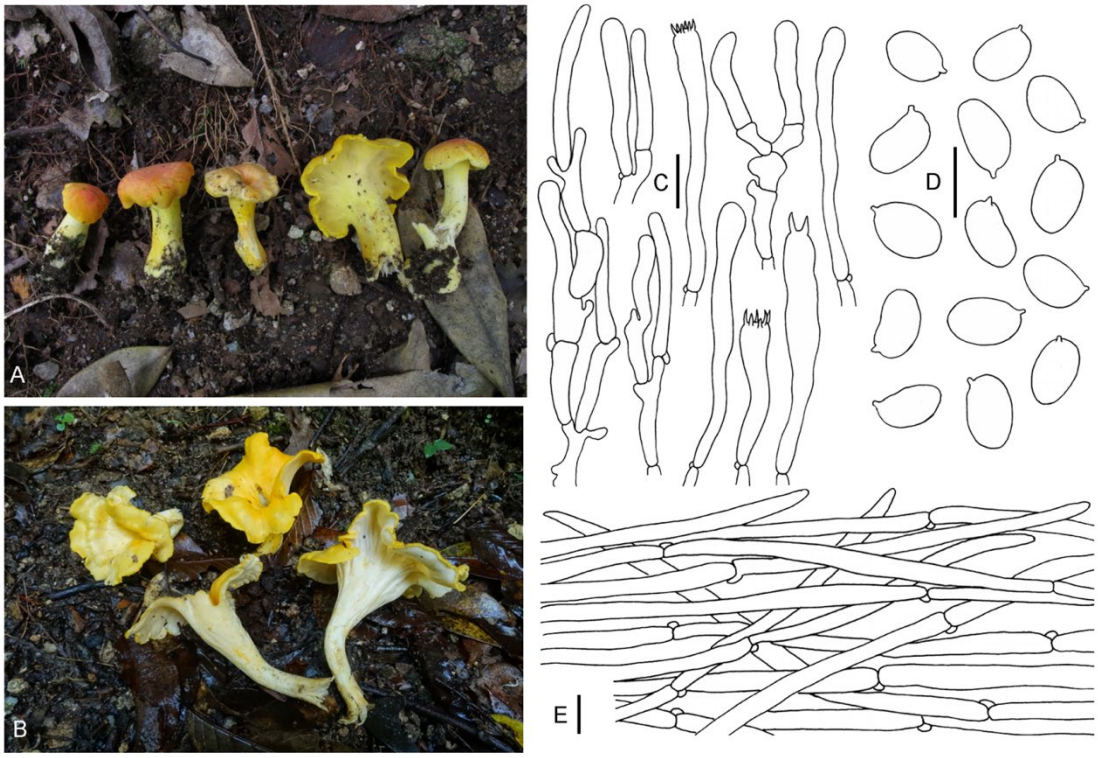


Figure 26 – Morphology of *Cantharellus magnus*. A, B. Basidiomata. C. Basidia. D. Basidiospores. E. Pileipellis. Scale bars: C, E = 20 µm; D = 10 µm.

Habitat and distribution – Solitary or scattered under broad-leaved forests in subtropical China. Known from Anhui, Guangdong, Hunan, Jiangxi and Zhejiang Provinces, south China.

Specimens examined – China. Anhui Province, Huangshan City, Huangshan scenic area, 27 Aug 2021, T.Q. Yu (GDGM85140), Same location, 3 Sep 2021, T.Q. Yu (GDGM85139); Guangdong Province, Shaoguan City, Ruyuan County, Nanling National Nature Reserve, alt. 600 m, 30 Jul 2017, M. Zhang (GDGM70328, GDGM70332, GDGM70350), B. Song (GDGM70272), H. Huang (GDGM70506); Same location, 24 Aug 2023, T. Li (GDGM93114); Jiangxi Province, Pingxiang City, Wugong Mountain National Scenic Area, alt. 1100 m, 26 Aug 2017, H. Huang (GDGM54903); Hunan Province, Sangzhi County, Badagong Mountain, Tianping Mountain, alt. 1456 m, 31 Jul 2020, Z.H. Chen (MHHNU32011); Same location, 31 July 2020, Z.H. Chen (MHHNU32009, MHHNU32013, MHHNU32014, MHHNU32061, MHHNU32846).

Notes – *Cantharellus magnus* is characterized by its large basidiomata, yellow, reddish yellow to orange red pileus, smooth hymenophore, and elliptical basidiospores (Cao et al. 2021a).

Phylogenetic studies showed that it represents an independent subgeneric clade which is easily separated by genetic distance from those smooth hymenophore species in *C.* subg. *Cantharellus*.

Recently, *C. laevigatus* N.K. Zeng, Y.Z. Zhang, Z.H. Chen & W.F. Lin was described from China; it cannot be distinguished morphologically from *C. magnus*. It differs slightly in smaller basidiomata (pileus 2.3–5.2 cm broad) and basidiospores (6.5−9 × 5−7.5 μm) (Zhang et al. 2023). However, the present phylogenetic analyses showed that the two species clustered together, with no distinct genetic gap between them (Figs. 1. 2). A Blast search showed 99.46% similarity in the *tef*1 sequences with only one site different (MHHNU32011 vs. Wei 10244), and 100% query cover in the LSU sequences (MHHNU32011 vs. IFP 019443). The slight morphological difference between the two species will likely disappear when more specimens are studied. Thus, *C. laevigatus* should be regarded as a synonym of *C. magnus*.

Cantharellus* subg. *Parvocantharellus Eyssart. & Buyck, Docums Mycol. 31(no. 121): 56 (2001)

Type species: *C. romagnesianus* Eyssart. & Buyck, Cryptog. Mycol. 20(2): 108 (1999)

Basidiomata very small to medium-sized. Pileus white, yellowish to brownish, sometimes with lilac-purple tinge, unchanging or changing to yellowish when handled. Context yellowish, unchanging when exposed. Terminal hyphae of pileipellis thin-walled, sometimes slightly thickened. Clamp connections abundant.

Notes – This is the most species-rich subgenus in China with 15 species reported, including 11 known species, i.e., *C. albus*, *C. austrosinensis*, *C. aurantinus*, *C. convexus*, *C. galbanus*, *C. koreanus*, *C. parvoluteolus* (= *C. luteolus*), *C. luteovirens*, *C. minoalbus*, *C. neopersicinus* and *C. zangii*, and four new species, i.e., *C. albidohymenius*, *C. roseocastaneus*, *C. pseudoaustrosinensis* and *C. subtilis.*

Cantharellus albus S.P. Jian & B. Feng, Phytotaxa 470(2): 137 (2020) Fig. 27

Chinese name:白鸡油菌

Pileus 18–42 mm broad, dry, with appressed fibrillose squamules, white to yellowish white (4A1–4A2), slightly changing to yellowish when handled. Hymenophore decurrent, composed of bifurcate and strongly interconnected low veins, white to yellowish white, unchanging or slightly changing to yellowish when bruised. Stipe 20–60 × 2–8 mm, solid, glabrous or faintly scaly, concolorous with pileus, but in the lower part usually yellowish, slightly changing to yellowish when handled. Basidiospores 5.5–7.5 × (4) 4.5–6 μm, broadly ellipsoid to subglobose. Basidia 43–60 × 8–12 μm, 4–6-spored, narrowly clavate. Pileipellis a cutis with long, repent and occasionally interwoven hyphae 5–13 μm wide, thin-walled. Clamp connections abundant in all tissues.

Habitat and distribution – Gregarious under broad-leaved forests in subtropical regions. Known from southern China.

Specimens examined – China, Guangdong Province, Guangzhou City, Baiyunshan National Forest Park, 160 m, 14 May 2016, M. Zhang (GDGM45932); Same location, 15 Jun 2018, M. Zhang (GDGM73460); 15 Jun 2019, Y. He (GDGM56646); 27 Aug 2019, Y. He (GDGM77819); 8 Jun 2020, X.S. Liang (GDGM80164); 15 Jun 2020, M. Zhang (GDGM81399); Shaoguan City, Nanling National Nature Reserve, 10 Jun 2022, M. Zhang (GDGM87297); Shaxi Town, 4 September 2023, Amateur (GDGM93449). Gunagxi Province, Nanning City, 2 Jul 2019 X.L. Wu (WXL201983, GDGM97200); Baise City, 31 Aug 2023 Z.C. Ruan (GDGM93722); Guilin City Xingan County, Gaoshang Town, 1 Jul 2023, Amateur (GDGM91707).

Notes – *Cantharellus albus* can be easily distinguished in the field by its small white to yellowish white basidiomata slightly changing to yellowish when bruised, strongly interveined hymenophore, and distinctly creamy or fruity scent (Jian et al. 2020). The white species *C. minioalbus* recently reported from China is similar to *C. albus.* However, *C. minioalbus* differs by its smaller basidiomata (usually less than 10 mm wide) unchanging when bruised, relatively well developed hymenophore, and smaller basidiospores (4.5–7.0 × 4–5.5 μm) (Zhang et al. 2021a).

Phylogenetic analyses well supported *C. albus* as a distinct species in *C.* subg. *Parvocantharellus*, and close to *C. parvoluteolus* (= *C. luteolus* Ming Zhang, C.Q. Wang & T.H.

Li). However, *C. parvoluteolus* differs by its yellow to orange pileus, grayish-yellow to grayish-orange hymenophores, and larger basidiospores (7–8 × 5.2–6.5 µm) (Zhang et al. 2021a).



Figure 27 – Morphology of *Cantharellus albus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C =10 µm; D, E = 20 µm.

Cantharellus albidohymenius Ming Zhang & T.H. Li, sp. nov. Fig. 28

Chinese name:白褶鸡油菌

Fungal Name: FN573124; Facesoffungi number: FoF 19028

Etymology – comes from the Latin words "*albidus*", meaning whitish and "*-hymenium*" refers to hymenophore; "*albidohymenius*" refers to the whitish hymenophore.

Diagnosis – Similar to *C. aurantinus*, but differs in having brownish orange minute fibrils on pileus surface, white to yellowish white hymenophore, and different DNA sequences.

Type – China. Yunnan Province, Dali Bai Autonomous Prefecture, Binchuan County, Jizushan Nature Reserve, under broad-leaved forests, alt. 2380 m, 2 Aug 2022, M. Zhang (GDGM90302).

Basidiomata small to medium sized. Pileus 4–6 cm broad, convex at first, applanate with center depressed at mature, not perforate, margin incurved when young, applanate, reflexed with age, sometimes irregularly split at margin, surface dry, pale yellow, pale orange to light orange, grayish orange to brownish orange at center (2A3–5A3, 5A5–5C5), glabrous or covered with brownish orange minute fibrils, especially at center. Context thin, 1.5–3.5 mm thick, fibrous, white to yellowish white, unchanging when bruised. Hymenophore gill-like, decurrent, composed of relatively well-developed, decurrent, branched to furcate gill folds, rugulose, strongly anastomose due to conspicuous transversal veins with age, 1–2 mm high, white to yellowish white (1A1,1A2–4A2), unchanging when bruised. Stipe 5–8 mm long, 8–10 mm thick, subcylindrical, tapering downward, glabrous or covered with minute fibrils, concolorous with pileus or paler to yellowish white. Odour fruity. Taste mild.

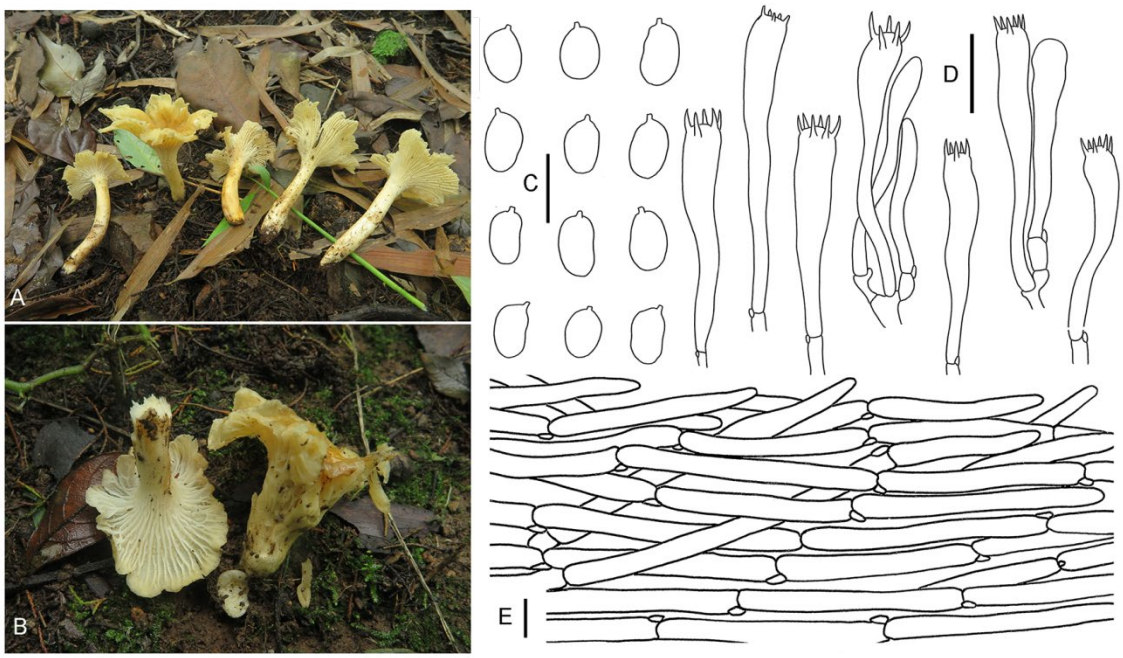


Figure 28 – Morphology of *Cantharellus albidohymenius*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C, E = 10 µm; D = 20 µm.

Basidiospores (7.5)8–9.5(10) × (4.5)5–5.5(6) µm, $L_m \times W_m$ = 8.78(±0.50) × 5.14(±0.31) µm, Q = 1.5–1.8, Q_m = 1.71± 0.09; smooth, broadly elliptical to oval. Basidia 55–90 × 9–12 µm, clavate, with 2–6 sterigmata, 4–8 µm long. Pileipellis a cutis, composed of horizontal, subparallel, cylindrical hyphae, 3–10 µm wide, colourless, thin-walled. Hymenophoral trama subregular to regular, composed of colourless, branched and cylindrical hyphae, 3–8 µm in diam. Stipitipellis a cutis, composed of parallel cylindrical hyphae 3–8 µm in diam. Clamp connections common.

Habitat and distribution – Solitary or scattered in forests dominated by broad-leaved trees (Fagaceae), mixed with a few trees of *Cupressus duclouxiana* in subtropical regions of China. Known from southwestern China.

Specimens examined – China, Yunnan Province, Dali Bai Autonomous Prefecture, Binchuan County, Jizushan Nature Reserve, under broad-leaved forests, alt. 2380 m, 2 Aug 2022, M. Zhang (GDGM90220, GDGM90244); Same location, alt. 2330 m, 2 Aug 2022, S.Z. Wang (GDGM90224).

Notes – *Cantharellus albidohymenius* is an uncommon and interesting species, which is similar to *C. cibarius* in morphology. However, phylogenetic analyses proved that

C. albidohymenius is a member of *C.* subg. *Parvocantharellus*, and close to *C. aurantinus* and *C. fibrillosus* Deepika, Upadhyay and Reddy. *Cantharellus aurantinus* recently reported from China, differs by its smaller basidiomata, light yellow to grayish orange pileus, pale yellow hymenophore, and smaller basidiospores (7–9 × 5–6 μm) (Zhang et al. 2021a). *Cantharellus fibrillosus* originally reported from India, differs by its fibrillose and golden wheat pileus with mustard brown at center, larger basidiospores (8.5–12 × 5–6 μm) and grows under coniferous forests (Deepika et al. 2014).

Cantharellus austrosinensis Ming Zhang, C.Q. Wang & T.H. Li, Journal of Fungi 7(11, no. 919): 13 (2021) Fig. 29

Chinese name:华南鸡油菌

Pileus 12–30 mm broad, dry, glabrous or tomentous, pastel yellow, light yellow to grayish yellow at mass (3A5–5A5, 3B5–4B5), with a grayish orange to brownish orange center (5B5–6B5, 5C5–6C5). Hymenophore decurrent, composed of bifurcate and interconnected low veins, pale yellow to light yellow (3A3–4A3, 3A5–4A5). Stipe 10–40 mm long, 2–5 mm thick, glabrous or with faintly scaly, hollow, concolorous with pileus. Basidiospores 6–8 × 4.8–6 μm, elliptical to broadly elliptical. Basidia 50–55 × 7–9 μm, clavate, 5–6(7)-spored. Pileipellis a cutis, composed of interwoven hyphae 5–12 μm in diam., thin-walled. Clamp connections abundant in all tissues.

Habitat and distribution – Solitary or scattered under mixed or conifer forests. Known from South China.

Specimens examined – China, Guangdong Province, Shaoguan City, Renhua County, Danxiashan National Nature Reserve, 103 m, 1 May 2020, M. Zhang (GDGM79507); Same location, 92 m, 5 Jun 2020, L.Q. Wu (GDGM81247); Feihuashui, 152 m, 3 Jun 2020, M. Zhang (GDGM81616); Xiafu, 199 m, N 25.00452471, E 113.71575467, 4 Jun 2020, M. Zhang (GDGM81249); Guanyinshan, 27 May 2020, M. Zhang (GDGM80151); Ruyuan County, Nanling National Nature Reserve, 550 m, 10 Jun 2020, M. Zhang (GDGM80211). Zhejiang Province, Ningbo City, Fenghua District, 22 Sep, 2023, B. Chen (GDGM93730). Guizhou Province, Longli County, Longjiashan, 5 Jul 2020, M. Zhang (GDGM81985). Yunnan Province, Chuxiong City, Zixishan Forest Park, 1 Aug 2022, M. Zhang (GDGM88657, GDGM89962), Nanhua County, wild mushrooms Market, 26 Aug 2020, M. Zhang (GDGM82877).

Notes – *Cantharellus austrosinensis* is a common species and widely distributed in Guangdong, Hunan, Jiangxi, Guizhou, Zhejiang and Yunnan Provinces of China. In the past, *C. austrosinensis* was identified as *C. minor* in southern China (Bi et al. 1993, Mao et al. 1998, Li et al. 2015). But recent studies have proved that the records of *C. minor* in China represent several different small chanterelle species, such as *C. austrosinensis*, *C. luteovirens*, *C. elongatipes*, *C. citrinus*, etc. (Zhang et al. 2021a, Cao et al. 2021a, Wang et al. 2023a).

Morphologically, it is difficult to distinguish *C. austrosinensis* from those small chanterelle species, such as *C. koreanus*, *C. convexus*, *C. tabernensis*, *C. galbanus*, *C. luteovirens*, etc. However, they can be clearly separated from each other by DNA sequences.

Cantharellus austrosinensis has only been discovered under mixed or conifer forests, and might form a symbiotic relationship with *Pinus massoniana* and *Pinus* spp., an ecological feature that may help with species differentiation.

Pileus 1.5–4 cm broad, glabrous, light yellow, light orange, grayish yellow to grayish orange (2A5–6A5, 2B5–6B5). Hymenophore decurrent, composed of bifurcate and interconnected low veins, pale yellow (2A3–4A3). Stipe 20–40 × 8–12 mm, solid, glabrous or faintly scaly, pale yellow to pale orange (2A3–5A3). Basidiospores (6.5)7–9 × (4.5)5–6 μm, broadly ellipsoid. Basidia 48–70 × 8–10 μm, 4–6-spored, narrowly clavate; sterigmata 3–8 μm long. Pileipellis a cutis with long, repent and occasionally interwoven hyphae 5–10 μm wide, thin-walled. Clamp connections abundant in all tissues.

Habitat and distribution – Solitary or scattered under broad-leaved forests in subtropical regions. Known from Henan and Jiangsu Province, China.

Specimens examined – China, China, Henan Province, Xinyang City, Nanwan Lake Scenic Area, 420 m, on soil in *Castanopsis* spp. dominated forest, 18 Jul 2016, M. Zhang (GDGM46278, GDGM46279, GDGM46413), T.H. Li (GDGM44383); Jiangsu Province, Nanjing City, Tzu-chin Mountain Scenic Area, alt. 300 m, 5 Sep. 2020, Z.H. Zhang (GDGM81888, GDGM81889, GDGM81899); Same location, 24 May 2021, Z.H. Zhang (GDGM84972); 5 June 2021, Z.H. Zhang (GDGM84974, GDGM84975, GDGM84978).

Notes – Phylogenetic analyses well-supported *C. aurantinus* as a distinct monophyletic lineage in *C.* subg. *Parvocantharellus* (Figs. 1–3), and is closely related to *C. fibrillosus*, *C. albidohymenius* and *C. roseocastaneus*. However, *C. fibrillosus* originally reported from India, can be distinguished by its larger basidiomata (pileus 5–8.2 cm broad) and basidiospores (8.5–12 × 5–6 µm) (Kumari et al. 2013); *C. albidohymenius* differs by its pale yellow to pale orange pileus with a brownish orange center, white to yellowish white hymenophore, and relatively larger and narrower basidiospores 8–9.5 × 5–5.5 µm; *C. roseocastaneus* differs in having a grayish red to reddish lilac pileus covered with minute fibrils, and a brownish gray to purplish gray stipe covered with minute fibrils.



Figure 29 – Morphology of *Cantharellus austrosinensis*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C =10 µm; D, E = 20 µm.

Cantharellus aurantinus Ming Zhang, Z.H. Zhang & T.H. Li, Journal of Fungi 7(11, no. 919): 11 (2021) Fig. 30

Chinese name:橙黄鸡油菌



Figure 30 – Morphology of *Cantharellus aurantinus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C =10 µm; D, E = 20 µm.

Cantharellus convexus Ming Zhang & T.H. Li, Journal of Fungi 8 (5, no. 483): 19 (2022) Fig. 31

Chinese name:凸盖鸡油菌

Pileus 5–12 mm broad, dry, tomentous, mostly yellowish white, pale yellow to pale orange (2A2, 2A3–5A3), but in some specimens can be yellowish brown to brown, with a deeper center to olive brown to yellowish brown (4E5–5E5). Hymenophore decurrent, with well-defined gill-like folds, occasionally forking towards pileus margin, with or without bifurcate low veins amongst the folds, yellowish white to pale yellow (2A2–4A2, 2A3–4A3). *Stipe* 10–20 × 1.5–3 mm, glabrous or faintly scaly, concolorous with pileus or paler. Basidiospores (50/2/2) 6–7 × 4.5–5 µm, broadly ellipsoid to subglobose. Basidia 32–50 × 7–9 µm, 4–6-spored, narrowly clavate. Pileipellis a cutis with long, repent, branched, and usually interwoven hyphae 3–15 µm wide, thin-walled. Clamp connections abundant in all tissues.

Habitat and distribution – Gregarious or scattered under broad-leaved forest (dominated by Fagaceae trees) in subtropical China. Currently known from Guangdong and Hunan Province, Southern China.

Specimens examined – China: Hunan Province, Chenzhou City, Sanjiangkou Town, Jiulongjiang National Forest Park, under *Castanopsis hystrix* mixed with other broad-leaved trees, alt. 200 m, 3 Aug 2017, M. Zhang (GDGM54841). Guangdong Province, Shaoguan City, Nanling National Nature Reserved, 29 Jul 2017, M. Zhang (GDGM60307); Same location, 9 Jul 2022, G.R. Zhong (GDGM88699, GDGM88608). Guangxi Province, Yulin City, Liuwandashan, 19 Jun 2024, ACE0302 (GDGM95158).

Notes – *Cantharellus convexus* is characterized by small basidiomata, convex pileus covered with fibrillose scales, distant and well-defined gill-like hymenophore sometimes without anastomosis among the folds, broadly elliptic to subglobose basidiospores, and thin-walled hyphae of pileipellis. Morphologically, *C. convexus* is similar to *C. austrosinensis, C. koreanus* and *C. luteovirens*. However, *C. austrosinensis* differs by its pastel yellow to grayish-yellow pileus

usually with a grayish-orange to brownish-orange center, relatively broad basidiospores (6–8 × 4.8–6 µm), and strictly associated with coniferous trees (*Pinus massoniana*) (Zhang et al. 2021a);
C. koreanus, originally described from the temperate region of South Korea, differs by its dirty yellow-brown to pale brown pileus usually with a brown to dark brown centre, relatively large basidiospores measuring 6–8(9) × 4.2–5.5(6.5) µm (Antonín et al. 2017). *C. luteovirens* differs by its yellow to orange pileus with a depressed center, grayish-yellow to grayish-orange hymenophores, larger and broader basidiospores (7–8 × 5.2–6.5 µm), and associated with *Acacia* trees (Zhang et al. 2021a).



Figure 31 – Morphology of *Cantharellus convexus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C =10 µm; D, E = 20 µm.

Phylogenetically, two specimens of *C. convexus* formed a well-supported monophyletic lineage in *C.* subg. *Parvocantharellus* and genetically distinct from all other *Cantharellus* taxa with known sequences. Two North America species, *C. appalachiensis* and *C. tabernensis*, were closely related to *C. convexus*. However, *C. appalachiensis* differs by its relatively larger and robuster basidiomata, drab yellow to dull brown pileus up to 50 mm broad, and relatively larger basidiospores (6.6–8.9 × 4.4–5.9 µm) (Buyck et al. 2010); *C. tabernensis* differs by its robust

basidiomata, dull orange-yellow to yellowish-brown pileus, vivid orange-yellow hymenophore and stipe, and relatively large basidiospores (6–9 × 4.4–5.9 μm) (Feibelman et al. 1996).

Cantharellus curvatus Buyck, R. Ryoo & Antonín, MycoKeys 76: 39 (2020)

Chinese name:弯褶鸡油菌

Notes – *Cantharellus curvatus,* originally reported from South Korea, is characterized by its small basidiomata, dull yellow to orangish yellow pileus, distant and pale yellow to grayish yellow hymenophore, ellipsoid basidiospores 7.5–9 × 5–6 μm, and slightly thick-walled terminal cells of pileipellis (Buyck et al. 2020). In China, *C. curvatus* was reported from Heilongjiang and Shandong Provinces (Wang et al. 2023a), and might represent a temperature Asian species. No specimen was collected by the present authors, for more information of this species please refer to the study by Buyck et al. (2020).

Cantharellus elongatipes D. Kumari, Ram. Upadhyay & Mod.S. Reddy, Mycology 4(4): 212 (2014) [2013] Fig. 32

= *Cantharellus sinominor* Ming Zhang, C.Q. Wang & T.H. Li, Journal of Fungi 7 (11, no. 919): 24 (2021)

= *Cantharellus subminor* T. Cao & H.S. Yuan, Stud. Mycol. 99 (no. 100121): 36 (2021)

Chinese name:长柄鸡油菌

Pileus 1–2.3 cm broad, dry, subtomentous, grayish yellow to grayish orange or orange at central (3B4–5B4), gradually fading to light yellow to light orange toward margin (3A4–5A4). Hymenophore decurrent, gill-liked ridges forked at margin, grayish yellow to grayish orange (3B5–5B5). Stipe 30–50 mm long, 2–3 mm thick, glabrous or faintly scaly, hollow, concolorous with pileus. Basidiospores (6)6.5–8.5(9) × (4.5)5–6 μm, elliptical to elongate elliptical. Basidia 37–74 × 7–9 μm, 5–6-spored, narrowly clavate. Pileipellis a cutis, composed of ascending to erect and occasionally branched hyphae, 3–12 μm wide, thin-walled. Clamp connections abundant in all tissues.

Habitat and distribution – Gregarious under mixed forest dominated by *Keteleeria* sp. and *Picea* sp. Known from southwestern China.

Specimens examined – China, Guizhou Province, Qiannan Buyi and Miao Autonomous Prefecture, Longli County, bought from a mushroom market, 1 Jul 2020, alt. 1080 m, M. Zhang (GDGM80824, GDGM80788, GDGM80791); Same location, 7 Jul 2021, M. Zhang (GDGM86139); Longli County, Longjiashan National Forest Park, alt.1000 m, 5 Jul 2020, M. Zhang (GDGM80842, GDGM80885); Duyun City, Doupengshan National Nature Reserve, 11 Sep 2019, M. Zhang (GDGM56448). Sichuan Province, Pingwu City, 18 Sep 2020, M. Zhang (GDGM84626). Yunnan Province, Puer City, Taiyanghe Nationa Forest Park, 20 Sep 2019, M. Zhang (GDGM78662), Meizihu Reservoir, 19 Sep 2019, M. Zhang (GDGM78482).

Notes – *Cantharellus elongatipes*, originally reported from India, is characterized by its small basidiomata with relatively long stipe, orangish yellow pileus, strongly decurrent to subdistant hymenophore, broadly elliptical basidiospores (6–7.5 × 4.5–5.5 μm) (Deepika et al. 2014). Two species, *C. sinominor* Ming Zhang, C.Q. Wang & T.H. Li and *C. subminor* T. Cao & H.S. Yuan, recently reported from China (Zhang et al. 2021a; Cao et al. 2021a), were proved to be synonyms of *C. elongatipes* by phylogenetic analyses (Wang et al. 2023a). The basidiospores in the Chinese samples were relatively larger than those originally described from Indian samples [7.8–8.8 × 5.2–5.8 μm in Cao et al. (2021a) and 6.5–8.5 × 5–6 μm in Zhang et al. (2021a) vs 6–7.5 × 4.5–5.5 μm in Deepika et al. (2014)].

In China, *Cantharellus* species with small basidiomata were easily misidentified as *C. minor* in the past, and this species was widely reported in most regions of China (Li et al. 2015, Zhao et al. 2021, Zhang et al. 2021a). However, recent studies have proved that *C. minor* does not occur in China, and specimens with small basidiomata represent several different species (Zhang et al. 2021a, Cao et al. 2021a, Zhang et al. 2022a). *C. elongatipes* is distributed in coniferous forests or mixed forests in Yunnan, Guizhou, Sichuan and adjacent places in southwest China.

Phylogenetic analyses showed that two specimens from Guangdong and Anhui Provinces were closely related to *C. elongatipes*, yet they exhibit significant differences in morphology and geographical distribution. Thus, additional specimens are needed to clarify their phylogenetic relationship.



Figure 32 – Morphology of *Cantharellus elongatipes*. A, B. Basidiomata. C. Basidispores. D. Basidia. E. Pileipellis. Scale bars: C, E =10 µm; D = 20 µm.

Cantharellus galbanus Ming Zhang, C.Q. Wang & T.H. Li, Journal of Fungi 7(11, no. 919): 15 (2021) Fig. 33

Chinese name:青黄鸡油菌

Pileus 5–10 mm broad, glabrous to subtomentous, greenish yellow (1A6), light yellow (1A5–3A5), yellow (2A6–2B6) to grayish yellow (2B5–3C5). Hymenophore decurrent, yellowish white to pale yellow (1A2–2A2, 1A3–2A3). Stipe 10–15 × 1–2 mm, hollow, glabrous, concolorous with pileus or paler to pastel yellow (1A4–2A4), greenish yellow to yellowish gray (1B2–2B2). Basidiospores 6–7.5 × 4.8–5.5 µm, elliptical to broadly elliptical. Basidia 52–76 × 7–8 µm, 4–6-

spored, narrowly clavate. Pileipellis a cutis, composed of horizontal to ascending, thin-walled hyphae 5–17 μm wide. Clamp connections abundant in all tissues.

Habitat and distribution – Gregarious under broad-leaved forest in tropical China. Known from southern China.

Specimens examined – China, Hainan Province, Ledong County, Jiangfengling Natinal Nature Reserve, alt. 950 m, on soil under Fagaceae trees mixed other broad leaf trees in tropical broadleaf forest, 13 Jul 2021, M. Zhang (GDGM86249); same location, alt. 950 m, 17 Jun 2017, M. Zhang (GDGM60568).

Notes – *Cantharellus galbanus* is a rare species, and only two specimens have been collected from tropical regions of southern China. It can be easily distinguished in field by its small greenish yellow basidiomata with relatively distant and well developed hymenophore (Zhang et al. 2021a). Phylogenetic analyses supported *C. galbanus* as a distinct species in subg. *Parvocantharellus*, separated from others by genetic distance.

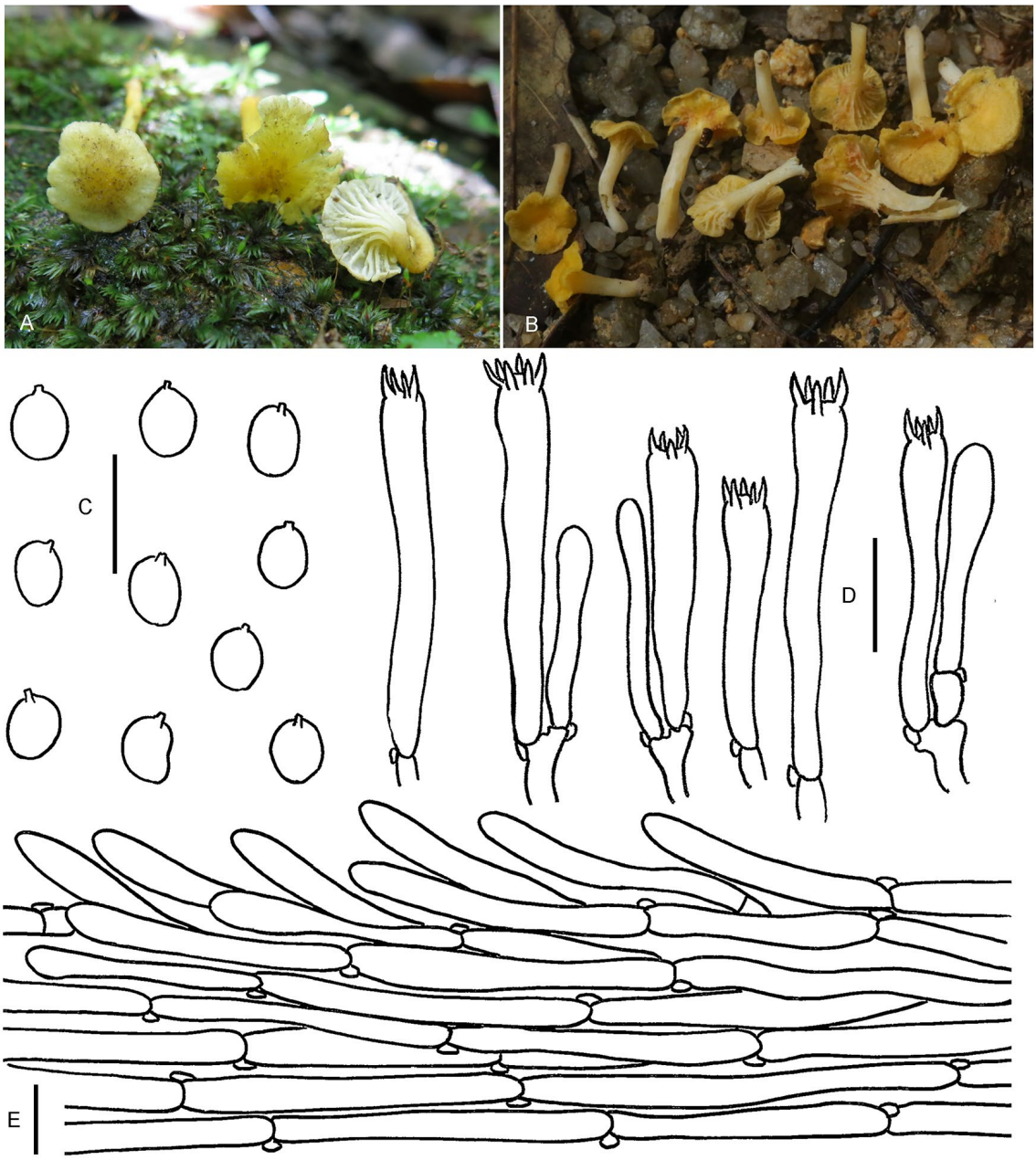


Figure 33 – Morphology of *Cantharellus galbanus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C =10 μm; D, E = 20 μm.

Cantharellus koreanus Buyck, Antonín & Ryoo, Mycol. Progr. 16(8): 755 (2017) Fig. 34

Chinese name:韩国鸡油菌

Pileus 15–40 mm broad, dry, glabrous or finely tomentose-fibrillose at centre, mostly pale yellow to light yellow (1A3–4A3, 1A4–4A4), olive brown to light brown (4D4–5D4) at centre, with obscurely sulcate at margin. Hymenophore adnate to subdecurrent, composed of bifurcate and interconnected low veins, yellowish white (2A2–4A2). Stipe 10–40 mm long, 2–5 mm thick, glabrous or with faintly scaly, hollow, concolorous with pileus, darker and more somber than lamellae. Basidiospores 5–8 × (4)4.5–6 µm, ellipsoid, broadly ellipsoid, thin-walled. Basidia 40–70 × 8–12 µm, 4–6-spored, narrowly clavate. Pileipellis a cutis, composed of cylindrical, thin-walled hyphae, 5–15 µm wide. Clamp connections abundant in all tissues.

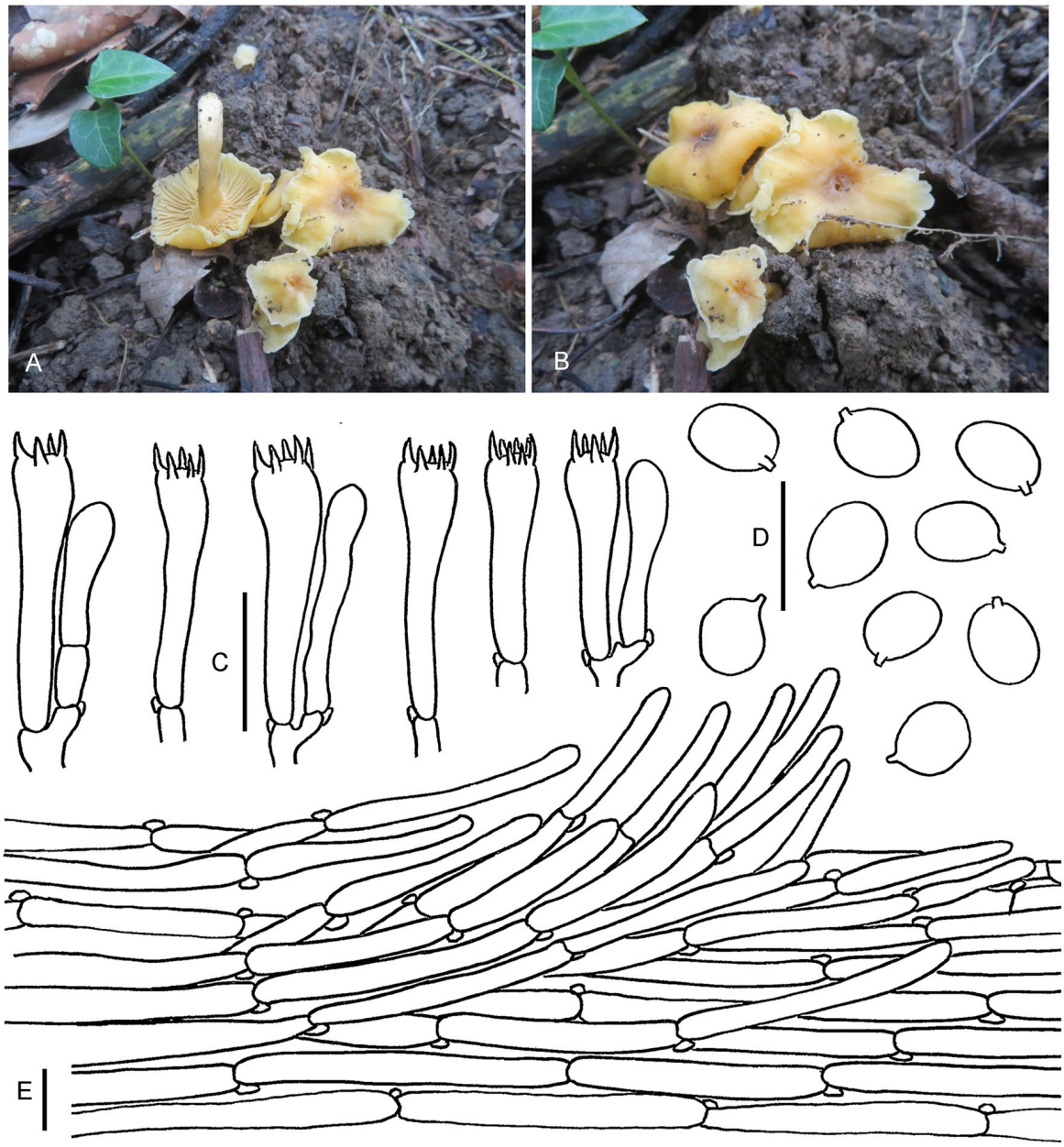


Figure 34 – Morphology of *Cantharellus koreanus*. A, B. Basidiomata. C. Basidia. D. Basidiospores. E. Pileipellis. Scale bars: C,E =20 µm; D = 10 µm.

Habitat and distribution – Gregarious or scattered under broad-leaved forests (dominated by Fagaceae trees) in subtropical regions of China. Known from Hunan Province of China and South Korea.

Specimens examined – China. Hunan Province, Zhangjiajie City, Zhangjiajie National Forest Park, alt. 1200 m, 17 Jul 2020, W.Q. Qin (GDGM79233); same location, alt. 1100 m, 5 Jul 2021, W.Q. Qin (GDGM85306); 23 July 2022, W.Q. Qin (GDGM90865).

Notes – *Cantharellus koreanus* is distributed across Asia, exhibiting morphological similarities to several other species, including *C. appalachiensis, C. austrosinensis, C. convex, C. luteovirens, C. pseudoaustrosinensis* and *C. tabernensis*. However, phylogenetic analyses showed that these species formed several distinct lineages, and can be clearly separated from each other. In China, *C. koreanus* is found in the subtropical broadleaved forests of Hunan Province.

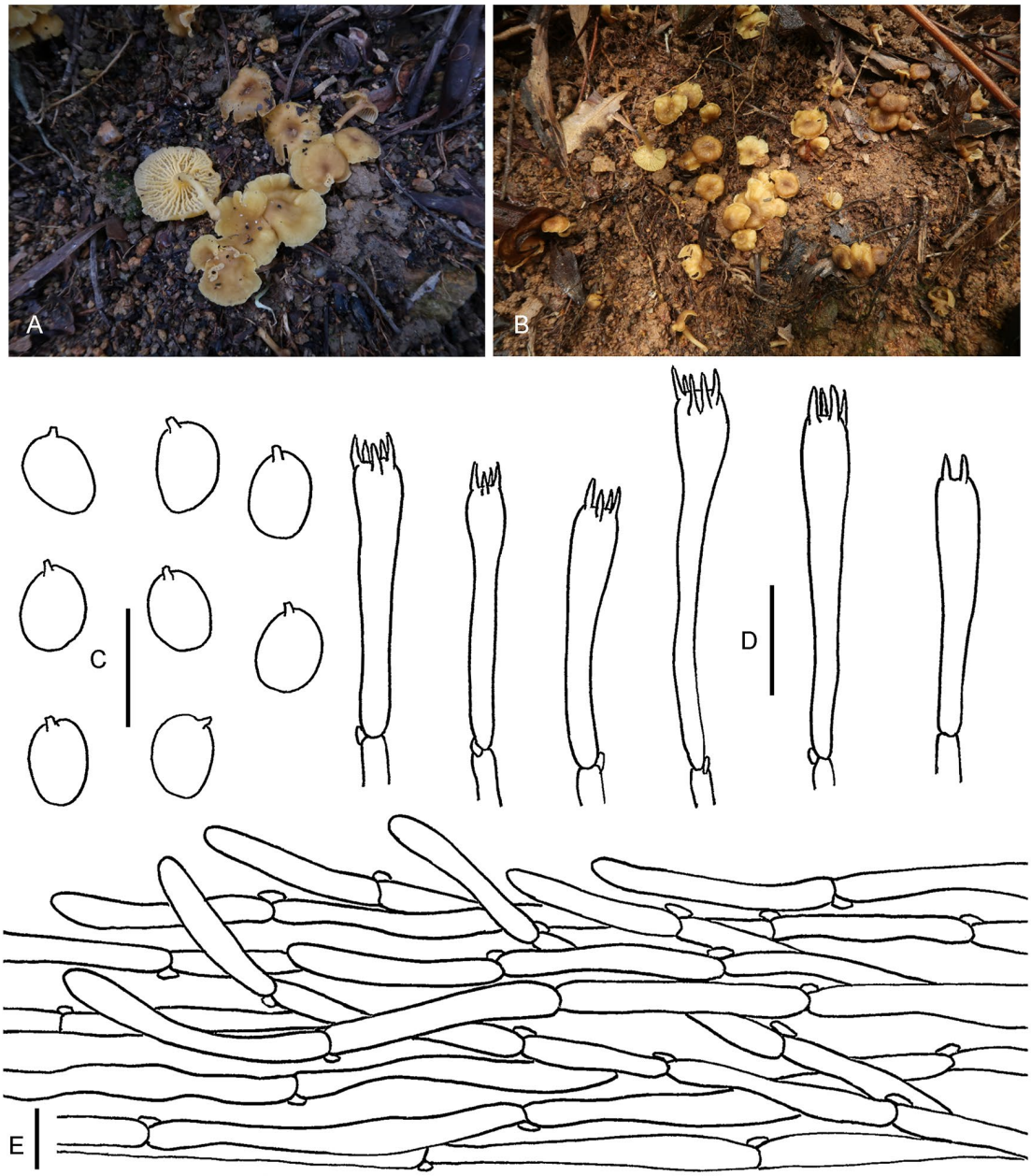


Figure 35 – Morphology of *Cantharellus luteovirens*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Cantharellus luteovirens Ming Zhang, C.Q. Wang & T.H. Li, Journal of Fungi 7(11, no. 919): 20 (2021) Fig. 35

Chinese name:黄绿鸡油菌

Pileus 15–42 mm broad, dry to hygrophanous, glabrous, pastel yellow (2A4–4A4), light yellow (2A5–4A5), yellow to yellowish orange (3A6–4A6), usually with grayish yellow (3C5–4C5) tinct at center, Hymenophore decurrent, yellowish white to pale yellow (2A2–3A2, 2A3–3A3). Stipe 20–30 × 2–3 mm, hollow, glabrous, concolorous or paler than pileus. Basidiospores 6–7(7.5) × (4.5)4.8–5.5(6) μm, broadly ellipsoid to subglobose. Basidia 40–70 × 6–10 μm, 2–6-spored, narrowly clavate. Pileipellis a cutis, composed of repent and occasionally branched hyphae 6–13 μm wide. Clamp connections abundant in all tissues.

Habitat and distribution – Gregarious in subtropical broad-leaved forests mainly dominated by acacia trees (such as *Acacia auriculiformis*, *Acacia* spp.) mixed with other broad-leaved trees. Only known from Guangdong Province, southern China.

Specimens examined – China, Guangdong Province, Guangzhou City, Baiyunshan National Forest Park, 160 m, 14 May 2016, M. Zhang (GDGM45899); Same location, 28 May 2020, M. Zhang (GDGM81395); 8 May 2020, X.S. Liang (GDGM81079); 12 Jun 2020, J.Y. Xu (GDGM80296); 16 Jun 2020, Y. He (GDGM80672); 12 Sep 2020, M. Zhang (GDGM82758, GDGM82768, GDGM82852); 28 Jun 2021, T. Li (GDGM85963); 20 May 2023, ACE (GDGM91304), Guorui Zhong (GDGM92173, GDGM92209). Shenzhen City, Maluanshan Forest Park, 21 Jun 2020, M. Zhang (GDGM80680); Xianhu Botanical Garden, Chinese Academy of Sciences, 3 Sep 2020, L.Q. Wu (GDGM83013). Huizhou City, Luofushan scenic spot, 2 Jul 2021, M. Zhang (GDGM85861).

Notes – *Cantharellus luteovirens* is a common but narrowly distributed species, found only in Guangdong Province of southern China. It can be seen from June to September, mainly grows under acacia trees, such as *Acacia confusa* and *A. auriculiformis*, and might be an obligate symbiotic with these trees (Zhang et al. 2021a). *Cantharellus austrosinensis* is similar to *C. luteovirens*, but can be distinguished by its pastel yellow to grayish yellow pileus with brown tinge at center, relatively well developed hymenophore and shorter basidia (50–55 × 7–9 μm) (Zhang et al. 2021a). Besides, *C. austrosinensis* mainly grows under coniferous forests.

Phylogenetically, *C. luteovirens* formed a distinct lineage in *C.* subg. *Parvocantharellus*, and can be separated from other species by genetic distance.

Cantharellus minioalbus Ming Zhang, C.Q. Wang & T.H. Li, Journal of Fungi 7(11, no. 919): 21 (2021) Fig. 36

Chinese name:小白鸡油菌

Pileus 3–10 mm broad, dry, with appressed fibrillose scales, white to yellowish white. Hymenophore decurrent, with well-defined gill-like folds, frequently forking towards pileus margin, white to pale yellow. Stipe 15–30 × 1.5–2.5 mm, solid, glabrous or faintly scaly, concolorous with pileus. Basidiospores 4.5–7.0 × 4–5.5(6.2) μm, broadly ellipsoid to subglobose. Basidia 44–66 × 6–8 μm, 2–6-spored, narrowly clavate. Pileipellis a cutis with long, repent, branched, and usually interwoven hyphae 3–13 μm wide, thin-walled. Clamp connections abundant in all tissues.

Habitat and distribution – Gregarious under *Castanopsis* spp. in tropical broad-leaved forests. Known from Yunnan Province, Southwest China.

Specimens examined – China, Yunnan Province, Puer City, Simao District, Taiyanghe National Forest Park, 1616 m, 24 Sep 2019, M. Zhang & J.Y. Xu (GDGM78901 holotype!, GDGM78915, GDGM78916, GDGM78926, GDGM78934); Same location, 1662 m, 25 Sep 2019, M. Zhang (GDGM78955), J.Y. Xu (GDGM78997); Xishuangbanna Dai Autonomous Prefecture, Dadugang Town, 29 Jul 2022, M. Zhang (GDGM89909).

Notes – *Cantharellus minioalbu*s is a quite distinct species, which can be easily identified in field by its small pure white basidiomata and grows under broad-leaved forests in tropical regions

(Zhang et al. 2021a). Phylogenetic analyses proved that *C. minioalbus* is a member of *C.* subg. *Parvocantharellus*, and can be separated from other species by genetic distance.

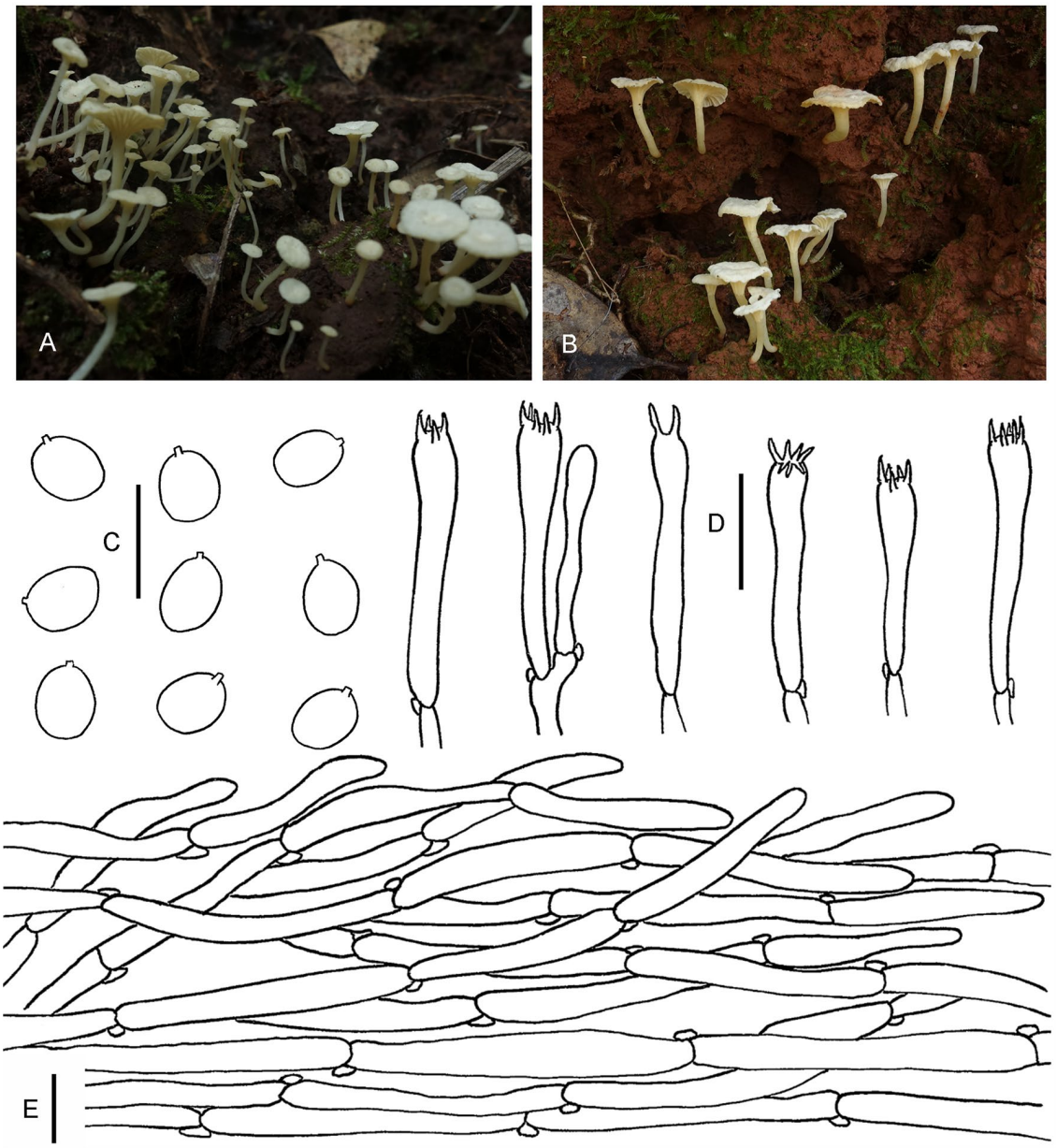


Figure 36 – Morphology of *Cantharellus minioalbus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Cantharellus neopersicinus Ming Zhang, T.H. Li & X.Y. Chen, Journal of Fungi 8(5, no. 483): 21 (2022) Fig. 37

Chinese name:新桃红鸡油菌

Pileus 15–45 mm broad, dry, glabrous, pastel red, pastel pink to pink (8A4–12A4). Hymenophore decurrent, with well-defined gill-like folds, strongly forking towards pileus margin, white to pinkish. Stipe 15–40 × 3–8 mm, hollow, glabrous, concolorous with pileus. Basidiospores (50/2/2) (6)7–8.5(9) × (4)4.5–5.5(6) µm, ellipsoid to subglobose. Basidia 45–62 × 7–9 µm, 4–6-spored, narrowly clavate. Pileipellis a cutis with long, repent to suberect, branched, and slightly interwoven hyphae 8–15 µm wide, thin-walled. Clamp connections abundant in all tissues.

Habitat and distribution –Gregarious or scattered under *Eucalyptus robusta* in tropical China. Known from Guangdong Province, Southern China.

Specimens examined – China. Guangdong Province, Leizhou City, Fangcha Village, under *Eucalyptus robusta*, alt. 105 m, 16 Oct 2021, X.Y. Chen (GDGM87366, GDGM85145); Shenzhen

City, Tiantoushan Forest Park, 6 Sep 2023, G.R. Zhong (GDGM93256); Dongguan City, Dapingzhang Forest Park, 28 Augt 2023, Amateur (GDGM93715).

Notes – *Cantharellus neopersicinus* is characterized by its small basidiomata, pastel red to pink pileus, gill-like hymenophore poorly-developed with strongly bifurcate low veins, ellipsoid to subglobose basidiospores.

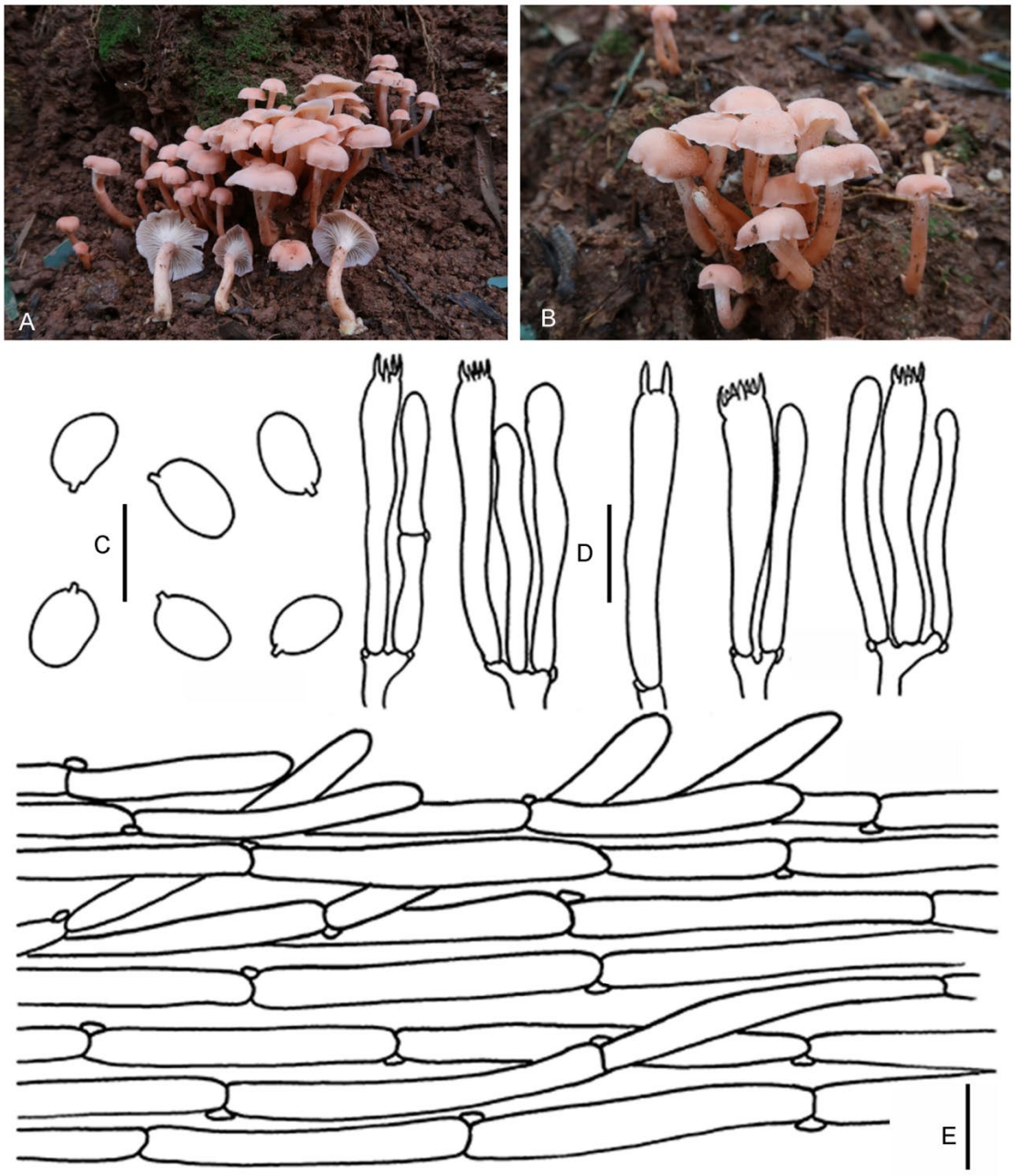


Figure 37 – Morphology of *Cantharellus neopersicinus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C, E = 20 µm; D = 10 µm.

Phylogenetic analyses showed that *C. neopersicinus* well nested into *C.* subg. *Parvocantharellus*, forming a well supported terminal clade, and closely related to *C. albus* and *C. luteolus*. However, *C. albus* can be distinguished by its white basidiomata slightly changing to yellowish when bruised, a spicy taste and relatively small basidiospores (5.5–7.5 × 4.5–6 µm) (Zhang et al. 2021a); *C. luteolus* differs by its small, yellow to orange basidiomata with grayish-yellow to grayish-orange hymenophores, and oval to subglobose basidiospores (7–8 × 5.2–6.5 µm) (Zhang et al. 2021a).

Morphologically, the pastel red to pink pileus of *C. neopersicinus* is similar to that of *C. cinnabarinus*, *C. coccolobae*, *C. phloginus* and *C. persicinus*. However, they can all be easily distinguished from *C. neopersicinus* by genetic distance. The former three species belong to *C*. subg. *Cinnabarinus*, while *C. persicinus* belongs to *C*. subg. *Cantharellus*. Additionally, *C. cinnabarinus* differs by its cinnabar red to bright orange pileus, thick-walled hyphal of pileipellis terminal cells, and small basidiospores (6.7–7.57 × 3.82–4.68 μm) and slightly thick-walled pileipellis (Buyck et al. 2011).

Cantharellus coccolobae differs by its salmon orange hymenophore, white stipe context partly changing to yellowish when cut, large basidiospores measuring (7.9)8.3–9.3(9.8) × (4.8)5.3–5.9(6) μm, longer basidia up to 120 μm and thick-walled hyphae of pileipellis. In addition, *C. coccolobae* was reported strictly associated with Coccoloba trees, while *C. neopersicinus* was under *Eucalyptus* trees (Buyck et al. 2016c). *Cantharellus phloginus* differs by its darker pileus, pale yellow to light yellow hymenophore, white context, and larger basidiospores of 6.8–9.5 (12) × 5–7 μm. *Cantharellus persicinus*, originally reported from North America, differs by its robust basidiomata, larger basidiospores (9.6–10.9 × 6.3–7.1 μm), thick-walled hyphae of pileipellis, and is associated with oaks or eastern hemlock (Petersen 1985).

Cantharellus parvoluteolus Ming Zhang, C.Q. Wang & T.H. Li, nom. nov. Fig. 38

= *Cantharellus luteolus* Ming Zhang, C.Q. Wang & T.H. Li, Journal of Fungi 7(11, no. 919): 18 (2021) Nom. illegit., Art. 53.1. non, *Cantharellus luteolus* Speg. 1909

Chinese name:小蛋黄鸡油菌

Fungal Name: FN573114

Pileus 20–32 mm broad, dry, tomentous, pastel yellow, light yellow, grayish yellow to light orange (3A4–5A4, 3B4–4B4). Hymenophore decurrent, light yellow (3A5–4A5), grayish yellow to greyish orange (3B5–5B5). Stipe 20–30 × 3–7 mm, hollow, glabrous, concolorous with pileus or paler to light yellow, grayish yellow (3A5–4B5) to light orange (4A5). Basidiospores 7–8 × 5.2–6.5 μm, elliptical to subglobose. Basidia 60–85 × 7–10 μm, 4–6-spored, narrowly clavate with many vacuoles. Pileipellis a cutis, composed of horizontal to ascending, thin-walled hyphae 4–12 μm wide. Clamp connections abundant in all tissues.

Habitat and distribution – Solitary under broad-leaved forests in tropical regions. Known from Hainan Province, southern China.

Specimens examined – China. Hainan Province, Ledong County, Jiangfengling National Nature Reserve, alt. 950 m, on soil under broad-leaved forest, 17 Jun 2017, M. Zhang (GDGM60393, holotype!); Same location, 13 Jul 2021, M. Zhang (GDGM86247); Changjiang County, Bawangling National Nature Reserve, 6 Jul 2013, M. Zhang (GDGM44258).

Notes – *Cantharellus parvoluteolus* is proposed here as a new name for the known species *C. luteolus* Ming Zhang, C.Q. Wang & T.H. Li, which was described by Zhang et al. (2021a). *C. luteolus* is a homonym of *Cantharellus luteolus* Speg. 1909, although the latter has been transferred into *Panellus*.

Cantharellus parvoluteolus is mainly characterized by small basidiomata, yellow to orange pileus, grayish-yellow to grayish-orange well developed gill-like hymenophores, elliptical to subglobose basidiospores, and thin-walled hyphae of the pileipellis.It is difficult to distinguish *C. parvoluteolus* from other small chanterelle species only by morphological features. Phylogenetic analyses proved that *C. parvoluteolus* formed a well supported distinct lineage in *C*. subg. *Parvocantharellus*, and can be separated from other species by DNA sequences.

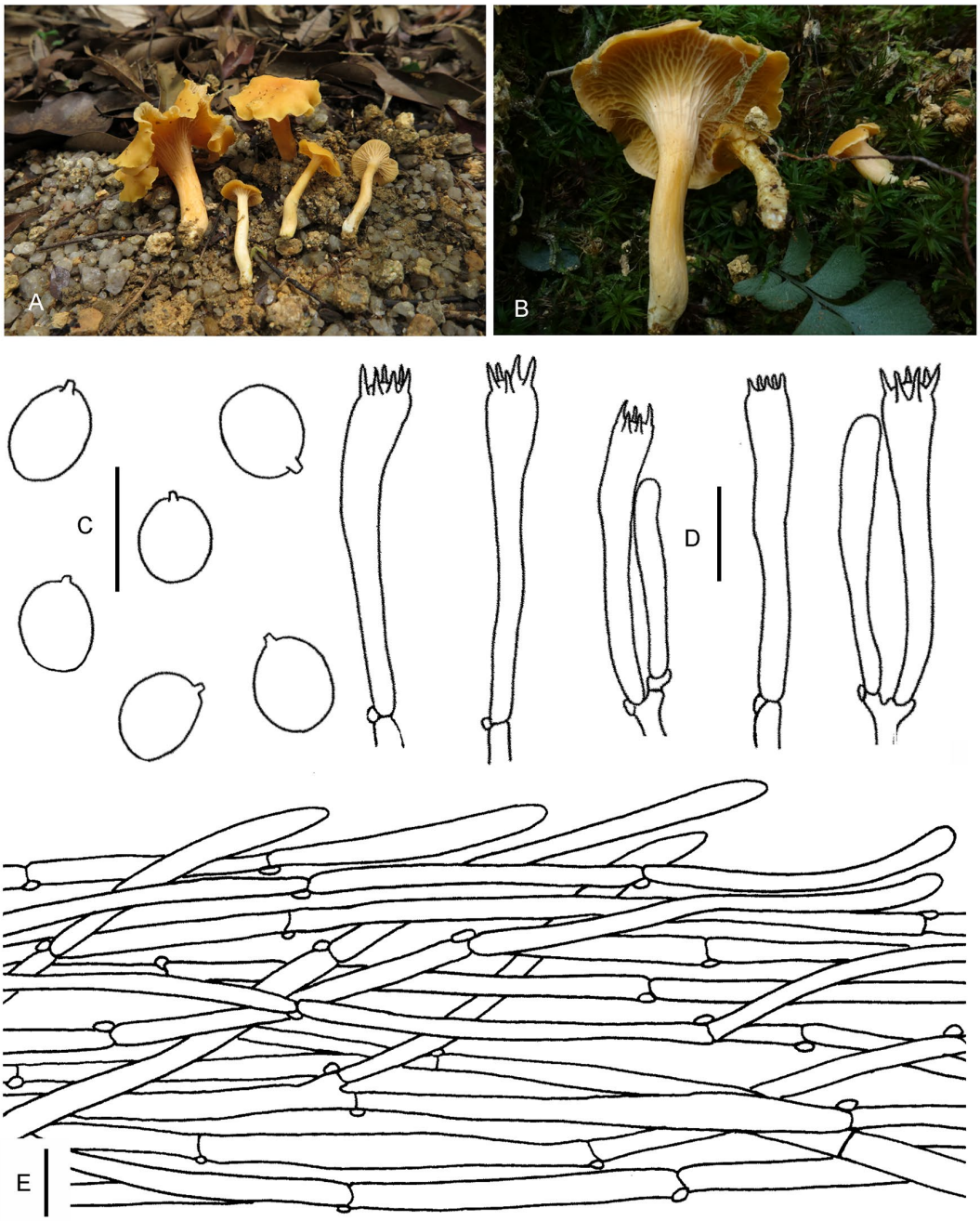


Figure 38 – Morphology of *Cantharellus parvoluteolus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C–E =10 µm. (reference to Zhang et al. 2021a)

Cantharellus pseudoaustrosinensis Ming Zhang, C.Q. Wang & T.H. Li, sp. nov. Fig. 39

Chinese name:假华南鸡油菌

Fungal Name: FN573126; Facesoffungi number: FoF 19030

Etymology – "*pseudo*-" means false, "*pseudoaustrosinensis*" refers to the species being similar to *C. austrosinensis* in macroscopic features.

Diagnosis – Differs from *C. austrosinensis* by its dark brown pileus center, whitish to yellowish white hymenophore, smaller basidiospores, larger basidia, and distinct DNA sequences.

Type – China, Guangdong Province, Shenzhen City, Maluanshan Forest Park, under broad-leaved forests, alt. 380 m, 21 June 2020, Ming Zhang (GDGM81426).

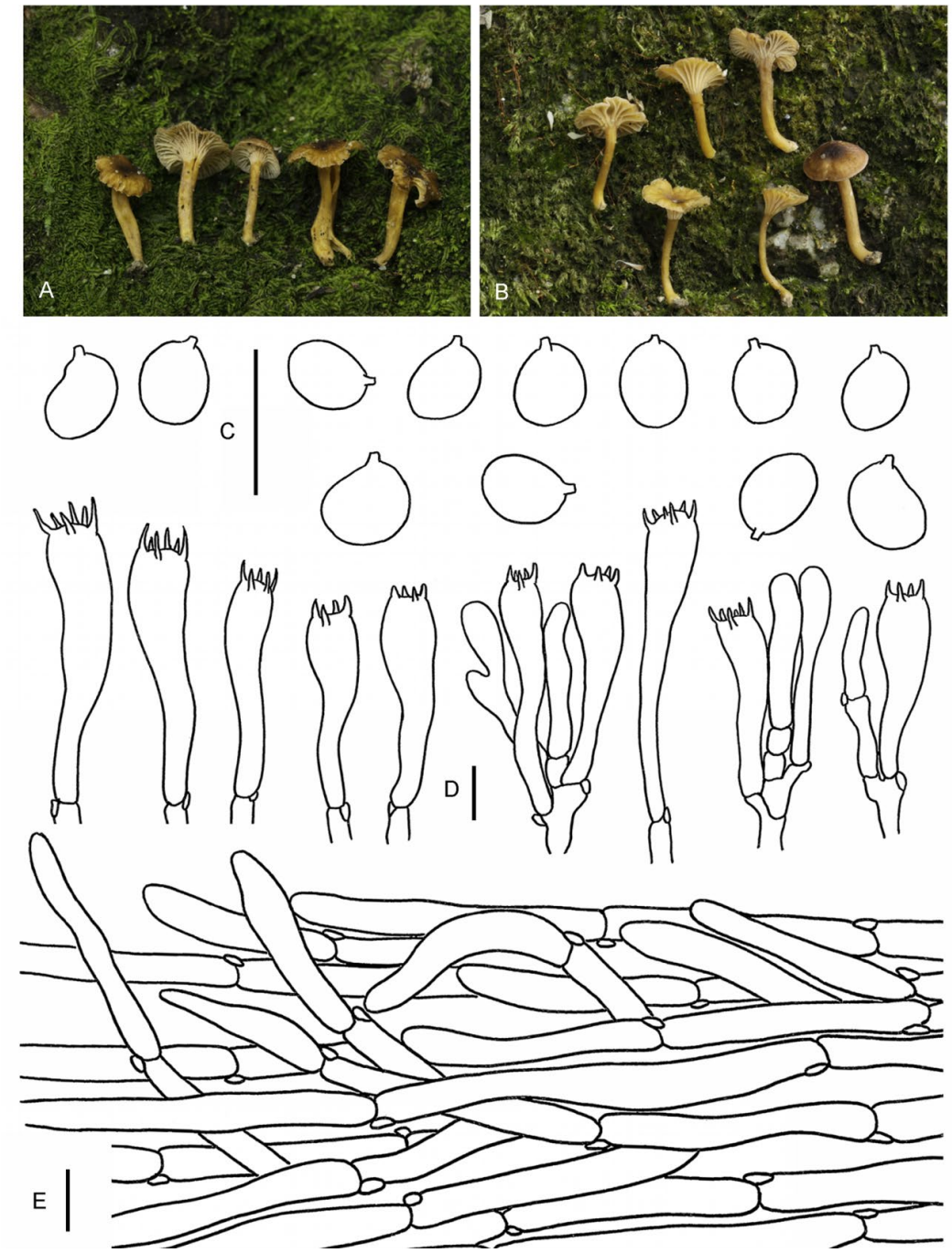


Figure 39 – Morphology of *Cantharellus pseudoaustrosinensis*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C–E =10 µm.

Basidiomata small sized. Pileus 1–2.5 cm broad, applanate with center depressed, margin incurved when young, applanate, reflexed with age, surface dry, pale yellow, grayish yellow, olive to olive brown or fuscous at center (2A3–4A3, 5E4–4E4), covered with olive brown to dark brown (4F4–7F4) minute fibrils at center. Context thin, 1–1.5 mm thick, fibrous, white to yellowish white, unchanging when bruised. Hymenophore decurrent, composed of relatively well-developed branched to furcate gill-like folds, 1–2 mm high, whitish to yellowish white (1A1,1A2–4A2), unchanging when bruised. Stipe 20–30 mm long, 2.5–6 mm thick, subcylindrical, glabrous or covered with minute fibrils, yellowish white to pale yellow (2A2–4A2;2A3–4A3). Odour fruity. Taste mild.

Basidiospores 6–7 × 4.5–5.5 µm, Lm × Wm = 6.52(±0.46) × 4.88(±0.29) µm, Q = (1.09)1.2–1.44(1.55), Q_m = 1.34 ± 0.11; smooth, broadly elliptical to oval. Basidia 35–80 × 8–11 µm, clavate,

4–6(7)-spored, sterigmata 3–5 μm long. Pileipellis a cutis, composed of horizontal, subparallel, cylindrical hyphae, 5–15 μm wide, colourless, thin-walled. Hymenophoral trama subregular to regular, composed of colourless, branched and cylindrical hyphae, 3–10 μm in diam. Stipitipellis a cutis, composed of parallel cylindrical hyphae 5–16 μm in diam. Cystidia absent. Clamp connections common.

Habitat and distribution – Solitary in forests dominated by broad-leaved trees (Fagaceae) in subtropical regions of China. Known from southern China.

Specimens examined – China, Guangdong Province, Shenzhen City, Maluanshan Forest Park, under broad-leaved forests, alt. 380 m, 21 Jun 2020, M. Zhang (GDGM81426); Hunan Province, Chenzhou City, Rucheng County, Jiulongjiang National Forest Park, alt. 200 m, 4 Sep 2016, M. Zhang (GDGM53492, GDGM53452).

Notes – *Cantharellus pseudoaustrosinensis*, *C. austrosinensis* and *C. luteovirens*, which are all distributed in southern China, are very similar in appearance and difficult to distinguish morphologically. However, the usually darker pileus centre of *C. pseudoaustrosinensis*, the yellower colour of *C. austrosinensis* and the slightly slender stipe of *C. luteovirens* are perhaps the distinguishable features, although they are not always stable. Their associated plants should be helpful to distinguish them: *C. austrosinensis* is only found in coniferous or mixed forests and might be symbiotic with pines (e. g. *Pinus massoniana*), and *C. luteovirens* grows under *Acacia* trees, while *C. pseudoaustrosinensis* grows under broad-leaved forests mainly dominated by Fagaceae trees. Phylogenetic analyses proved that they represent three distinct species, and well-supported in the phylogenetic trees (Figs. 1–3).

Cantharellus roseocastaneus Ming Zhang, B. Chen & Q.Q. Huang, sp. nov. Fig. 40

Chinese name:玫红褐鸡油菌

Fungal Name: FN573125; Facesoffungi number: FoF 19029

Etymology – "*roseocastaneus*" refers to the rosy castaneous pileus color.

Diagnosis – Distinguished by its small basidiomama with a grayish reddish brown to rosy castaneous pileus, yellowish white, pale yellow to pale orange hymenophore strongly interveined, elliptical basidiospores, and distinct phylogenetic position.

Type – China. Zhejiang Province, Hangzhou City, Hangzhou Botanical Garden, 23 May, 2023, Q.Q. Huang (GDGM91302).

Pileus 15–35 mm broad, applanate with center slightly depressed, margin incurved when young, applanate, reflexed with age, sometimes irregularly split at margin; surface dry, grayish red, grayish rose, rose, grayish magenta, purplish pink to reddish lilac (10A4–14A4,10B4–14B4) at mass, grayish brown to grayish ruby at center (10E3–12E3), sometimes grayish orange to grayish red (5B4–10B4) with a grayish brown (5E3–10E3) center, covered with minute fibrils, especially at center. Context thin, 1–1.5 mm thick, fibrous, yellowish white, unchanging when bruised. Hymenophore decurrent, gill-like, composed of relatively well-developed, branched to furcate gill folds, 1–2 mm high, yellowish white, pale yellow to pale orange (3A3–5A3), unchanging when bruised. Stipe 20–35 mm long, 2–5 mm thick, subcylindrical, glabrous or covered with minute fibrils, brownish gray to purplish gray (10C2–14C2). Odour fruity. Taste mild.

Basidiospores (5.5)6–8(8.5) × (4.5)5–6 μm, Lm × Wm = 6.91(±0.72) × 5.18(±0.42) μm, Q = (1.09)1.2–1.4(1.6), Q_m = 1.33 ± 0.13), smooth, broadly elliptical, thin-walled. Basidia 50–70 × 7–12 μm, clavate, 4–6-spored, sterigmata 4–8 μm long. Pileipellis a cutis, composed of horizontal, subparallel, cylindrical hyphae, 5–10 μm wide, colourless, thin- to thick-walled, less than 0.5 μm wide. Hymenophoral trama subregular to regular, composed of colourless, branched and cylindrical hyphae, 5–15 μm wide. Stipitipellis a cutis, composed of parallel cylindrical hyphae 3–8 μm wide. Clamp connections common.

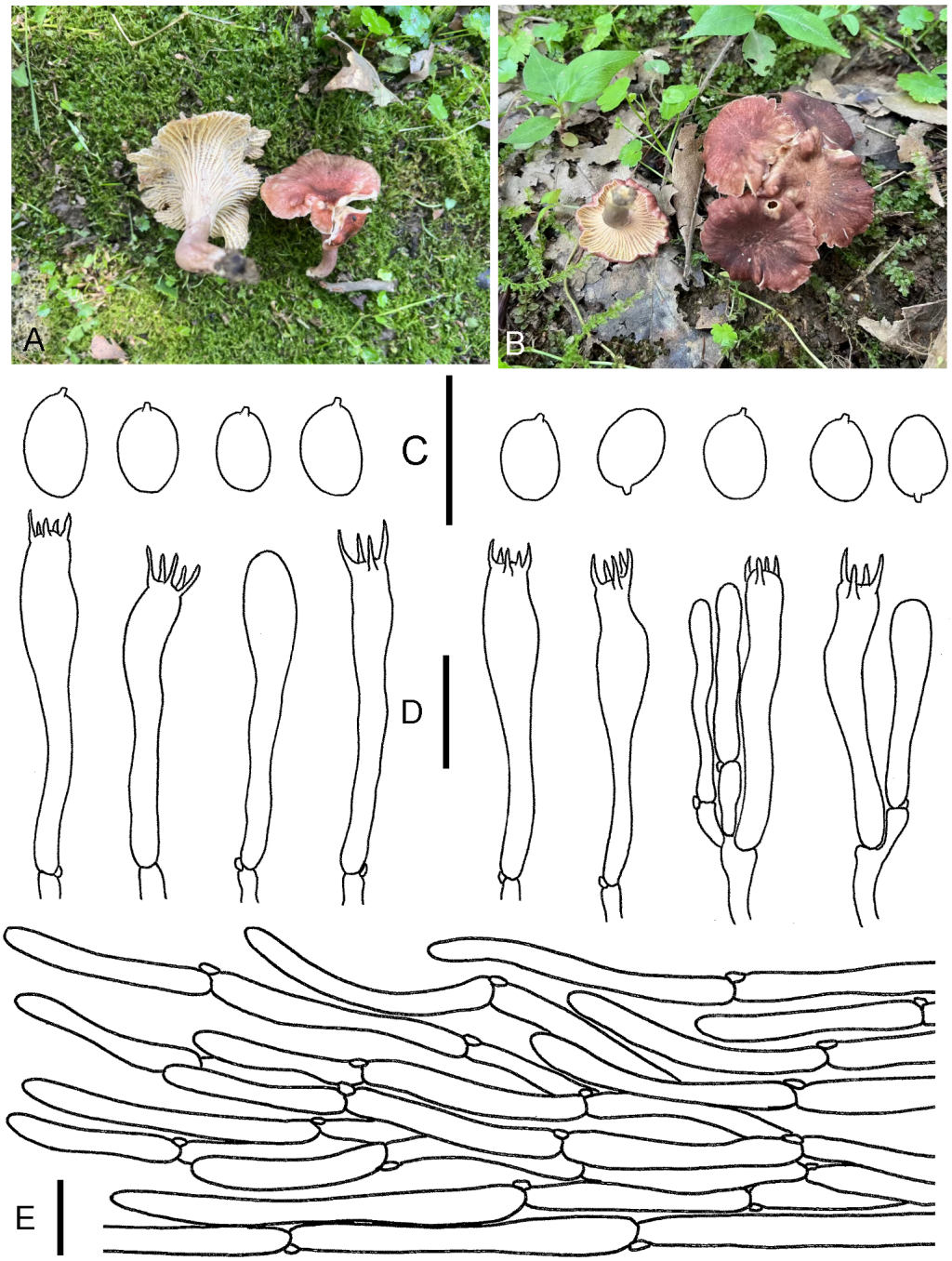


Figure 40 – Morphology of *Cantharellus roseocastaneus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Habitat and distribution – Solitary in broad-leaved forests dominated by Fagaceae (*Castanopsis tibetana*, *Castanopsis* spp.) in subtropical regions of China. Known from eastern China.

Additional specimen examined – Zhejiang Province, Ningbo City, Beishan, under *Castanopsis tibetana* forest, 3 Jul 2023, B. Chen (GDGM91690).

Notes – Phylogenetic analyses showed that samples of *C. roseocastaneus* formed a distinct monophyletic lineage in *C.* subg. *Parvocantharellus*. However, *C. roseocastaneus* can be distinguished from the other species in *C.* subg. *Parvocantharellus* by its grayish red to reddish lilac pileus covered with minute fibrils, especially at center, pale yellow to pale orange relatively well-developed hymenophore, brownish gray to purplish gray stipe usually covered with minute fibrils and broadly elliptical basidiospores.

Several species, including *C. amethysteus* (Quél.) Sacc., *C. atrolilacinus* Eyssart., Buyck & Halling, *C. lewissi* Buyck & V. Hofst., and *C. violaceovinosus* M. Herrera, Bandala & Montoya, in *C*. subg. *Cantharellus*, exhibit a similar colored pileus to that of *C. roseocastaneus*. However,
C. amethysteus originally reported from Europe, has larger basidiomata (up to 10 cm broad) and larger basidiospores 9.5–12 × 6–7 μm (Eyssartier and Buyck 2000, Buyck et al. 2018);
C. atrolilacinus, described from Costa Rica, has larger basidiomata with a darker pileus tinge to blackish or dark lilac gray, relatively larger basidiospores (7–9 × 4.5–6 μm) and thick-walled elements of pileipellis (Eyssartier et al. 2003); *C. lewissi* has pale yellow to pale orange pileus covered with dark purpulish-lilac fibrils, narrower basidiospores (7.08–8.96 × 4.17–5.21 μm) with a larger Q value (Q = 1.45–1.7), and thick-walled elements of pileipellis (Buyck & Hofstetter 2011, Buyck et al. 2014); and *C. violaceovinosus* reported from North America, can be distinguished by its larger basidiomata (up to 11.3 cm broad) and larger basidiospores (7–10 × 5–6.5 μm) (Herrera et al. 2018).

Cantharellus subtilis Ming Zhang, C.Q. Wang & T.H. Li sp. nov. Fig. 41

Chinese name:小巧鸡油菌

Fungal Name: FN573127; Facesoffungi number: FoF 19031

Etymology – "*subtilis*" means slender, referring to the small and exquisite basidiomata.

Diagnosis – Similar to *C. elongatipes* morphologically and molecularly, but differs in more distinctly paler pileus margin, slightly less orange tinge of basidiomata and an independent phylogenetic location.

Type – China. Guangdong Province, Shaoguan City, Shixing County, Chebaling National Nature Reserve, alt. 370 m, under mixed forests mainly dominated by Fagaceae mixed with a small number of *Pinus massoniana*, alt. 370 m, 6 Jun 2020, M. Zhang (GDGM81310).

Basidiomata small-sized. Pileus 12–30 mm broad, convex to applanate, usually slightly depressed at center, margin incurved when young, applanate or slightly reflexed with age, obscure striated on surface; surface dry, glabrous or tomentose at central, pale yellow, pale orange, light yellow to light orange (3A4–5A4, 3A3–5A3), slightly darker at center, often with a pale yellow zone at margin. Context thin, 0.5–1.5 mm thick in the center of pileus, fibrous, pale yellow to light yellow (3A3–3A5), unchanging when bruised. Hymenophore decurrent, gill-like, well or poorly developed ridges, 1–2 mm high, composed of bifurcate and interconnected low veins, pastel yellow (1A4–3A4). Stipe 25–40 mm long, 3–5 mm thick, subcylindrical, tapered downward, glabrous, concolorous with pileus or paler. Odor none and taste mild.

Basidiospores 6–8.5 × 5–6.5 μm, $L_m \times W_m$ = 7.30(±0.67) × 5.39(±0.46) μm, Q = (1.2)1.25–1.41(1.6), Q_m = 1.35 ± 0.08, elliptical to broadly elliptical. Basidia 42–80 × 7–9 μm, clavate, 4–7-spored, sterigmata 2–5 μm long. Pileipellis a cutis, composed of interwoven hyphae 5–14 μm in diam., colourless, thin-walled. Hymenophoral trama composed of cylindrical hyphae 3–10 μm in diam. Stipitipellis a cutis of cylindrical, parallel hyphae, 3–8 μm wide, branched, septate. Clamp connections abundant in all tissues.

Habitat and distribution – Solitary under *Pinus massoniana* mixed with broad-leaved trees such as *Castanopsis hystrix, Castanopsis* spp. Known from Guangdong Province, southern China.

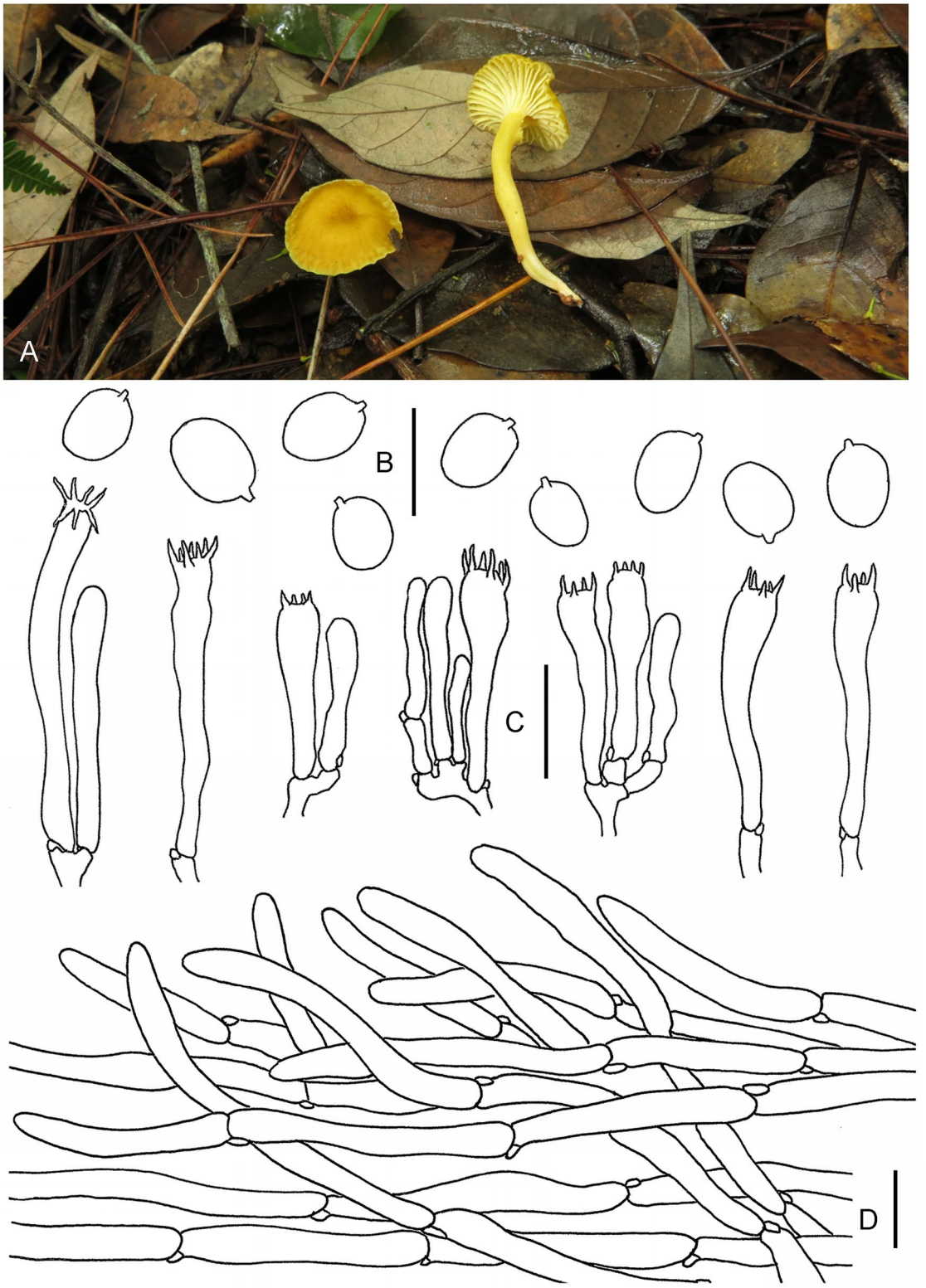


Figure 41 – Morphology of *Cantharellus subtilis*. A. Basidiomata. B. Basidiospores. C. Basidia. D. Pileipellis. Scale bars: B =10 µm; C, D =20 µm.

Notes – *Cantharellus subtilis* can be easily distinguished in field by its small yellow to orange basidiomata with a relatively long stipe. Several species, *C. austrosinensis*, *C. elongatipes*, *C. galbanus* and *C. luteovirens* are similar to *C. subtilis* in morphology. However, *C. austrosinensis* differs by its grayish yellow pileus with brownish orange tinge at center, relatively narrower basidiospores and shorter basidia (Zhang et al. 2021a); *C. elongatipes* differs by its relatively longer stipe and narrower basidiospores, and is only known from southwest China (Zhang et al.

2021a, Cao et al. 2021a, Wang et al. 2023a); *C. galbanus* reported from the tropical area of China, differs by its greenish yellow to grayish yellow pileus, yellowish white hymenophore and relatively narrower basidiospores, and is only known from the tropical regions of southern China (Zhang et al. 2021a); *C. luteovirens* differs by its pastel yellow pileus and relatively smaller basidiospores, and might be symbiotic with *Acacia auriculiformis* and *Acacia* sp. (Zhang et al. 2021a). In addition, phylogenetic analyses proved that *C. subtilis* represents a distinct species and well-supported in the phylogenetic trees (Figs. 2).

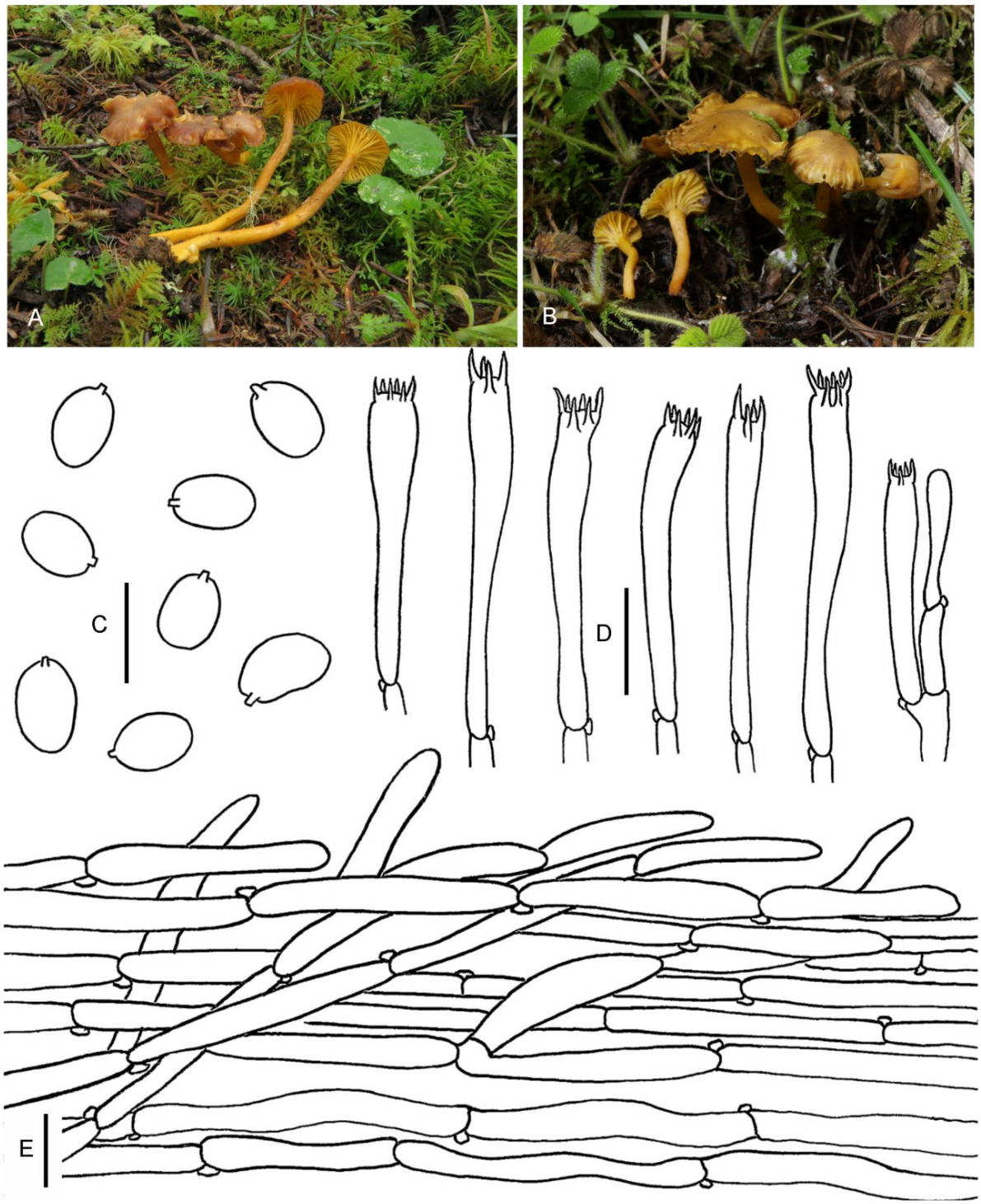


Figure 42 – Morphology of *Cantharellus zangii*. A, B. Basidiomata. C. Basidispores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Cantharellus zangii X.F. Tian, P.G. Liu & Buyck, Mycotaxon 120: 100 (2012) Fig. 42

= *C. sikkimensis* K. Das, Buyck, D. Chakr., Baghela, S.K. Singh & V. Hofst., Phytotaxa 222(4): 273 (2015)

Chinese name:臧氏鸡油菌

Pileus 10–40 mm broad, dry, glabrous, irregularly wrinkled, brown to dark brown (6E6–7E6, 6F6–7F6) at first, gradually fading to light brown to brownish orange (5C5–6C5, 5D5–6D5). Hymenophore decurrent, composed of bifurcate and interconnected low veins, light yellow (3A5), olive yellow (3C6), grayish yellow (4B6) to pale orange (5A4). Stipe 50–130 × 3–6 mm, hollow, glabrous, brownish orange (5C5) to light orange (6A5) on upper half, grayish yellow (4B5) on lower half. Basidiospores 8–11(12) × 5.5–7(8) μm, ellipsoid to sub-reniform, thin-walled. Basidia 70–90 × 8–11 μm, 5–6-spored, narrowly clavate. Pileipellis a cutis, composed of repent to ascending and occasionally branched hyphae 5–18 μm wide. Clamp connections abundant in all tissues.

Habitat and distribution –Gregariously under *Abies georgei* and *Abies densa* in subalpine coniferous forest or mixed forest. Known from southwestern China.

Specimens examined – China, Yunnan Province, Diqing Tibetan Autonomous Prefecture, Shangrila County, Bitahai National Nature Reserve, 3850 m, N 27°84′ E 99°98′, 3 Sep 2020, M. Zhang (GDGM82399, GDGM82389); Same location, 4 Sep 2020, M. Zhang (GDGM83193, GDGM82374, GDGM83171, GDGM83173, GDGM83186, GDGM83228); Same location, 5 Aug 2022, M. Zhang (GDGM90162).

Notes – *Cantharellus zangii* is a subalpine species, mainly distributed in the Himalayas and Hengduan Mountains region of southwestern China, under *Abies* forests. It can be easily distinguished from other subalpine *Cantharellus* species by its small brown tinged basidiomata with long and hollow stipe, ellipsoid basidiospores, and narrowly clavate basidia up to 90 μm long (Tian et al. 2012, Zhang et al. 2021a). Recently, *C. sikkimensis* was reported from India, and was proved to be a later synonym of *C. zangii* on the base of morphological characters and molecular phylogenetic analyses (Zhang et al. 2021a, Wang et al. 2023a).

Craterellus Pers., Mycol. Eur. (Erlanga) 2: 4 (1825)

=*Pseudocraterellus* Corner, Beih. Sydowia 1: 268 (1958) [1956]

=*Pterygellus* Corner, Monogr. Cantharelloid Fungi: 166 (1966)

Type species: *Craterellus cornucopioides* (L.) Pers. 1825

Basidiomata small to medium-sized, funnel-shaped basidiomata usually with hollow stipes, growing individual or in groups on soil or rotten wood, sometimes clustered at base, gymnocarpic. Pileus small to medium, mostly 10–40 mm broad, sometimes up to 70 mm in some species, usually funnel- or trumpet-shaped, omphaloid to nearly applanate with a slightly depressed center, perforated or non-perforated, yellow, brownish yellow, gray, brownish gray, brown, dark gray to black, surface dry, glabrous to tomentous or with strongly squamulose or flocci in some species. Hymenophore varying from nearly smooth, over veined to distinctly lamellate, with gills mostly distinctly forked in varying degrees, yellow, yellowish orange, grayish to gray, changing or unchanging in colour when bruised. Stipe central or excentric, sometimes highly reduced and cannot be separated from pileus in some species, glabrous to squamulose, usually fistulose and perforated in the cap center, rarely solid. Context thin, unchanging or changing to brown, reddish or black when exposed. Odour mostly not obvious, but in some species with distinctly fruity. Taste mild. Spore print white. Basidiospores ovoid, ellipsoid to broad ellipsoid, inamyloid, smooth, thin-walled. Basidia stichic, very variable in length between species, mostly (2)4–6(8)-spored. Pileipellis poorly differentiated, a cutis or trichocutis, rarely a trichoderm, hyphal terminations thin- to slightly thick-walled. Cystidia of a particular type not differentiated. Clamp connections absent or present.

Phylogenetic analyses have demonstrated that *Craterellus* constitutes a monophyletic group within family Hydnaceae, and sister to *Cantharellus*. The genera *Pseudocraterellus* and *Pterygellus* are well-nested within the *Craterellus* group. In the present study, six main clades were supported

in the ITS and multi-gene phylogenetic trees, and were labelled as Clades I–VI, which partially correspond to the result of Cao et al. (2021a). In the following study, species in the genus *Craterellus* are treated alphabetically.

Craterellus albidus Chun Y. Deng & J. Zhang, Phytotaxa 472(3): 262 (2020) Fig. 43

Chinese name:白喇叭菌

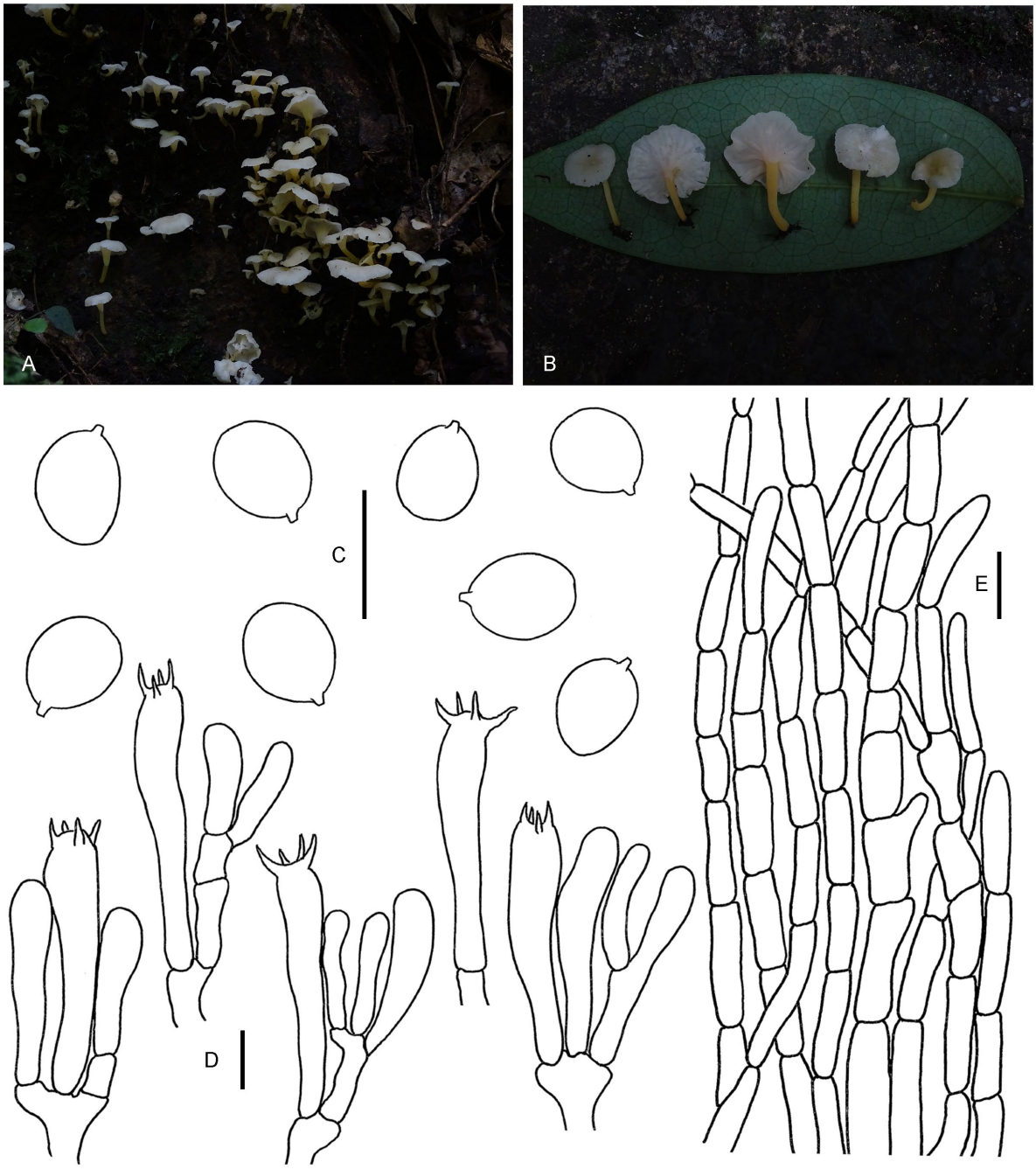


Figure 43 – Morphology of *Craterellus albidus*. A, B. Basidiomata. C. Basidispores. D. Basidia. E. Pileipellis. Scale bars: C–E =10 μm.

Basidiomata very small-sized. Pileus 5–15 mm diam, convex to plano-convex with a shallow depression at center, non-perforate, surface white to cream white, tomentous, margin incurved at first, usually wavy when mature. Hymenophore decurrent, poorly developed, smooth, sometimes wrinkly or very ill-defined veins, white to cream white, unchanging in colour when injured. Stipe

5–15 mm long, 1–2 mm thick, central, hollow, light yellow, greenish yellow, vivid yellow to orange yellow (1–4A6–1–4A8), glabrous. Taste and odour indistinct.

Basidiospores (7.5)8–10 × (6.5)7–8 µm (Lm × Wm = 9.36(±0.56) × 7.22(±0.37) µm, Q = (1.13)1.2–1.45(1.55), Q_m = 1.37 ± 0.18), ellipsoid to broadly ellipsoid, smooth, thin-walled, hyaline in KOH. Basidia 43–60 × 7–8 µm, cylindric to subclavate, 4-spored, sterigmata 6–10 µm long, apex acuminate. Pileipellis a cutis, composed of repent, short, thin-walled hyphae 4–8 µm wide, occasionally branched. Stipitipellis composed of subparallel or parallel hyphae measuring 7–9 µm wide, hyaline. Cystidia absent. Clamp connections absent in all tissues.

Habitat and distribution – Scattered or gregarious on soil or rotted wood under broad-leaved forest in subtropical region of southwest China. Known from southwest China.

Specimens examined – China. Guizhou Province, Duyun City, Qiannan Buyi and Miao Autonomous Prefecture, Huanghe Village, Doupeng Mountain, alt. 1084 m, 17 Aug 2019, C.Y. Deng (GDGM84494, isotype). Same location, alt. 1000 m, 21 Aug 2023, M.L. Xie liyi11235, (GDGM97252).

Notes – *Craterellus albidus* is characterized by its small basidiomata, white pileus, white and smooth hymenophore, light yellow to orange yellow stipe, broadly ellipsoid basidiospores (7.5)8–10 × (6.5)7–8 µm, and growing on very rotting wood (Zhang et al. 2020). These combined features easily separate it from other *Craterellus* species. Phylogenetic analyses showed that *Cr. albidus* well nested within Clade III (*Cr.* subg. *Imperforati*), and was close to *Cr. parvogriseus*. However, *Cr. parvogriseus*, originally reported from India, differs by its gray to brownish gray pileus, white to grayish white hymenophore and larger basidiospores (7–12 × 6.5–9 µm) (Das et al. 2017).

Craterellus albimarginatus N.K. Zeng, T. Jiang & Xu Zhang, Life 15(2, no. 157): 9 (2025)

Chinese name:白边喇叭菌

Notes – *Craterellus albimarginatus*, recently reported from the tropical regions of southern China, is characterized by its small basidiomata, grayish-brown pileus with a pure white margin, white hymenophore tinged violet, and ellipsoid basidiospores (7–9 × 5–6.5 µm). The present phylogenetic analyses showed that *Cr. albimarginatus* formed a distinct lineage in Clade III (*Cr.* subg. *Imperforati*) (Figs. 4, 5), and closely related to *Cr. sinensis*, *Pterygellus polymophus* and two unnamed sequences. However, *Cr. sinensis* newly described in present study differs in having a yellowish brown to dark gray pileus without a white margin, grayish white to pastel gray hymenophore, and larger basidiospores (8.5–10.5× 5–6 µm). Additionally, *Cr. sinensis* is only known from the subalpine regions of southwest China. *Pterygellus polymophus*, originally reported from Malaysia, can be easily distinguished by its yellow to orange basidiomata, strigose pileus and broader basidiospores (7–9 × 6–7 µm *vs* 8.5–10 × 7–8 µm) (Corner 1966).

In the present study, a sample labelled as GDGM95043 exhibits morphological features similar to those of *Cr. albimarginatus*, including the small basidiomata, grayish-brown pileus with a white margin, smooth hymenophore, and ellipsoid basidospores (7–9 × 5–6 µm). However, there are differences between them at the molecular level, and a Blastn search based on ITS sequences showed that they have only 94.32% identity. These differences suggest that they may be different species. Due to the lack of sufficient samples, this study provisionally identifies GDGM95043 as *Cr. albimarginatus*. Further research with more samples and multi-gene analysis is needed to clarify its taxonomic status.

Craterellus aprilis Ming Zhang & T.H. Li, sp. nov. Fig. 44

Chinese name:四月喇叭菌

Fungal Name: FN573128; Facesoffungi number: FoF 19032

Etymology – "*aprilis*" means April, referring to the species can be found in April.

Diagnosis – similar to *Cr. minor*, but differs in less obvious reddening and blackening discoloration of the context, smaller basidiospores and the independent phylogenetic position.

Type – China, Fujian Province, Nanping City, Mangdang Mountain, mixed forests, 26 Apr 2023, Amateur (GDGM91209).

Basidiomata small-sized. Pileus 1.5–4 cm broad, more or less convex when young, gradually applanate, depressed in the center when mature, usually perforated when mature; margin incurved when young, wavy or irregular when mature, with obscure striate on surface, membranous; surface dry, glabrous to subtomentous, greenish gray, yellowish gray, grayish yellow to brownish gray (1B/C2–7B/C2; 1B/C3–7B/C3); Context thin, 1–1.5 mm thick, white to grayish white (1A1–1A2), nearly unchanged to slightly discoloring to pinkish or reddish where injured, then to faintly blackish. Hymenophore decurrent, as poorly-developed gill-like ridges, distant, composed of bifurcate, less than 1.5 mm high vein-like folds, particularly towards pileus margin, concolorous with pileus or paler to grayish white, usually with purplish gray tinge when young and gradually paler when mature. Stipe 20–40 mm long, 3–5 mm thick, subcylindrical, glabrous, hollow, concolorous with pileus; basal mycelium white. Odour and smell not distinct.

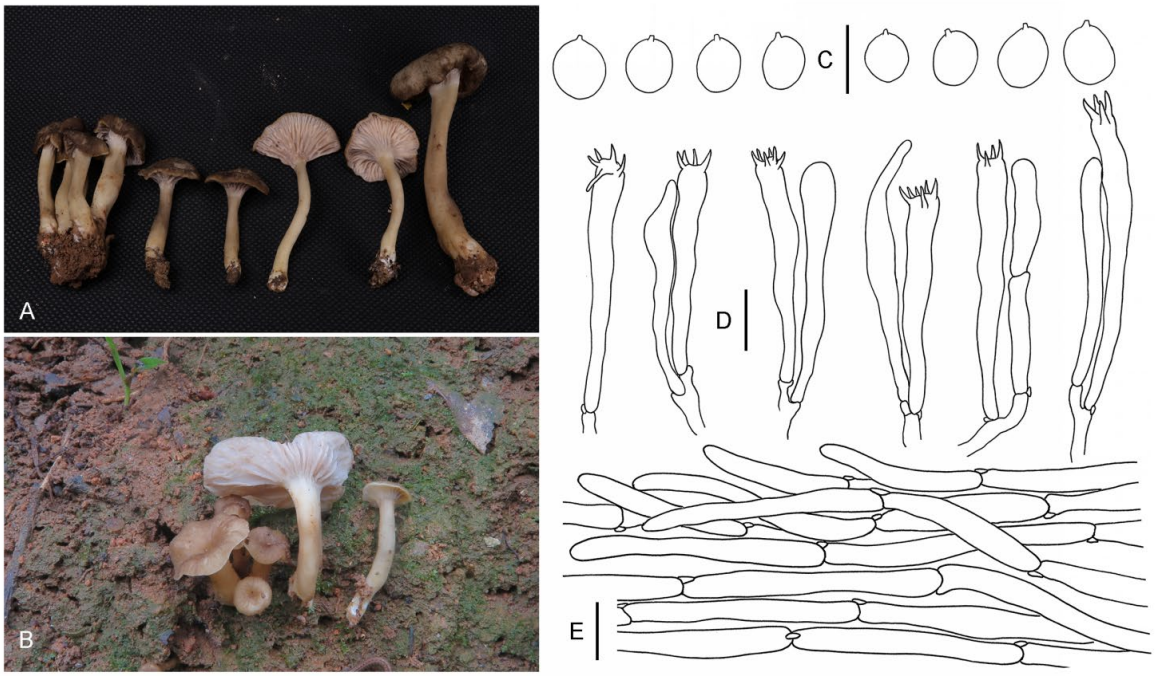


Figure 44 – Morphology of *Craterellus aprilis*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Basidiospores (7)7.5–10 × 6.5–7.5(8) µm [Lm × Wm = 8.23(±0.65) × 7.05(±0.36) µm, Q = (1.06)1.13–1.28(1.42), Q_m = 1.17 ± 0.09], broadly elliptical to oval, thin-walled. Basidia 66–85 × 8–12 µm, clavate, thin-walled, 2–6-spored, sterigmata 5–7 µm long. Pileipellis a cutis, composed of repent and occasionally interwoven hyphae, 4–14 µm in diam., colourless to yellowish brown in KOH, thin-walled. Hymenophoral trama composed of cylindrical hyphae 5–10 µm in diam. Stipitipellis a cutis, composed with thin-walled, paralleled, hyphae 4–16 µm broad. Cystidia absent. Clamp connections common.

Habitat and distribution – Scattered or gregarious under mixed forest in subtropical regions. Known from South China.

Specimens examined – Guangdong Province, Zhaoqing City, Dinghushan National Nature Reserve, alt. 100 m, 10 Apr 2024, M. Zhang (GDGM93956); Same location, 27 Apr 2023, Amateur (GDGM91206); Guangzhou City, Maofengshan Forest Park, 19 Apr 2023, M. Zhang (GDGM92099); Hunan Province, Shaoyang City, Xinning County, Huilongsi Town, 18 Apr 2024, Y.L. Deng (GDGM93773); Changsha City, Yuanliu Town, 21 Apr 2023, Z.Q. Liu (GDGM93659) Zhejiang Province, Ningbo City, 25 Apr 2023, B. Chen (GDGM91208);

Notes – *Craterellus aprilis* occurs early in the year in April, and mainly grows under coniferous or mixed forests in the subtropical regions of southern China. It is mainly characterized

by its greenish gray to brownish gray pileus usually perforated at centre, poorly-developed gill-like hymenophore concolorous with pileus, and broadly elliptical basidiospores (7.5–10 × 6.5–7.5 µm).

Phylogenetic analyses showed that specimens of *Cr. aprilis* clustered together and formed a monophyletic group in Clade I (*Cr.* subg. *Lamelles*) (Figs. 4, 5), and closely related to *Cr. melanoxeros*, *Cr. minor*, and *Cr. subalpinus*. However, *Craterellus melanoxeros*, a species endemic to Europe, differs by its larger basidiomata (pileus up to 10 cm), pallid yellow to dull yellow pileus turning blackish at margin, yellowish to pinkish liliac stipe turning blackish when old or bruised, rose pinkish to violet hymenophore, and relatively narrower basdiospores (8–11 × 6–7 µm) (Breitenbach and Kränzlin, 1986, Pegler et al. 1997, Akata and Kumbaşli 2014). *Craterellus minor*, recently reported from China, differs by its grayish-yellow pileus, yellowish white to reddish gray hymenophore changing to pastel red to reddish pink at first then to black when bruised, pale yellow to grayish yellow stipe changing to reddish pink when bruised, broader basidiospores measuring 8–10.5(11) × (6.5)7–8.5 µm and smaller basidia (56–75 × 8–13 µm) (Zhang et al. 2022b, present study). *Craterellus subalpinus* differs by its grayish yellow to brownish orange pileus, yellowish white to yellowish gray hymenophora, pale yellow to white yellow stipe and subalpine distribution.



Figure 45 – Morphology of *Craterellus atrobrunneolus*. A–C. Basidiomata. D. Basidia. E. Basidiospores. F. Pileipellis. Scale bars: D, F = 20 µm; E = 10 µm.

Craterellus atrobrunneolus T. Cao & H.S. Yuan, Mycotaxon 136(1): 64 (2021) Fig. 45

= *Craterellus conatus* G.P. Zhao, J.J. Hu, B. Zhang & Y. Li, MycoKeys 91: 101 (2022)

= *Craterellus longitipes* N.K. Zeng & T. Jiang, Life 15: 157 (2025)

= *Craterellus striatus* G.P. Zhao, J.J. Hu, B. Zhang & Y. Li, MycoKeys 91: 104 (2022)

Chinese name:暗褐喇叭菌

Basidiomata small-sized. Pileus 1.5–3.5 cm broad, convex when young with a depressed center, gradually applanate to infundibuliform, depressed in the center when mature, umbilicate, usually perforated when mature; surface dry, margin incurved when young, wavy or irregular when mature, subglabrous to subtomentous, with obscure striate on surface, grayish brown, dark ruby, dark purple to purplish gray to gray (11F2–14F2, 11F3–14F3, 14F1). Context thin, 1–1.5 mm thick, white to grayish white, unchanging when exposed. Hymenophore decurrent, without a clearly delimitation from the stipe surface, poorly-developed, wrinkly, composed of bifurcate vein-like folds, strongly connected, white, grayish white to purple gray (1A1, 1B1, 13A/B2-14A/B2). Stipe 25–50 mm long, 3–8 mm thick, subcylindrical, slightly tapering downward, smooth or finely rugulose, hollow, concolorous with pileus or paler to light brown, to reddish brown (7D4-9D4); basal mycelium white. Odour mild. taste not distinct.

Basidiospores 7–8.5 × 4.5–6 μm [Lm × Wm = 7.52(±0.5) × 5.37(±0.52) μm, Q =1.25–1.6, Q_m = 1.41 ± 0.11], broadly elliptical, oval to suborbicular, thin-walled. Basidia 60–75 × 7–8 μm, clavate, thin-walled, 4–6-spored, sterigmata 4–8 μm long. Pileipellis a cutis, composed of repent and occasionally interwoven hyphae, 4–14 μm wide, colourless, thin-walled. Hymenophoral trama composed of cylindrical hyphae 3–8 μm in diam. Stipitipellis a cutis, composed with thin-walled, parallel, hyphae 3–8 μm wide. Clamp connections absent.

Habitat and distribution – Solitary or scattered under broad-leaved forests in subtropical regions of China. Known from southwest, southern and eastern China.

Specimens examined – China, Yunnan Province, Yi Autonomous Prefecture of Chuxiong, 4 Oct 2022, X.L. Gao (GDGM89523); Same location, 28 Aug 2024, X.L. Gao (GDGM97177, GDGM97178); Zhejiang Province, Kaihua County, Qianjiangyuan National Park, 17 Jul 2020, J.B. Pu & W.Q. Liang (GDGM83803); Guangdong Province, Shaoguan City, Renhua County, Danxiashan National Nature Reserve, 4 Jun 2020, Z.X. Chen (GDGM81396).

Notes – *Craterellus atrobrunneolus*, recently reported from southwest China (Cao et al. 2021), can be easily distinguished in the field by its grayish brown to dark brown pileus deeply depressed at centre, grayish white to purple gray hymenophore with poorly developed bifurcate vein-like folds, and light brown to grayish brown stipe.

Phylogenetic analyses showed that three species *Cr. connatus, Cr. longitipes* and *Cr. striatus* recently reported from China all clustered together with *Cr. atrobrunneolus*, and formed a major species lineage in Clade V. They also share the same morphological characteristics with *Cr. atrobrunneolus*, such as similar brown pileus, grayish hymenophore, hollow stipe, and similar sized basidiospores (Zhao et al. 2022, Jiang et al. 2025). According to the GCPSR, the four species were strongly supported as a single phylogentetic species. Thus, *Cr. connatus, Cr. longitipes* and *Cr. striatus* are treated as synonyms of *Cr. atrobrunneolus* in this study.

Craterellus aureus Berk. & M.A. Curtis, Proc. Amer. Acad. Arts & Sci. 4: 123 (1860) Fig. 46

= *Craterellus luteus* T.H. Li & X.R. Zhong, Phytotaxa 360(1): 38 (2018)

Chinese name:金黄喇叭菌

Pileus 2–8 cm broad, surface dry, light yellow to light orange (2A5–6A5), subglabrous; pileus margin slightly curving outwards when young, often wavy or lobed at maturity, sometimes splitting down to stipe with age. Hymenophore decurrent, smooth to slightly folded, yellowish white to orange white (2A2–6A2). Stipe confluent with pileus, without obvious boundary, 2–5 cm high, 5–12 mm wide, glabrous, hollow, concolorous with hymenophore, usually curved and eccentric; basal mycelium white. Odour not distinct. Basidiospores 8–10(10.5) × (5.5)6–7(7.5) μm, Lm × Wm = 9(±0.63) × 6.41(±0.41) μm, Q =1.14–1.58, Q_m = 1.41 ± 0.1], ellipsoid to ovoid,

smooth, hyaline in KOH, with granular contents. Basidia 50–91 × 6–10 µm, subclavate to cylindrical, hyaline to yellowish in KOH; 2–6-spored, sterigmata 5–7.5 µm long. Pileipellis a a cutis, composed of repent and suberected hyphae 4.5–8.5 µm broad. Stipitipellis a cutis, composed with thin-walled, paralleled hyphae 3–5 µm broad. Clamp connections absent in all tissues.

Habitat and distribution – solitary or scattered under broadleaved forests dominated by Fagaceae and Theaceae trees. Known from South China.

Specimens examined – China, Guangdong Province, Shaoguan City, Chebaling National Nature Reserve, 28 Jul 2016, X.R. Zhong & Hao Huang (GDGM 46432, GDGM48105); Same location, 4 Jul 2016, T. Li (GDGM46327, GDGM46455); 18 Sep 2017, H. Huang (GDGM 49495, GDGM60384). Nanling National National Nature Reserve, 29 Aug 2023, G.R. Zhong (GDGM93208); Huizhou City Luofushan Scenic Spot, 2 Jul 2021, M. Zhang (GDGM85856); Meizhou City, 8 July 2023, Y.J. Liu (GDGM91697); Yunnan Province, Puer City, Taiyanghe National Forest Park, 20 Sept 2019, M. Zhang (GDGM78716); Same location, 21 Sept. 2019, M. Zhang (GDGM78640); Xishuangbanna Dai Autonomous Prefecture, Daduguang Town, 29 Jul 2022, M. Zhang (GDGM89898); Anhui Province, Huangshan City, Huangshan Scenic Spot, 11 Aug 2020, Ming Zhang (GDGM79168, GDGM82525); XuanCheng City, Guangde County, 22 Jul 2023, Amateur (GDGM88767); Hainan Province, Ledong County, Jianfengling National Nature Reserve 13 Jul 2021, M. Zhang (GDGM86251); Guizhou Province, Libo City, Huangjianghe National Wetland Park, 9 Jul 2021, M. Zhang (GDGM86060); Fujian Province, Longyan City, Changting County, L.P. Wu (GDGM91713); Jiangsu Province, Yixing City, Longchi Mountain, Z.L. Chen (GDGM93717); Zhejiang Province, Huzhou City, Amateur (GDGM92541).

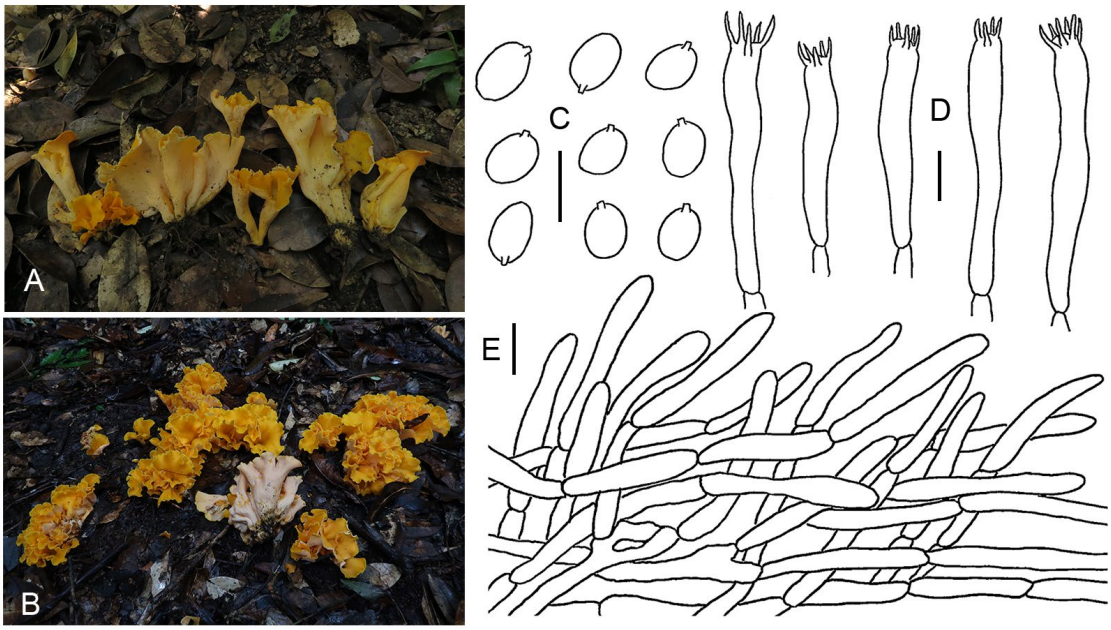


Figure 46 – Morphology of *Craterellus aureus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: D = 10 µm; E, F = 20 µm.

Notes – *Craterellus aureus* is a common and widespread species, mainly growing in subtropical to tropical broad-leaved forests in southern China. This species exhibits considerable variation in macro-morphology. The basidiomata can be petaloid, funnel-shaped, trumpeted, or tubular, with a stipe that may or may not be obvious. The pileus diameter can range from 20 mm to 80 mm, and the pileus colour ranges from yellow to orange, and even reddish-orange. The hymenophore colour can range from white to yellowish orange. Additionally, the basidiomata can be either solitary, scattered, or clustered.

Phylogenetic analyses showed that specimens of *Cr. aureus* and *Cr. luteus* clustered together, and formed a well supported major monophyletic clade, close to *Cr. odoratus*. However, *Cr. luteus*,

originally reported from China, has been proven to be a later synonym for *Cr. aureus* based on morphological features and phylogenetic analyses (Zhang et al. 2022c). *Cr. odoratus* originally described from North America, differs by its more fragile basidiomata, narrower basidiospores (8.9–11.8 × 4.4–6.3 μm) and strong pleasant odour (Petersen 1979b, Lincoff 1989).

Craterellus badiogriseus T. Cao & H.S. Yuan, Stud. Mycol. 99 (no. 100121): 42 (2021) Fig. 47

Chinese name:灰褐喇叭菌

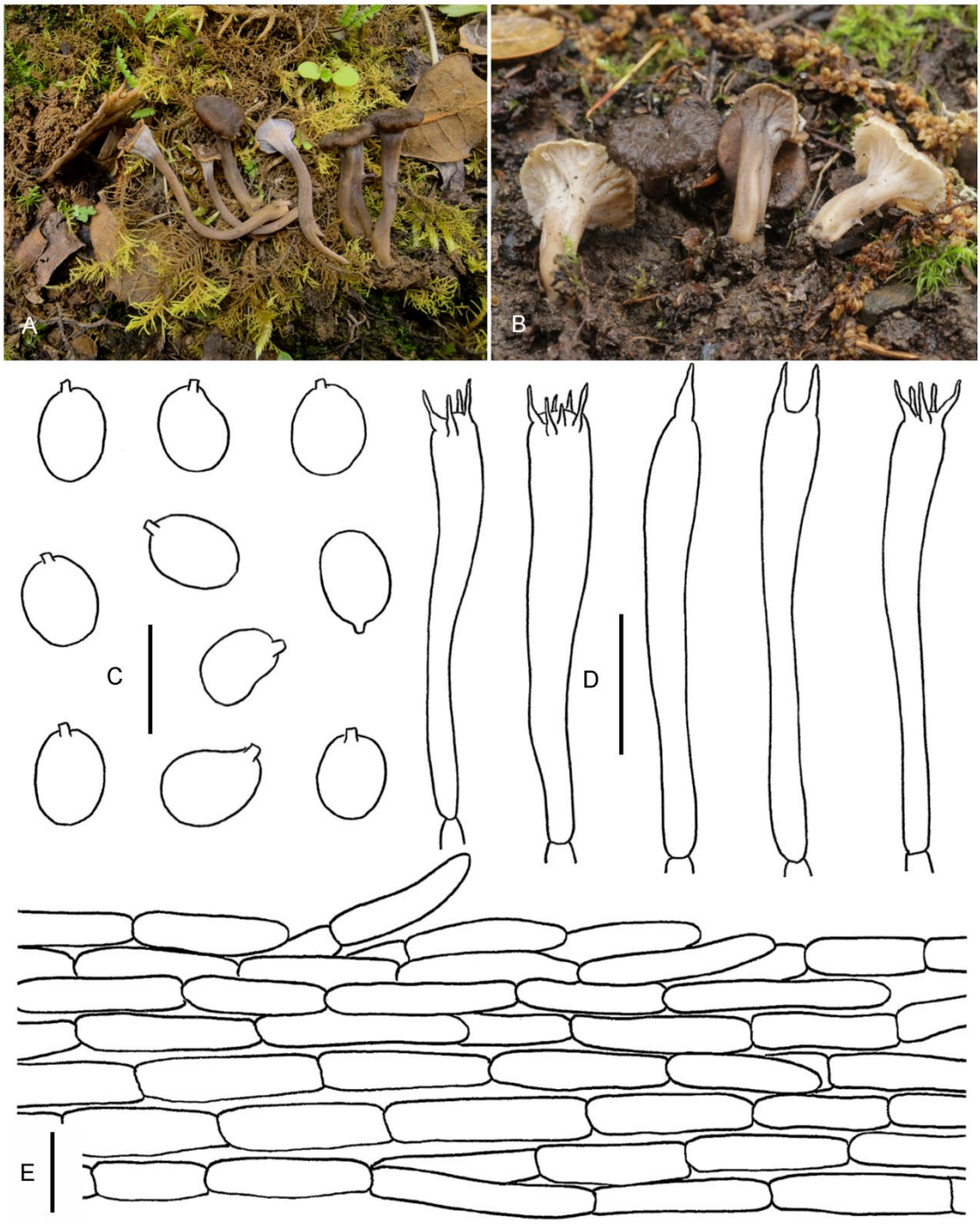


Figure 47 – Morphology of *Craterellus badiogriseus*. A, B. Basidiomata. C. Basidispores. D. Basidia. E. Pileipellis. Scale bars: C = 10 μm; D, E = 20 μm.

Basidiomata small-sized. Pileus 10–18 mm broad, convex to nearly applanate with a depressed center, non-perforated; surface dry, glabrous to velutinate, grayish yellow, olive brown,

brownish orange, brown to dark brown (3C3–6C3, 3D4–6D, 5F4–7F4), margin thin, slightly involute, paler than pileus surface. Hymenophore decurrent, smooth to wrinkly with ill-defined veined, white, grayish white to pastel gray (1A1–1C1). Stipes 10–35 mm× 2–5 mm, subcylindrical, hollow, surface glabrous, concolorous with pileus or slightly paler. Odour fruity. Taste mild.

Basidiospores (7.5) 8–10.5(11) × (5.5)6–7.5 μm, [Lm × Wm = 8.82(±0.96) × 6.4(±0.67) μm, Q =(1.23)1.3–1.45(1.61), Q_m = 1.37 ± 0.08], broadly ellipsoid, smooth, thin-walled, hyaline, some with granular contents. Basidia 68–96 × 6–10 μm, subcylindric, subclavate to clavate, 1-6-spored, sterigmata 4–11.5 μm long. Pileipellis a cutis, composed of repent, short cylindrical hyphae, 5–12 μm wide, thin-walled, subparallel, rarely branched; terminal elements rounded at apex, 17–70 × 5.5–11.5 μm. Clamp connections absent.

Habitat and distribution – Scattered or gregarious in subalpine broad-leaved forests dominated by *Quercus spinosa* or in mixed forests. Known from Liaoning and Sichuan Provinces, northeast and southwest China.

Specimens examined – China, Sichuan Province, Aba Tibetan and Qiang Autonomous Prefecture, Xiaojin County, Lianghekou Town, alt. 3400 m, 12 Aug 2024, M. Zhang (GDGM94500). Kangding City, Jiagenba Town, Pengbuxi Village, alt. 3684 m, 16 Aug 2024, M. Zhang (GDGM96736).

Notes – Cao et al. (2021a) first reported this species from northeast China, and showed an infundibuliform (may be misplaced) and atypical basidiomata photo (the basidiomata are too old) in their article. In the present study, another two specimens were collected and studied, and the characteristics of *Cr. badiogriseus* were resummarized as above. *Cr. badiogriseus* is characterized by the small basidiomata (pileus 10–18 mm broad), the grayish yellow to dark brown pileus usually depressed at center, smooth to veined hymenophore colored white to pastel gray, the glabrous stipes, and broadly ellipsoid basidiospores measuring (7.5) 8–10.5(11) × (5.5)6–7.5μm (Cao et al. 2021a; present study).

Phylogenetic analyses showed that several sequences named as "*Cr. griseobrunneus*", "*Cr. lignicola*", "*Cr. microsporus*", "*Cr, ochraceus*" and "*Cr. velutinus*", separately, clustered together with *Cr. badiogriseus.* According to GCPSR, it is strongly suggested that they represent one species close to *Cr. brunneus*. However, the latter differs by its paler pileus and hymenophore, shorter basidia (less than 70 μm long), and the thin-walled pileipellis hyphae.

Craterellus brunneus Ming Zhang & J.Y. He, sp. nov. Fig. 48

Chinese name:褐喇叭菌

Fungal Name: FN573129; Facesoffungi number: FoF 19033

Etymology – "*brunneus*" means brown, referring to the brown pileus color.

Diagnosis – Distinguished from *Cr. guizhouensis* by its shorter stipe, larger basidiospores, longer basidia and unique DNA sequences.

Type – China. Zhejiang Province, Jinhua City, under broad-leave forests mainly dominated by Fagaceae trees, 8 Jul 2022, J.Y. He (GDGM91705).

Basidiomata small-sized. Pileus 10–20 mm broad, nearly applanate with depressed centre when young, concave to subinfundibuliform at maturity, surface dry, glabrous to subtomentose, olive, olive brown to brown (2E5–6E5), occasionally pale gray in some specimens; margin incurved at first, usually wavy and lobed when mature, slightly paler than centre. Context 0.5 mm thick in the center of the pileus, sharply attenuate towards margin, grayish white, unchanging when exposed. Hymenophore decurrent, poorly developed, smooth or wrinkly with very ill-defined veined, white to pale gray, unchanging in colour when injured. Stipe 10–28 × 1.5–4 mm, central, subcylindrical, hollow, surface glabrous, concolorous with pileus; basal mycelium white. Odour none. Taste mild.

Basidiospores 8.5–10.5 × 6–7.5 μm, [L_m × W_m = 9.38(±0.58) × 6.6(±0.46) μm, Q = (1.21)1.28–1.5(1.75), Q_m = 1.42 ± 0.12], elliptical to oval thin-walled, colourless in KOH. Basidia 50–70 × 7–10 μm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, 4–6 spored; sterigmata 4–7 μm long. Hymenophoral trama composed of subregular to slightly

interwoven hyphae 3–6 μm in diam., thin-walled. Pileipellis composed of long, repent, branched, thin-walled hyphae, 4–9 μm wide, colourless in KOH. Stipitipellis a cutis, composed of cylindrical, parallel hyphae, measuring 4–8 μm in diam. Clamp connections absent in all tissues.

Habitat and distribution – Scattered or gregarious under Fagaceae trees in subtropical broad-leaved forests. Known from southern and eastern China.

Specimen examined – China, Guangdong Province, Shaoguan City, Renhua County, Danxiashan National Nature Reserve, 20 Sep 2017, M. Zhang (GDGM55075).

Notes – *Craterellus brunneus* is characterized by its small basidiomata, olive to olive brown pileus depressed at center, white to pale gray hymenophore, elliptical to oval basidiospores and lack of clamp connections. *Craterellus brunneus* resembles *Cr. badiogriseus* in their tiny sizes of basidiomata. However, *Cr. brunneus* has a paler pileus, thinner stipe, shorter basidia, and thin-walled hyphae of pileipellis.

Phylogenetic analyses based on multi-gene showed that two samples named as "*Cr. Fibrillosus*" (unpublished) were well clustered together with *Cr. brunneus* and formed a monophyletic lineage in Clade III (*Cr*. subg. *Imperforati*), suggesting they represent the same species. *Cr. brunneus* closely related to *Cr. sinuosus* and *Cr. badiogriseus*. However, *Cr. sinuosus* can be easily distinguished by its larger basidiomata, pale grayish to grayish brown pileus with floccoso-squamose in the center, and larger basidiospores (10–13 × 7.5–9 μm) (Corner 1966).

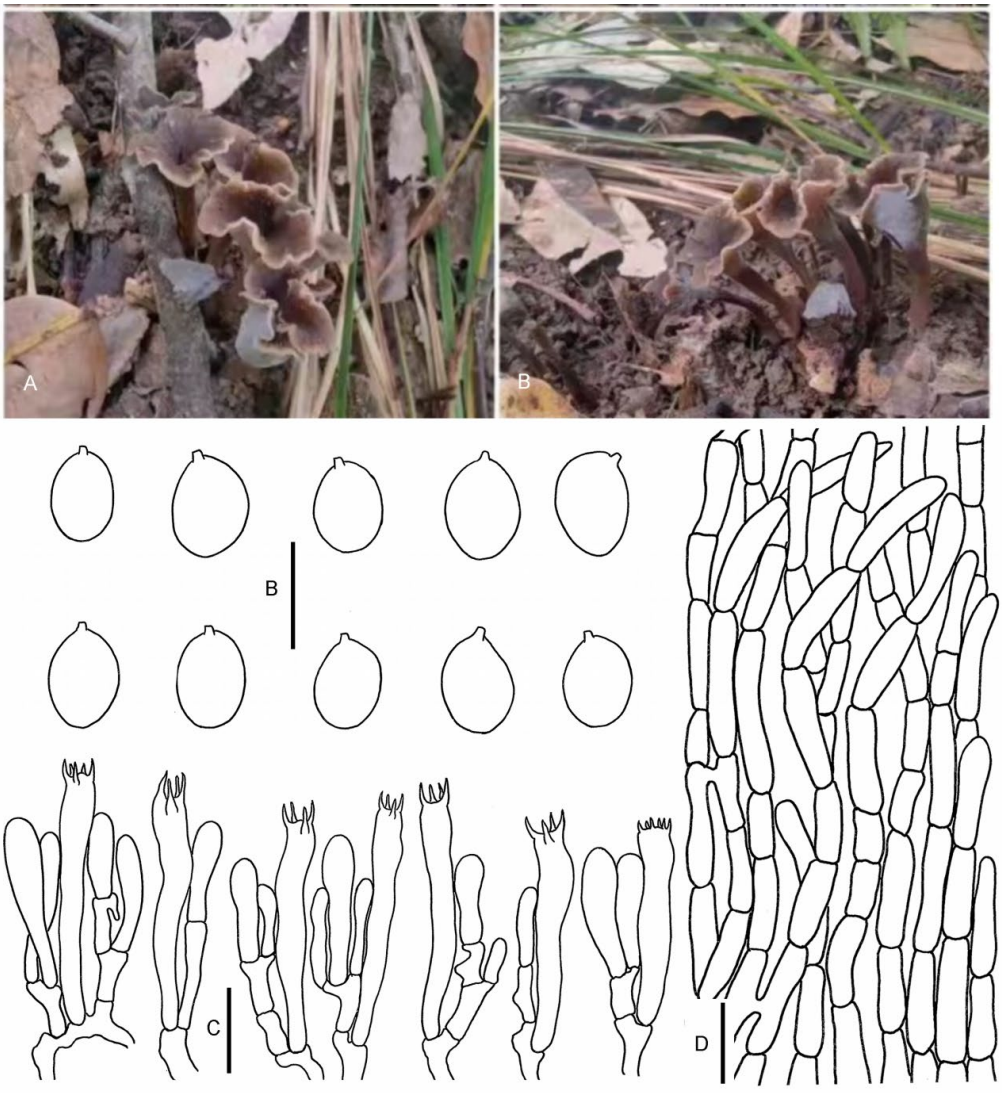


Figure 48 – Morphology of *Craterellus brunneus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 μm; D, E = 20 μm.

Craterellus croceialbus T. Cao & H.S. Yuan, Stud. Mycol. 99 (no. 100121): 42 (2021) Fig. 49

Chinese name:橙白边喇叭菌

Basidiomata small to medium-sized. Pileus 20–70 mm broad, deeply depressed in the center and perforation continuous with hollow stipe, infundibuliform, surface dry, glabrous to velutinate, brownish orange to light brown (5D4–7D4) when young, changing to grayish brown to gray when old or drying (5D1–3–7D1–3); margin incurved at first, usually wavy and lobed when mature, slightly paler than centre. Context thin, 0.3–0.8 mm thick in the center of the pileus, sharply attenuate towards margin, unchanging when exposed. Hymenophore decurrent, poorly developed, smooth or wrinkly with very ill-defined veined, white, yellowish gray to gray (4B1–4B2), unchanging in color when injured. Stipes indistinct, confluent with pileus, 15–30 mm long, 5–10 mm wide, hollow, surface glabrous, concolorous with hymenophore; basal mycelium grayish white. Odour fruity. Taste mild.



Figure 49 – Morphology of *Craterellus croceialbus*. A. Basidiomata. B. Basidiospores. C. Basidia. D. Pileipellis. Scale bars: B = 10 µm; C, D = 20 µm.

Basidiospores 8.5–11.5 × 6.5–8 µm [Lm × Wm = 9.78(±0.7) × 7.42(±0.47) µm, Q =1.2–1.5, Qm = 1.32 ± 0.09], elliptical to oval, thin-walled, colourless in KOH usually with granular

contents. Basidia 60–85 × 6–8 μm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, 2–4-spored; sterigmata 7–10 μm long. Pileipellis composed of repent, branched, thin to slightly thick-walled hyphae, subparallel, rarely branched, 4–15 μm wide, colourless in KOH, terminal elements rounded at apex. Stipitipellis a cutis, composed of cylindrical, parallel hyphae, measuring 4–8 μm in diam. Cystidia absent. Clamp connections absent.

Habitat and distribution – Scattered, gregarious or caespitose under broad-leaved forests. Known from central, southwest and northeast China.

Specimens examined – China, Hubei Province, Suizhou City, Sui County, Wanhe Town, alt. 840 m, 29 May 2023, H.J. Liu (GDGM91292); Jilin Province, 10 Jul 2021 J.P. Li (GDGM86694); Sichuan Province, Dazhou City, Yihan County, Hongling Town, 20 Jul 2023, Z. You (GDGM91689); Same location, 28 Oct 2023, Z. You (GDGM93013).

Notes – *Craterellus croceialbus*, recently reported from the temperate region of northeastern China, is characterized by its small baisidomata (10–20 mm broad), brownish gray pileus, hollow stipes, ellipsoid basidiospores and the absence of clamps (Cao et al. 2021a). The present phylogenetic analyses showed that several specimens clustered together with the type specimen of *Cr. croceialbus*, indicating that they represent the same species. This is also consistent with the morphological features, except that the pileus diameter can reach up to 70 mm in our samples.

In China, *Cr. croceialbus* has long been misidentified as *Cr. cornucopioides* (Li and Bau 2003, Li et al. 2015), However, *Cr. cornucopioides* differs in having larger basidiomata (pileus up to 15 cm broad), two-spored basidia and larger basidiospores (up to 14 μm long) (Smith 1968, Smith et al. 1979, Tibuhwa 2018). *Cr. macrosporus* and *Cr. squamatus*, recently described from northeast China also resemble *Cr. croceialbus*. However, *Cr. macrosporus* can be easily distinguished by its larger basidiospores measuring (12.5)12.8–14.5(15) × (8.8)9–11(11.5) μm (Cao et al. 2021a); *Cr. squamatus* differs by its small basidiomata, gray to dark brown pileus covered with darker brown raised scales, larger and broader basidiospores (11.5)12–13.8(14) × (8.2)8.5–9.5(10) μm in size, and shorter basidia (35–62 × 5–7.5 μm) (Cao et al. 2021a).

Craterellus grisellonigricans Ming Zhang & T.H. Li, sp. nov. Fig. 50

Chinese name:变灰黑喇叭菌

Fungal Name: FN573132; Facesoffungi number: FoF 19034

Etymology – "*grisello-*" means grayish; "*nigricans*" means becoming blackish; "*grisellonigricans*" referring to the grayish to blackish discoloration of the stipe.

Diagnosis – Similar to *Cr. sordidus* but differs in more lilaceous colour and grayish-blackish discoloration; distinguished from other similar taxa by the combination of lilaceous white to grayish lilac pileus and hymenophore, light or quite bright yellow stipe slightly discoloring grayish-blackish when bruised, and basidiospores measuring 9.5–12(14) × (8.5)9–10 μm.

Type – Vietnam. Lam Dong Province, Da Lat City, Bi Doup Nui Ba National Park, alt. 1500 m, 15 Oct 2017, M. Zhang (GDGM70814).

Basidiomata small-sized. Pileus 20–35 mm broad, convex when young, gradually applanate, depressed in the center when mature, margin incurved when young, wavy or irregular when mature, obscure stripe on surface, membranous; surface dry, pinkish white, purplish white to violet white at first (9A2–17A2), densely covered with pinkish white to white appressed scales to floccose squamules at first, nearly glabrous in age, slightly changing to blackish when bruised. Context thin, 0.5–1 mm thick, fibrous, unchanging when exposed. Hymenophore decurrent but with a clearly delimitation from the stipe surface, as well-developed gill-like ridges, distant, composed of bifurcate, vein-like folds, particularly towards pileus margin, pinkish white to violet white (9A2–13A2) when young, grayish rose, purplish gray, grayish magenta to reddish lilac (13B2–14B2, 12C4–14C4) when mature. Stipe 30–60 mm long, 3–5 mm thick, subcylindrical, tapering downward, glabrous, hollow, light yellow (1A5–4A5), slightly changing to blackish when bruised, basal mycelium white. Odour and smell not distinct.

Basidiospores (9.5)10–12(14) × (8)9–10 μm [Lm × Wm = 10.93 (±0.97) × 9.42 (±0.63) μm, Q = (1.05)1.10–1.25(1.4), Q_m = 1.16 ± 0.08], broadly elliptical, oval to suborbicular, thin-walled.

Basidia 50–90 × 9–10.5 µm, clavate, thin-walled, with 2–6 sterigmata, 5–9 µm long. Pileipellis a cutis, composed of repent and occasionally interwoven hyphae, 7–13 µm wide, colourless, thin-walled, terminal cell cylindrical, up to 150 µm long. Hymenophoral trama composed of cylindrical hyphae 5–12 µm wide. Stipitipellis a cutis, composed with thin-walled hyphae 4–7 µm wide. Cystidia absent. Clamp connections common.

Habitat and distribution – Solitary or scattered under mixed forest in tropical regions. Known from southern Vietnam.

Specimen examined – Vietnam. Lam Dong Province, Da Lat City, Bi Doup Nui Ba National Park, alt. 1500 m, 15 Oct 2017, M. Zhang (GDGM70794).

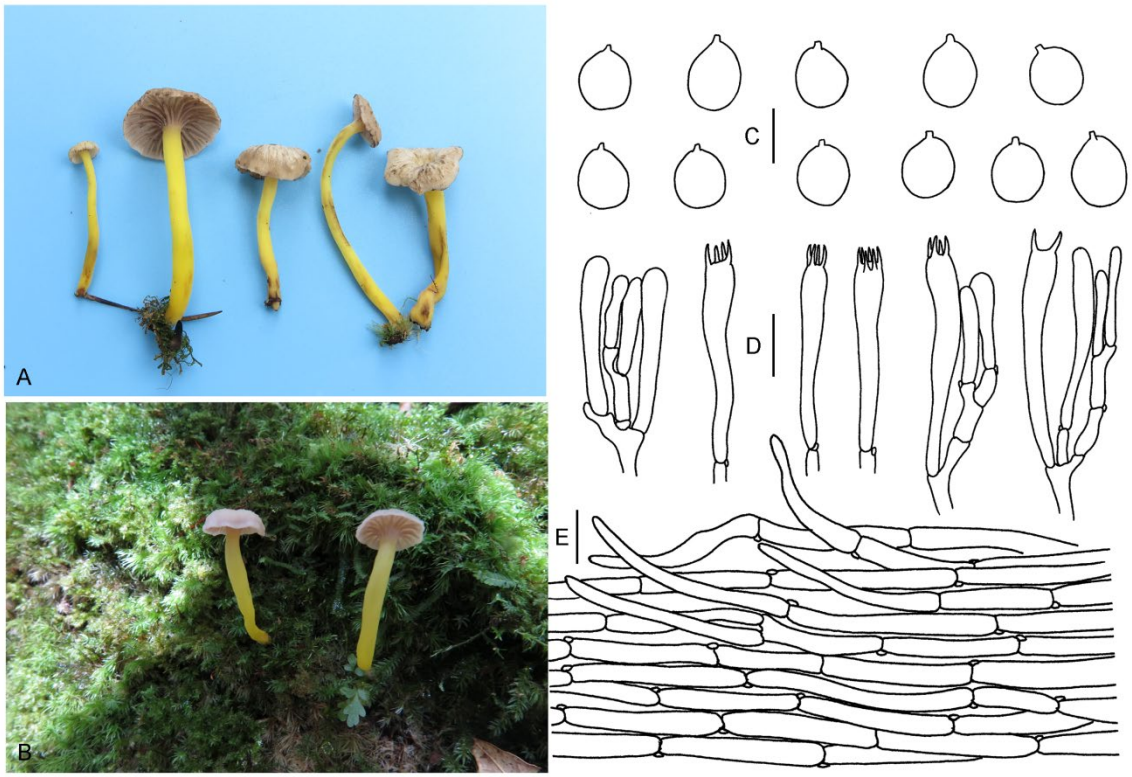


Figure 50 – Morphology of *Craterellus grisellonigricans*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Notes – *Craterellus grisellonigricans* is characterized by its small basidiomata, pinkish white to orange gray pileus, pinkish white to reddish lilac well-developed gill-like hymenophore, light yellow stipe slightly changing to blackish when bruised, and oval to suborbicular basidiospores.

Morphologically, *Cr. grisellonigricans* resembles *Cr. sordidus*, however, *Cr. sordidus* differs in light yellow to brownish orange pileus, grayish yellow to grayish orange hymenophore when young, gradually changing to brownish orange to grayish red when mature, gray to medium gray when old, light yellow stipe unchanging when bruised, and smaller basidiospores 8.5–10 × (6)7–9 µm (Corner 1966; present study).

Phylogenetic analyses showed that *C. grisellonigricans* nested into Clade I (*Cr.* subg. *Lamelles*), closely related to *Cr. subalpinus*, *Cr. sordidus*, *Cr. aprilis* and *Cr. melanoxeros*. However, *Cr. melanoxeros* differs by its larger basidiomata, saffron yellow pileus, yellowish to pinkish liliac stipe, rose pinkish to violet hymenophore and smaller basidiospores (8–11 × 6–7 µm) (Breitenbach and Kränzlin 1986, Pegler et al. 1997). *Craterellus subalpinus*, described in the present study, differs in having a grayish yellow to brownish orange pileus, yellowish white to yellowish gray hymenophore, pale yellow to white yellow stipe unchanging when bruised, and smaller basidiospores (8.5–10.5 × 6.5–8 µm). *Cr. aprilis* differs in having greenish gray to

brownish gray basidiomata with grayish white to brownish gray hymenophore, and smaller basidiospores (7.5–10 × 6.5–8 μm).

Craterellus guizhouensis Ming Zhang, C.Q. Wang & T.H. Li, sp. nov. Fig. 51

Chinese name:贵州喇叭菌

Fungal Name: FN573130; Facesoffungi number: FoF 19035

Etymology – "*guizhouensis*" refers to the type locality of Guizhou Province of China.

Diagnosis – Differs from *Cr. albimarginatus* in having smaller basidiomata, olive brown to brown pileus, longer stipes, and broader basidiospores; distinct by its small and olive brown to brown pileus with a thin yellow white margin, white to grayish white hymenophore, relatively long stipe, and the distinct phylogenetic position.

Type – China. Guizhou Province, Tongren City, Fanjingshan National Nature Reserve, alt. 2000 m, 1 Aug 2019, Y. He (GDGM77697).

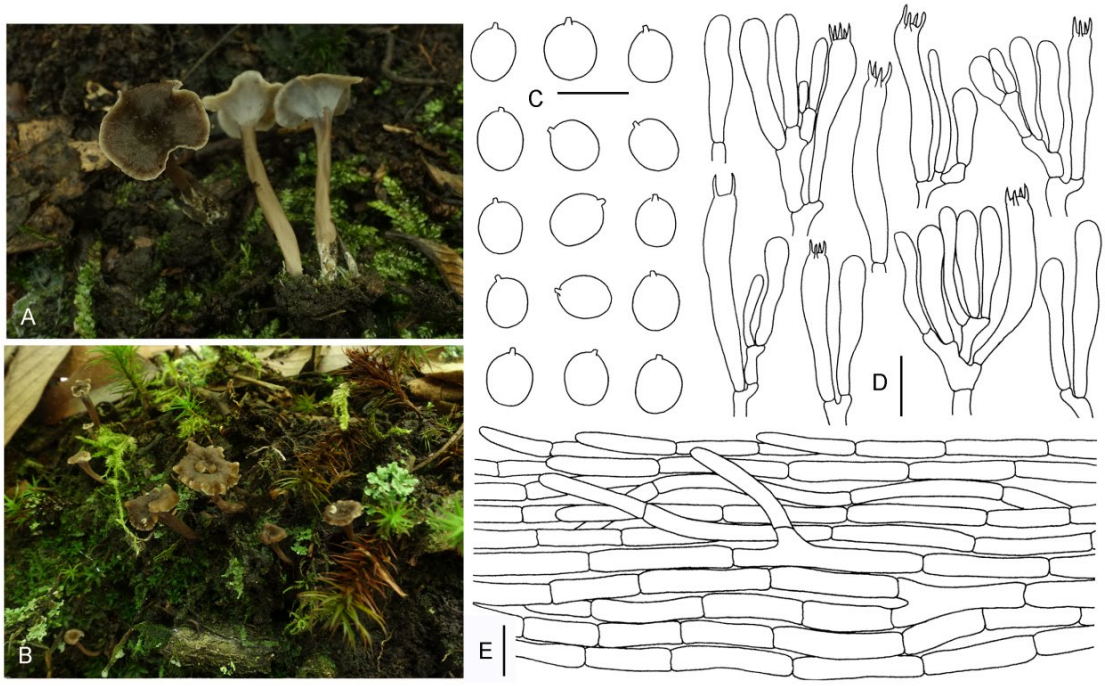


Figure 51 – Morphology of *Craterellus guizhouensis*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 μm; D, E = 20 μm.

Basidiomata very small-sized. Pileus 5–15 mm broad, applanate when young, concave to subinfundibuliform at maturity, surface dry, glabrous, olive, olive brown to brown (2E5–6E5), occasionally pale gray in some specimens; margin incurved at first, usually wavy and lobed when mature, pale yellow to pale orange. Context 0.5 mm thick in the center of the pileus, sharply attenuate towards margin, grayish white, unchanging when exposed. Hymenophore decurrent, poorly developed, smooth, sometimes wrinkly or very ill-defined veined, pale gray to pastel gray (1B1–1C1), unchanging in color when injured. Stipe 20–40 × 1.5–2.5 mm, central, subcylindrical, solid, hollow, surface glabrous to covered with tiny olive brown scales, concolorous with pileus; basal mycelium white. Odour none.

Basidiospores 7–9 × 6–7 μm, [$L_m \times W_m$ = 8.18(±0.52) × 6.73(±0.41) μm, Q = (1.07)1.14–1.28(1.41), Q_m = 1.21 ± 0.08], smooth, elliptical to oval, thin-walled, colourless in KOH. Basidia 48–63 × 7–9 μm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, 2–5-spored; sterigmata 5–7 μm long. Hymenophoral trama composed of interwoven hyphae 3–7 μm in diam., hyphae often inflating towards septa. Pileipellis composed of long, repent, branched, thin-walled

hyphae, 5–13 μm wide, colourless in KOH. Stipitipellis a cutis, composed of parallel hyphae measuring 3–8 μm in diam. Clamp connections absent in all tissues.

Habitat and distribution – Solitary or scattered under broad-leaf forest in subtropical region of southwest China. Known from Guizhou Province, southwest China.

Specimens examined – China. Guizhou Province, Tongren City, Fanjingshan National Nature Reserve, alt. 2000 m, 1 Aug 2019, Y. He (GDGM77697); Same location and date, alt. 2100 m, L.Q. Wu (GDGM77716).

Notes – *Craterellus guizhouensis* is a slender, olive brown to brown tinged species with smooth hymenophore, and growing under broad-leaved forests in southwest China. *Craterellus albimarginatus*, recently reported from the tropical region of southern China, resembles *Cr. guizhouensis*. However, the former has larger basidiomata with a grayish brown pileus, shorter stipes, and narrower basidiospores (7–9 × 5–6.5 μm) with a larger Q value (1.27–1.6) (Jiang et al. 2025). Additionally, *Craterellus brunneus*, *Cr. indicus* and *Cr. parvogriseus* are similar to *Cr. guizhouensis* in morphology. *Craterellus brunneus* differs in having olive to olive brown pileus, longer basidia (up to 70 μm), and relatively larger basidiospores with a larger Q value (1.28–1.51 vs 1.14–1.28). *Craterellus indicus* differs in having a light brownish to sand-colored pileus, creamish hymenophore, yellowish gray stipe and slightly larger basidiospores 7.5–10.5 × 6–7 μm (Kumari et al. 2012). *Craterellus parvogriseus* differs in its gray to brownish gray pileus, white to grayish white hymenophore, and larger basidiospores (7–12 × 6.5–9 μm) (Das et al. 2017).

Phylogenetic analyses supported *Cr. guizhouensis* as a distinct species in Clade III (*Cr.* subg. *Imperforati*), and closely related to two sequences labelled as *Cr. atratus*. However, *Cr. atratus* was originally described from Brazil, differs by its campanulate to broadly campanulate pileus, covered with appressed radially fibrillose, larger basidiospores measuring 9–10(11) × 7–8.5(9) μm, and abundant clamp connections (Wilson et al. 2012). In addition, samples named as *Cr. atratus* formed two distinct lineages in the phylogenetic tree. One lineage composed of specimens from South America, could be *Cr. atratus*, and nested into Clade VI (Fig. 5), while one lineage composed of samples from Southeast Asia might represent a different species. Additionally, two samples from Yunnan in the present study are also close to *Cr. guizhouensis*, but differ in having smaller and darker basidiomata with relatively longer stipes, and the edges of pileus covered with distinct black matted-hairy and lacking yellowish-white rings, and smaller basidiospores.

Craterellus gypseus Ming Zhang, C.Q. Wang & T.H. Li, sp. nov. Fig. 52

Chinese name:石膏色喇叭菌

Fungal Name: FN573133; Facesoffungi number: FoF 19037

Etymology – "*gypseus*" means gypsum-like colour, referring to the white gypsum colour of its hymenophore.

Diagnosis – Morphologically and molecularly similar to *Cr*. *badiogriseus*, but differs in paler and more or less olivaceous pileus, whiter hymenophore and larger basidiospores; distinct from other close species by the combination of obvious gypsum hymenophore colour, absence of clamp connections and distinct phylogenetic position.

Type – China. Guizhou Province, Libo City, Huangjianghe Wetland Park, alt. 840 m, N 25°57′, E 107°70′, 9 Jul 2021, M. Zhang (GDGM86113).

Basidiomata very small-sized. Pileus 10–20 mm broad, convex with depressed centre when young, applanate, concave to subinfundibuliform at maturity, surface dry, tomentose, olive, olive brown to brown (2E5–6E5), occasionally pale gray in some specimens; margin incurved at first, usually wavy and lobed when mature, slightly paler than centre. Context 0.5 mm thick in the center of the pileus, sharply attenuate towards margin, grayish white, unchanging when exposed. Hymenophore decurrent, poorly developed, smooth or wrinkly with very ill-defined veined, white to pale gray, unchanging in color when injured. Stipe 10–28 × 1.5–5 mm, central, subcylindrical, hollow, surface glabrous, concolorous with pileus or paler; basal mycelium white. Odour none. Taste mild.

Basidiospores (8.5)9–12 × 7–8.5 µm, [L_m × W_m = 10.32(±0.84) × 7.92(±0.46) µm, Q = 1.17(1.25)–1.35(1.57), Q_m =1.30 ±1.12], smooth, elliptical to oval thin-walled, colourless in KOH. Basidia 55–65 × 7–10 µm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, with 1–4-spored; sterigmata 4–7 µm long. Hymenophoral trama composed of subregular to slightly interwoven hyphae 4–8 µm in diam., thin-walled. Pileipellis composed of long, repent, branched, thin-walled hyphae, 5–10 µm wide, colourless in KOH. Stipitipellis a cutis, composed of cylindrical, parallel hyphae, measuring 4–8 µm in diam., not secondarily septate. Cystidia absent. Clamp connections absent in all tissues.

Habitat and distribution – Solitary or scattered under Fagaceae trees (*Quercus phillyraeoides* and others) in subtropical broad-leaved forests. Known from southwest China.

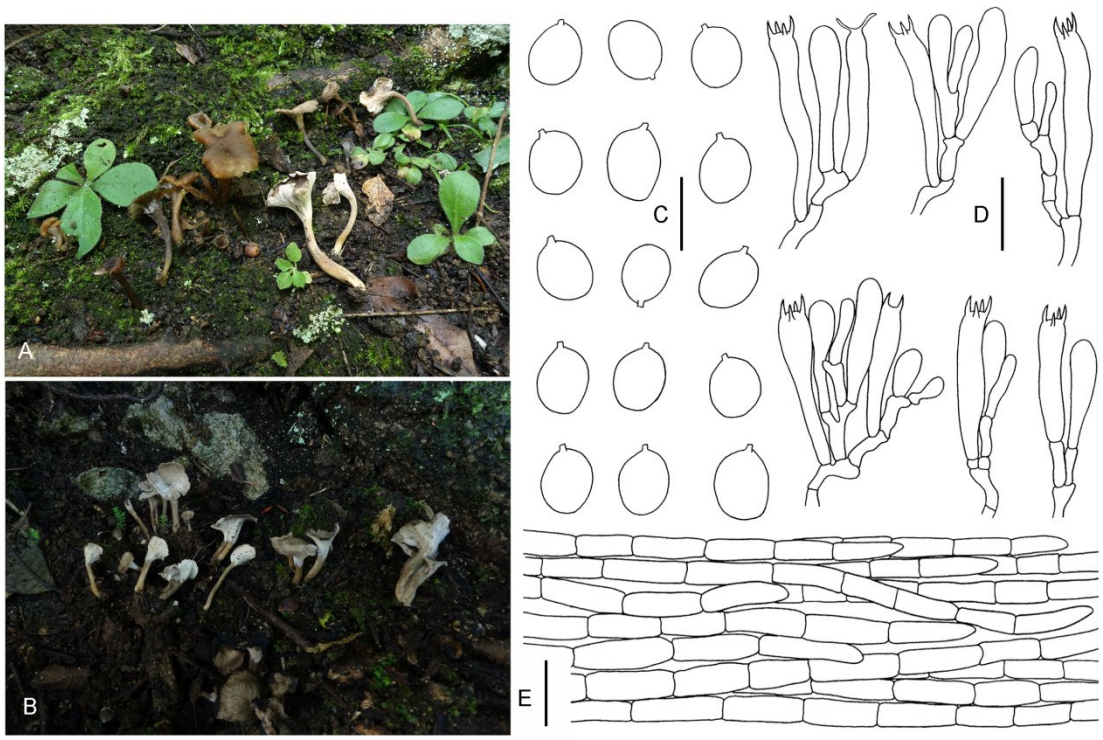


Figure 52 – Morphology of *Craterellus gypseus*. A, B. Basidiomata. C. Basidispores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Specimens examined – China, Guizhou Province, Libo City, Huangjianghe Wetland Park, alt. 840 m, N 25°57′, E 107°70′, 9 Jul 2021, M. Zhang (GDGM86113-1); Hainan Province, Ledong County, Jiangfengling Natinal Nature Reserve, alt. 940 m, on soil under Fagaceae trees mixed other broad leaf trees in tropical broadleaf forest, 18 Jun 2017, M. Zhang (GDGM60415).

Notes – *Craterellus gypseus* is closely related to the morphologically similar and molecularly related species, such as *Cr. badiogriseus*, *Cr. brunneus* and *Cr. parvogriseus*. However, *Cr. badiogriseus* differs by its brownish gray to black pileus, brownish gray to gray hymenophore, and smaller basidiospores (7.5–11 × 6.5–8 µm) (Cao et al. 2021a). *Craterellus brunneus* can be distinguished by the smaller basidiospores (8.5–10.5 × 6–7.5 µm). *Craterellus parvogriseus*, originally reported from India, differs by its gray to brownish gray pileus, white to grayish white irregularly folded hymenophore clearly demarcated from the sterile stipe apex, and larger basidia (up to 70 µm), as well as the different phylogenetic location (Das et al. 2017).

Phylogenetic analyses on the base of multi-locus datasets supported *Cr. gypseus* as a distinct lineage, well nested into Clade III (*Cr.* subg. *Imperforati*), and closely related to an undescribed sample (GDGM60415) from China in this study. But it can be easily separated from others by genetic distance.

Craterellus involutus N.K. Zeng & T. Jiang, Life 15, 157 (2025) Fig. 53

Chinese name:卷边喇叭菌

Basidiomata small sized. Pileus 1–4.5 cm broad, infundibuliform, deeply depressed in the center, perforate; surface dry, velutinate, brownish orange, dark blond, light brown, brown to dark brown (5C4–5F4; 6C4–6F4); margin thin, obviously incurved. Hymenophore decurrent, smooth or wrinkly with very ill-defined veined, pale gray, light gray to medium gray (1B1–1D1), without a clearly delimitation from the stipe surface. Stipe indistinct, unified with pileus, 10–40 mm long, 3–8 mm thick, hollow, surface dry, gray to dark gray (1C1–1F1). Basidiospores 8–10.5 × 6.5–8 µm, globose to subglobose, smooth, thin-walled, yellowish in KOH. Basidia 50–70 × 7–10 µm, 2–5-spored, subclavate to subcylindrical, thin-walled, colourless in KOH; sterigmata 5.5–9 µm long. Pileipellis a cutis, composed of repent, short, parallel to somewhat suberect hyphae 7–15 µm in width, subcylindric, thin to thick-walled (0.5 µm), yellowish in KOH. Clamp connections absent in all tissues.

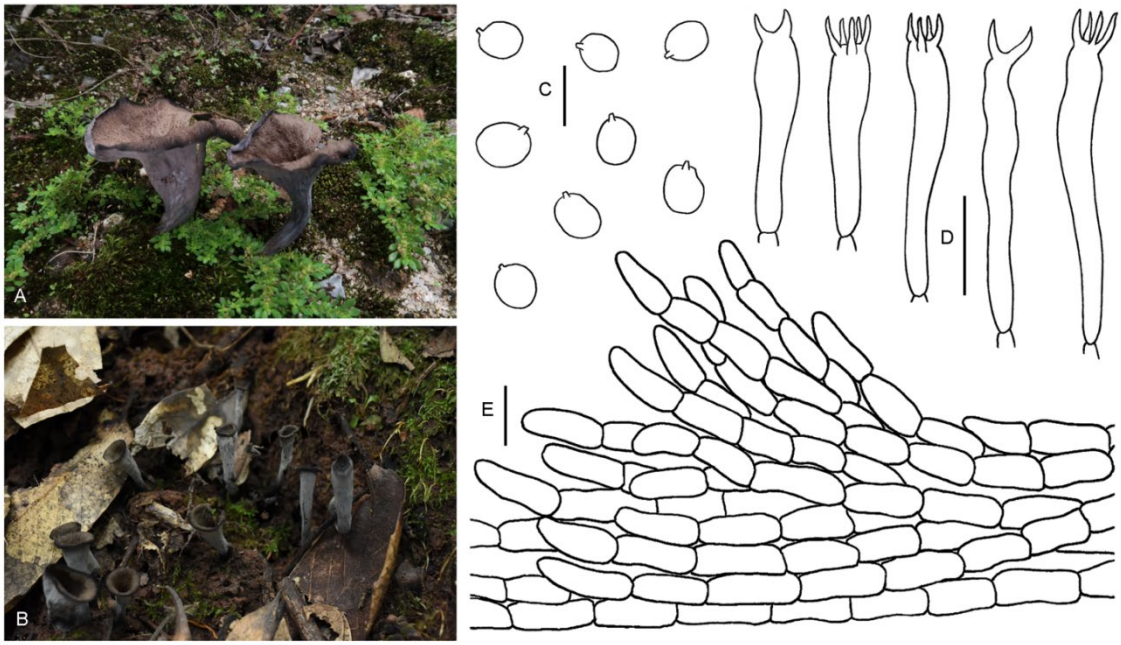


Figure 53 – Morphology of *Craterellus involutus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Habitat and distribution – Solitary or in groups in subtropical to tropical broad-leaved forests. Known from southwest and southern China.

Specimens examined – China, Yunnan Province, Puer City, Simao District, Taiyanghe National Forest Part, 1616 m, 20 Sep 2019, M. Zhang (GDGM78644); Same location, 1647 m, 24 Sep 2019, M. Zhang (GDGM78893, GDGM78913, GDGM78922); Same location, 1662 m, 25 Sept 2019, J.Y. Xu (GDGM78973). Guangdong Province, Shaoguan City, Nanling National Nature Reserve, 30 Aug 2023, G.R. Zhong (GDGM93237); Fujian Province, Nanping Town, 2 Sep 2023, B. Ben (GDGM93720).

Notes – *Craterellus involutus*, recently reported from the tropical regions of southern China, exhibits unique morphological traits that distinguish it from morphologically similar species, *Cr. croceialbus*, *Cr. macrosporus*, and *Cr. squamatus*, which were also reported from China. However, *Cr. croceialbus* differs by its relatively larger basidiomata, brownish gray to grayish brown pileus and larger basidiospores (10–12 × 6.8–8 µm). *Cr. macrosporus* can be easily distinguished by its larger basidiomata and larger basidiospores (12.8–14.5 × 9–11 µm).
Cr. squamatus differs in having smaller basidiomata, light brown to dark brown pileus, and larger basidiospores (12–13.8 × 8.5–9.5 µm). Additionally, *Cr. cornucopioides* occurs in temperate

regions of North America and Eurasia (Matheny et al. 2010, Kuo 2015a), and had also been widely reported in China, differs in having larger basidiomata (pileus up to 15 cm broad) and basidiospores (13–14 × 7–8 μm); currently there is no specimen of *Cr. cornucopioides* available from China. *Cr. fallax* reported from North America, can be distinguished by its larger basidiomata (up to 8 cm broad), and larger basidiospores (11–14 × 7–9 μm) (Smith 1968).

Phylogenetic analyses confirmed that *Cr. involutus* formed a distinct clade in Clade VI (*Cr.* subg. *Craterellus*), and can be differentiated from other species based on genetic distance.

Craterellus lutescens (Fr.) Fr., Epicr. Syst. Mycol. (Upsaliae): 532 (1838) Fig. 54

Chinese name:变黄喇叭菌

Basidiomata small-sized. Pileus 1.5–3 cm broad, more or less convex when young, gradually applanate with a depressed center, sometimes perforated when mature; margin incurved when young, wavy or irregular when mature, obscure striate on surface; surface dry, smooth or with obscure striate toward margin, grayish orange, brownish orange to brown (5B5–6B5, 6D5); Context thin, 0.5–1 mm thick, fibrous, yellowish withe to orange white, unchanging when exposed. Hymenophore decurrent, but with a clearly delimitation from the stipe surface, poorly-developed, smooth, sometimes wrinkly or very ill-defined veined, light yellow to light orange (2A5-5A5). Stipe 20–40 mm long, 3–5 mm thick, subcylindrical, tapering downward, glabrous, hollow, yellow to orange, deeper than hymenophore; basal mycelium white. Odour and smell not distinct.

Basidiospores 9–11 × 6.5–9 μm [Lm × Wm = 9.84 (±0.59) × 7.63 (±0.74) μm, (Q = (1.17)1.25–1.38(1.42), Q_m = 1.29 ± 0.07], broadly elliptical, oval to suborbicular. Basidia 60–80 × 9–11 μm, clavate, thin-walled, 2–6-spored, sterigmata 3–6 μm long. Pileipellis a cutis, composed of repent and occasionally erect hyphae, 5-8 μm in diam., colourless, thin-walled. Hymenophoral trama composed of cylindrical hyphae 4–10 μm in diam. Stipitipellis a cutis, composed with thin-walled hyphae 3–9 μm broad. Clamp connections common.

Habitat and distribution –Gregarious on soil in subalpine mixed forest dominated by *Cyclobalanopsis delavayi* and *Pinus yunnanensis*. Known from southwest China.

Specimens examined – China, Yunnan Province, Lijiang City, Yulong County, Jiuhe Village, 1 Sep 2020, alt. 2400 m, M. Zhang (GDGM83242, GDGM83245). Dali City, Yunlong County, Tianchi Nature Reserve, 6 Sep 2023, X.L. Gao (GDGM93445); Same location, 22 Aug 2024, X.L. Gao (GDGM95071).

Notes – *Craterellus lutescens* originally reported from Europe, has been widely reported in North America, Central America and Asia. It is mainly characterized by the brightly colored basidiomata with grayish orange to brownish orange pileus, light yellow to light orange hymenophore nearly smooth, and yellow to orange stipe. *Craterellus tubaeformis* resembles *Cr. lutescens* in morphology, however, the former can be easily distinguished by its relatively well-developed gill-liked hymenophore tinged with grayish to gray color, dark yellowish brown to blackish brown pileus, and dull yellow to brownish orange stipe (Corner 1966, Smith 1968, Pegler et al. 1997, Kuo 2015b). The new species, *Cr. sublutescens* described in the present study, is similar to *Cr. lutescens* in morphology, but differs by its smaller basidiomata (5–15 mm broad), white hymenophore, smaller basidiospores (7–8.5 × 6–7 μm), and the absence of clamp connections in all tissue.

Phylogenetic analyses showed that several Chinese samples clustered together with samples from Europe, and formed a well supported monophyletic clade, which is easily separated from other *Craterellus* species by genetic distance.

Craterellus lutescens was reported to be commonly found in coniferous forests, under spruce, mountain fir trees, or pinewoods near the seashore in North America and Europe (Petersen 1969, Kuo 2020). In China, *Cr. lutescens* is only known from the subalpine regions of southwest China, under coniferous forests or mixed forests mainly dominated by *Pinus yunnanensis*.



Figure 54 – Morphology of *Craterellus lutescens*. A–C. Basidiomata. D. Basidiospores. E. Basidia. F. Pileipellis. Scale bars: D = 10 µm; E, F = 20 µm.

Craterellus macrosporus T. Cao & H.S. Yuan, Stud. Mycol. 99(no. 100121): 45 (2021)

Chinese name:大孢喇叭菌

Notes – *Craterellus macrosporus*, recently reported from northeast China, has been classified within the '*Cr. cornucopioides* complex' and is closely related to *Cr. squamatus* in both morphology and genetic characteristics. However, *Cr. macrosporus* differs from *Cr. squamatus* by its larger basidiomata (up to 35 mm broad), glabrous pileus, larger basidiospores (12.8–14.5 × 9–11 µm), and longer basidia (80–105 × 9–13.5 µm) (Cao et al. 2021a). The present phylogenetic analyses supported *Cr. macrosporus* as a distinct lineage in Clade VI (*Cr*. subg. *Craterellus*), and close to *Cr. squamatus*. No specimen was collected by the present authors; for more information on this species refer to the study by Cao et al. (2021a).

Craterellus minor N.K. Zeng, Y.Z. Zhang, P. Zhang & Zhi Q. Liang, Frontiers in Microbiology 13 (no. 906296): 10 (2022) Fig. 55

Chinese name:小喇叭菌

Basidiomata small to medium-sized. Pileus about 1.5–5 cm broad, more or less convex when young, gradually applanate, depressed in center, perforated or non-perforated; surface dry, subtomentose, grayish yellow, yellowish gray, brownish gray to grayish brown (1C2–5C2, 3D3–5D3); Hymenophore decurrent, poorly-developed, composed of bifurcate, vein-like folds, particularly towards pileus margin, yellowish white, orange white, reddish white to reddish gray (4A2–9A2, 7B2–9B2), changing to pastel red to reddish pink (7A5–11A5) at first when bruised, then black. Stipe 20–50 × 4–8 mm, central, hollow, cylindrical, slightly concave and curved, surface dry, glabrous, pale yellow to grayish yellow (2A3–4A3; 2B3–4B3), changing to reddish pink at first when bruised, then black, basal mycelium white.

Basidiospores 8–10.5(11) × (6.5)7–8.5 µm, Q = (1.07)1.14–1.43(1.57), Qm = 1.36 ± 0.13, ellipsoid to broadly ellipsoid, smooth, thin- to slightly thick-walled. Basidia 52–75 × 8–13 µm, long, narrow, subcylindrical, 2–6-spored, sterigmata 5–10 µm long. Pileipellis a cutis composed of mostly cylindrical, 6–15 µm wide; terminal cells subcylindrical to subclavate with obtuse apex, 5–12 µm wide. Clamp connections present.



Figure 55 – Morphology of *Craterellus minor*. A–C. Basidiomata. D. Basidiospores. E. Basidia. F. Pileipellis. Scale bars: D = 10 µm; E, F = 20 µm.

Habitat and distribution – Solitary or scattered in subtropical broad-leaved forests. Known from Central and Southwest China.

Specimens examined – China. Hunan Province, Sangzhi County, Badagong Mountain, alt. 750 m, 15 Sep 2020, P. Zhang (MHHNU32505); Zhejiang Province, Huzhou City, Nanxun District, 22 Oct 2024, Z.L. Zhou (GDGM97432). Hubei Province, Jingmen City, Yaoerping, C.Y. Li D-2

(GDGM96888); Chongqing City, Wushan Town, 11 Oct 2023, J.X. Pan (GDGM92979); Chongqing City, Yubei district, 15 Oct 2023, X. Long (GDGM93000).

Notes – *Craterellus minor*, recently reported from Central China, was described by Zhang et al. (2022b) based on two small and atypical basidiomata. In the present study, additional macro-morphology characteristics were observed and recorded from a larger number of specimens, as detailed above. The most distinctive feature is the colour change of the hymenophore and stipe upon bruising.

Craterellus minor is similar to *Cr. aprilis, Cr. grisellonigricans, Cr. sordidus* and *Cr. subalpinus* with yellow stipe in morphology. However, *Cr. aprilis* can be easily distinguished by its greenish gray to brownish gray basidiomata, poorly-developed hymenophore usually with purplish gray tinge, and different DNA sequences. *Craterellus grisellonigricans* differs in having pinkish white to orange gray pileus, pinkish white to reddish lilac hymenophore, light yellow stipe slightly changing to blackish when bruised, and larger basidiospores 9.5–12(14) × (8.5)9–10 μm. *Craterellus sordidus* differs in having larger basidiomata, light yellow to brownish orange pileus gradually changing to yellowish gray to brownish gray with age, grayish yellow to grayish orange hymenophore changing to gray to medium gray when old. *Craterellus subalpinus* differs by its grayish yellow to brownish orange pileus, yellowish white to yellowish gray hymenophore, narrower basidiospores (8.5–10.5 × 6.5–8 μm) and subalpine distribution.

Phylogenetic analyses showed that *Cr. minor* nested into Clade I (*Cr.* subg. *Lamelles*), and was closely related to *Cr. tubaeformis* and *Cr. melanoxeros*. However, *Cr. tubaeformis* can be easily distinguished by its dark yellowish brown to blackish brown pileus, yellowish to grayish or brownish hymenophore without colour changing when bruised, and dull yellow to brownish orange stipe unchanging when bruised (Corner 1966, Smith 1968, Pegler et al. 1997, Kuo 2015b). Additionally, samples of *Cr. tubaeformis* formed three main different lineages in our phylogenetic analyses. All samples are from North America and Europe, and have been reported mainly distributed in coniferous forests, while *Cr. minor* grows under broad-leaved forests.

Cr. melanoxeros, endemic to Europe, differs in having larger basidiomata (pileus up to 10 cm), saffron yellow pileus sometimes with lilaceous tint and changing blackish when bruised or old, rose pinkish to violet hymenophore, robust stipe and narrower basidiospores measuring 6–7 μm wide (Breitenbach and Kränzlin 1986, Pegler et al. 1997, Akata and Kumbaşli 2014).

Craterellus murinus Ming Zhang & T.H. Li, sp. nov. Fig. 56

Chinese name:鼠灰喇叭菌

Fungal Name: FN573131; Facesoffungi number: FoF 19036

Etymology – "*murinus*" means mouse gray, referring to the mouse gray pileus colour of this species.

Diagnosis – Distinguished from *Cr. atrobrunneolus* by its grayish brown to light gray pileus, relatively well developed pale gray to medium gray hymenophore, larger basidiospores and DNA sequences.

Type – Vietnam. Lam Dong Province, Da Lat City, Bi Doup Nui Ba National Park, alt. 1700 m, 15 Oct 2017, M. Zhang (GDGM70969).

Basidiomata small-sized. Pileus 1.5–3.5 cm broad, more or less convex when young, gradually applanate, depressed in the center when mature, usually perforated when mature, margin incurved when young, wavy or irregular when mature, with obscure striate on surface, membranous; surface dry, glabrous to subtomentous, grayish brown to grayish ruby (8E3–12E3) when young, then fading to brownish gray, pale gray to light gray (8D2–12D2, 1B1–1C1) with age; Context thin, 1 mm thick, fibrous, grayish white, unchanging when exposed. Hymenophore decurrent, as well-developed gill-like ridges, distant, composed of bifurcate vein-like folds, particularly towards pileus margin, pale gray when young (1B1), pale gray to medium gray (1B1–1E1) when mature. Stipe 30–50 mm long, 3–5 mm thick, subcylindrical, tapering downward, glabrous, hollow, concolorous with pileus or paler to medium gray (1E1) when mature, basal mycelium white. Odour and smell not distinct.

Basidiospores (7.5)8–10 × (6.5)7–8 µm [Lm × Wm = 8.75(±0.79) × 7.28(±0.43) µm, Q = (1.07)1.12–1.29(1.33), Q_m = 1.20 ± 0.07], broadly elliptical to oval, thin-walled. Basidia 45–73 × 7–10 µm, clavate, thin-walled, with 2–4 sterigmata, 5–7 µm long. Pileipellis a cutis, composed of repent and occasionally interwoven hyphae, 4–12 µm in diam., colourless, thin-walled. Hymenophoral trama composed of cylindrical hyphae 5–12 µm in diam. Stipitipellis a cutis, composed with thin-walled, paralleled, hyphae 4–10 µm broad. Cystidia absent. Clamp connections absent.

Habitat and distribution – Scattered or gregarious under mixed forest in tropical regions. Known from southern Vietnam.

Specimens examined – Vietnam. Lam Dong Province, Da Lat City, Bi Doup Nui Ba National Park, alt. 1700 m, 15 Oct 2017, T.H. Li (GDGM70970)



Figure 56 – Morphology of *Craterellus murinus*. A–C. Basidiomata. D. Basidiospores. E. Basidia. F. Pileipellis. Scale bars: D = 10 µm; E, F = 20 µm.

Notes – *Craterellus murinus* is characterized by its mouse gray basidiomata with a deeply depressed pileus usually perforated at center, pale gray to medium gray and relatively well-developed gill-liked hymenophore composed of bifurcate vein-like folds, particularly towards pileus margin, hollow stipe, and broadly elliptical basidiospores. *Cr. atrobrunneolus* and *Cr. foetidus* are similar to *Cr. murinus*. However, *Cr. atrobrunneolus* differs by its dark brown to almost black pileus, smooth to slightly folded, bluish gray hymenophore, and smaller basidiospores (6.5–7.8 × 4.5–6 μm) (Cao et al. 2021a). *Craterellus foetidus*, originally described from North America, differs by its larger basidiomata (pileus up to 7 cm broad), pale to dark gray pileus covered with finely radially blackish appressed fibers and scales, gray to lilac gray hymenophore often developing a pinkish dusting or cinnamon to brownish stains, and narrower basidiospores (8–10.5 × 5–6 μm) (Smith 1968, Kuo 2015c).

In the phylogenetic analyses *Cr. murinus* formed a distinct lineage in Clade V (*Cr*. subg. *Imperforati*) in the multi-locus tree (Fig. 5), and it can be easily separated from other species of *Craterellus* with known sequences by genetic distinct.

Craterellus parvofuscus Ming Zhang, C.Q. Wang & T.H. Li sp. nov. Fig. 57

Chinese name:暗褐小喇叭菌

Fungal Name: FN573140; Facesoffungi number: FoF 19044

Etymology – "*parvo-*" means small; "*parvofuscus*" refers to the small and dark fuscous basidiomata.

Diagnosis – Similar to *Cr. niger* especially in the small blackish non-perforate pileus and slender stipe, but differs being obviously striate toward margin, with a pastel gray to medium gray hymenophore, villose stipe, thin-walled basidia and pileipellis hyphae, absence of clamp connections, and distinct DNA sequences.

Type – China. Guangdong Province, Zhaoqing City, Dinghushan National Nature Reserve, alt. 140 m, 26 Sep 2024, M. Zhang (GDGM97394).

Basidiomata very small-sized. Pileus 5–15 mm broad, applanate, depressed at centre, non-perforated, surface dry, tomentose, brownish gray, grayish brown to dark brown (4F2–4F5, 5F2–5F5), with a brownish orange margin; margin even, usually wavy or grooved when mature. Hymenophore decurrent, poorly developed, smooth or wrinkly with very ill-defined veins, pastel gray to medium gray (1C1–1E1), unchanging in color when injured, without a clearly delimitation from the stipe surface. Stipe 13–20 × 1–2 mm, central, subcylindrical, tapering toward base, hollow, surface dry, covered with fibrillose hairs, concolorous with pileus, or yellowish brown to brown. Odour none. Taste mild.

Basidiospores 7.5–9 × 5–6 μm, [Lm × Wm = 8.27(±0.48) × 5.56(±0.38) μm, Q = 1.33(1.45)–1.6(1.63), Q_m =1.48 ±0.09], smooth, elliptical to oval, thin-walled, colourless in KOH. Basidia 45–55 × 7–8 μm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, 4–6-spored; sterigmata 4–7 μm long. Hymenophoral trama composed of subregular to slightly interwoven hyphae 5–9 μm in diam., thin-walled. Pileipellis composed of long, repent, branched, thin to slightly thick (less than 0.5 μm wide) walled hyphae, 5–9 μm wide, colourless in KOH. Stipitipellis a cutis, composed of cylindrical, parallel hyphae, measuring 4–10 μm in diam. Cystidia absent. Clamp connections absent.

Habitat and distribution – Solitary or scattered in broad-leaved forests (dominated by Fagaceae trees) in subtropical regions. Known from southern China.

Specimens examined – China, Guizhou Province, Tongren County, Fanjingshan National Nature Reserve, alt. 1200 m, 29 Jul 2019, Y. He (GDGM77895); Guangdong Province, Zhaoqing City, Dinghushan National Nature Reserve, alt. 150 m, 28 May 2023, Y. Fu (GDGM92335); Same location, 19 Jun 2024, J. Pan (GDGM92785).

Notes – Phylogenetic analyses showed that samples of *Cr. parvofuscus* nested into Clade V, and are closely related to *Cr. carolinensis* and *Cr. parvopullus* (Figs. 4, 5). However, *Cr. carolinensis* originally reported North Carolina, differs by its radially and reticulately rugulose pileus finely to coarsely scaly at margin, longer stipe (up to 40 mm long) changing to fuscous black

when bruised, fuscous to benzo brown hymenophore, slightly larger basidiospores (8–10.5 × 5.2–7 µm), and larger basidia (60–100 × 6–8.4 µm) (Petersen 1969). *Cr. parvopullus* can be distinguished by its "*Cr. cornucopioides*-like" basidiomata, deeply depressed and perforated at pileus center, without any obvious demarcation between pileus and stipe, broader basidiospores and larger basidia (Zhang et al. 2022b).

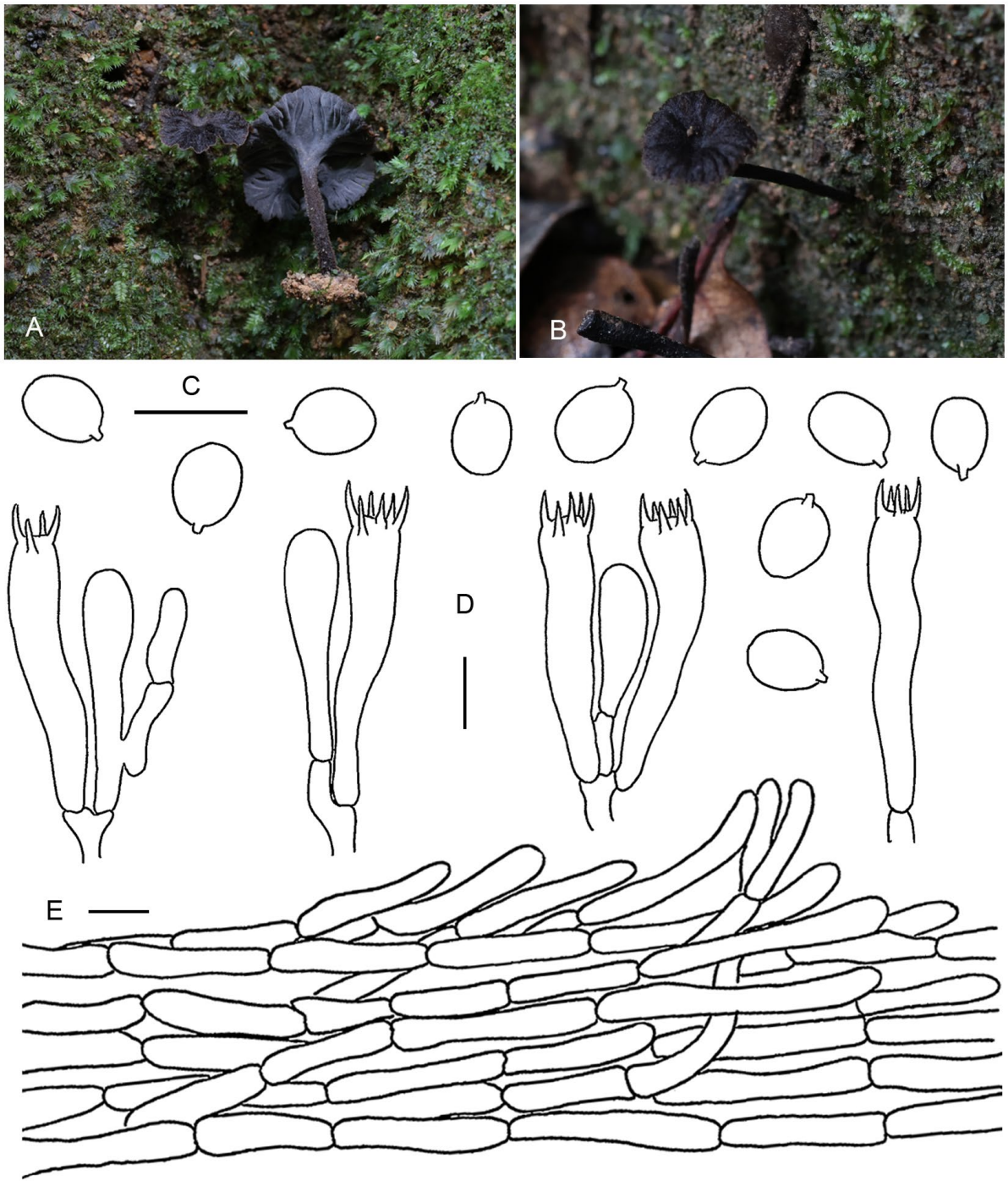


Figure 57 – Morphology of *Craterellus parvofuscus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C–E= 10 µm.

Morphologically, *Cr. albostrigosus* C.K. Pradeep & K.B. Vrinda, *Cr. atratoides* T.W. Henkel, Aime & A.W. Wilson, *C. atratus* (Corner) Yomyart, Watling, Phosri, Piapukiew & Sihanonth, *Cr. calyculus* (Berk. & Curt.) Burt., *Cr. niger* Sá, F.G.B. Pinheiro & Wartchow, *Cr. strigosus* T.W. Henkel, Aime & A.W. Wilson, and *Cr. subundulatus* (Peck) Peck resemble

Cr. parvofuscus. However, *Cr. albostrigosus* differs by its chocolate brown to grayish brown pileus covered with white erect fibrillose, strigose hairs, gray hymenophore forming a demarcating zone with stipe, solid stipe covered with erect pointed strigose-fibrillose hairs, larger basidiospores (9–11.5 × 6–8 μm) (Bijeesh et al. 2018); *Cr. atratoides* is distinct by its perforate pileus, glabrous stipe, bluish gray hymenophore, larger basidiospores (10.8–12 × 7.1–9 μm), and presence of abundant clamp connections (Wilson et al. 2012); *Cr. atratus* differs in having gray, campanulate to broadly campanulate pileus, covered with appressed radially fibrillose, larger basidiospores measuring 9–10(11) × 7–8.5(9) μm, and abundant clamp connections (Wilson et al. 2012);
Cr. calyculus reported from South Carolina, differs by its deep oliveceous brown pileus with crenulate to minutely fimbriate at margin, deep orange-ochre hymenophore, glabrous stipe and larger basidiospores (9.7–12.1 × 6.8–9.1 μm) (Petersen 1969); *Cr. niger* differs in having brilliant blackish pileus covered with radially finely appressed fibrillose, bluish hymenophore, glabrous stipe, thick-walled basidia and pileipellis hyphae, and the presence of clamp connections (Sá et al. 2014); *Cr. strigosus*, originally reported from Guyana, differs by having slightly larger, broadly ellipsoid basidiospores (8–10 × 5.9–8 μm), and presence of clamp connections (Wilson et al. 2012); and *Cr. subundulatus* differs by its deep olive buff pileus covered with radially fibrillose, glabrous stipe and smaller basidiospores (6.2–7.6 × 4.6–5 μm) (Petersen 1969).

Craterellus parvogriseus U. Singh, K. Das & Buyck, Cryptog. Mycol. 38(3): 359 (2017) Fig. 58

Chinese name:小灰喇叭菌

Basidiomata very small-sized. Pileus 10–25 mm broad, convex with depressed centre when young, applanate, concave to subinfundibuliform at maturity, surface dry, tomentose, gray, yellowish gray to brownish gray (4B1, 4B2–6B2); margin incurved at first, usually wavy when mature. Context thin, grayish white, unchanging when exposed. Hymenophore decurrent, poorly developed, smooth or wrinkly with very ill-defined vein, white to grayish white, unchanging in color when injured, without a clearly delimitation from the stipe surface. Stipe 10–30 × 1.5–5 mm, central, subcylindrical, hollow, surface smooth, concolorous with pileus; basal mycelium white. Odour none. Taste mild.

Basidiospores (9)9.5–11(12) × (6.5)7–8.5 μm, [Lm × Wm = 10.18(±0.72) × 7.5(±0.57) μm, Q = 1.17(1.25)–1.38(1.5), Qm =1.35 ±0.09], smooth, elliptical to oval thin-walled, colourless in KOH. Basidia 68–93 × 7–13 μm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, with 2–4 sterigmata; sterigmata 7–9 μm long. Pileipellis composed of long, repent, branched, thin-walled hyphae, 4–15 μm wide, colourless in KOH. Stipitipellis a cutis, composed of cylindrical, parallel hyphae, measuring 4–9 μm in diam., not secondarily septate. Cystidia absent. Clamp connections absent in all tissues.

Habitat and distribution – Scattered or caespitose under Fagaceae trees in subtropical broad-leaved forests. Known from eastern China.

Specimens examined – China, Zhejiang Province, Lishui City, Suichang Town, Jiulongshan National Nature Reserve. alt. 849 m, N 28°32′, E 118°82′, 10 Oct. 2020, J.B. Pu & W.Q. Liang (GDGM84174). Guizhou Province, Tongren City, Fanjingshan National Park. 28 Jul 2019, L.Q. Wu &Y. He (GDGM77880).

Notes – *Craterellus parvogriseus*, which was originally reported from India is recorded for the first time in China in this study. It is characterized by small baisidiomata, gray to brownish gray pileus, white to grayish white hymenophore with ill-defined gill-like vein, grayish white and hollow stipe, and elliptical basidiospores 7–12 × 6.5–9 μm (Das et al. 2017). Phylogenetic analyses showed that two specimens from China were well clustered together with the type specimen of *Cr. parvogriseus*, and formed a monophyletic clade in Clade III (*Cr.* subg. *Imperforati*), sister to *Cr. albidus*. However, the latter differs by its small basidiomata, white pileus, white and smooth hymenophore, light yellow to orange yellow stipe, and smaller basidiospores measuring (7.5)8–10 × (6.5)7–8 μm (Zhang et al. 2020b; present study). *Cr. albidus* was found growing on rotting wood, while *Cr. parvogriseus* grows on soil (Das et al. 2017, Zhang et al. 2020b; present study).

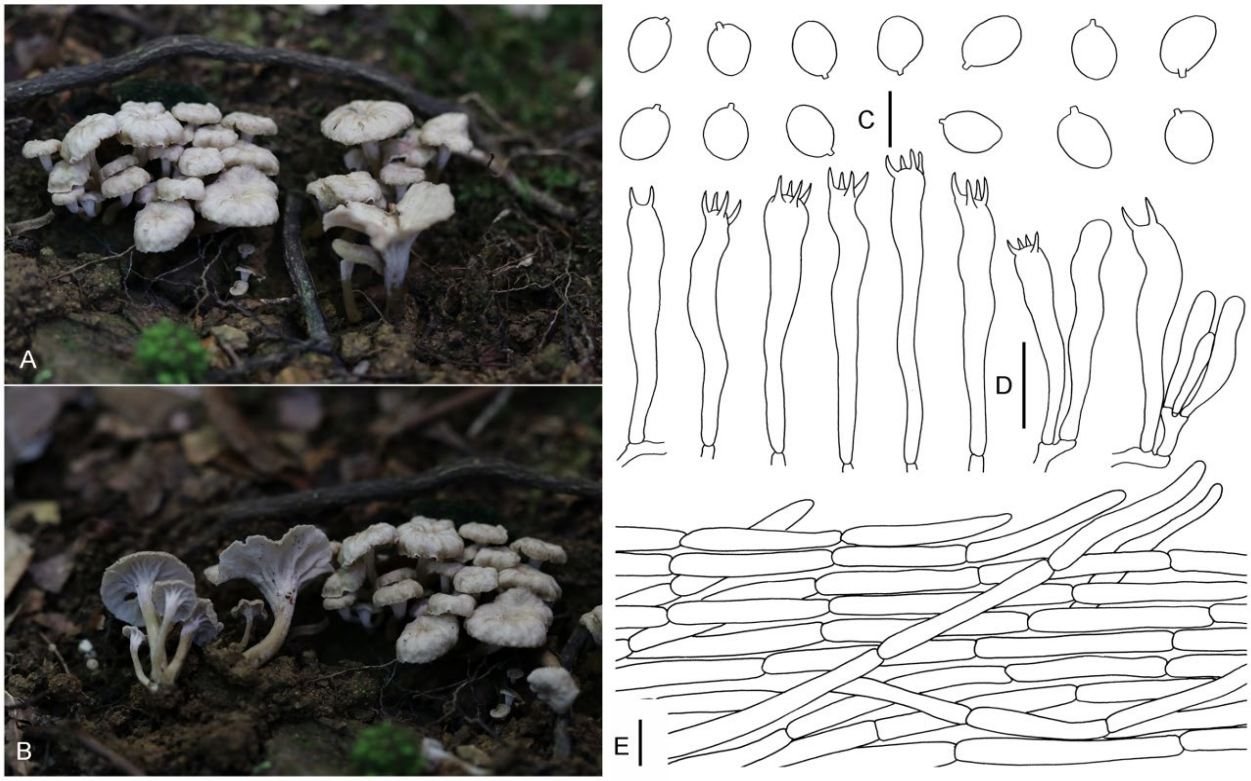


Figure 58 – Morphology of *Craterellus parvogriseus*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Craterellus parvopullus N.K. Zeng, Y.Z. Zhang & Zhi Q. Liang, Frontiers in Microbiology 13 (no. 906296): 11 (2022) Fig. 59

Chinese name:小黑喇叭菌

Basidiomata small-sized. Pileus18–48 mm broad, infundibuliform, infundibuliform, deeply depressed in the center, perforate, surface dry, tomentose, brownish gray (4D2–8D2, 4E2–8E2); margin thin, slightly incurved. Hymenophore decurrent, smooth to slightly folded, brownish gray to dark gray (5C2–5F2, 5F1). Stipes indistinct, confluent with pileus, hollow, gradually taper downward; surface glabrous, concolorous with hymenophore. Basidiospores 7–8.5 × 6.5–7 µm, broadly ellipsoid, smooth, thin-walled, hyaline. Basidia 70–95 × 7–13 µm, subclavate to clavate, 4–6-spored, sterigmata 5–8 µm long. Pileipellis a cutis, composed of repent, cylindrical hyphae, 5–10 µm wide, thin to thick-walled, subparallel, rarely branched. Clamp connections absent.

Habitat and distribution – Gregarious on the ground in broad-leaved forests. Only known from tropical regions of south China.

Specimens examined – China. Yunnan Province, Puer City, bought from an open fair, 28 Jul 2022, M. Zhang (GDGM90715). Same location, bought from roadside market, 28 Aug 2024, X.L. Gao (GDGM97180).

Notes – *Craterellus parvopullus* is easily confused with *Cr. croceialbus*, *Cr. macrosporus* and *Cr. squamatus* in China. However, these species can be easily distinguished by their larger basidiospores (10–12 × 6.8–8 µm for *Cr. croceialbus*, 12.8–14.5 × 9–11 µm for *Cr. macrosporus* and 12–13.8 × 8.5–9.5 µm for *Cr. squamatus*) (Cao et al. 2021a). *Cr. parvopullus* is only known from tropical regions of Yunnan and Hainan Provinces, while *Cr. croceialbus*, *Cr. macrosporus* and *Cr. squamatus* are reported from temperate regions of northeastern China. Phylogenetic analyses showed that *Cr. croceialbus*, *Cr. macrosporus* and *Cr. squamatus* belong to Clade VI (*Cr.* subg. *Craterellus*), while *Cr. parvopullus* nested into Clade V (*Cr*. Subg. *Ovoidi*).

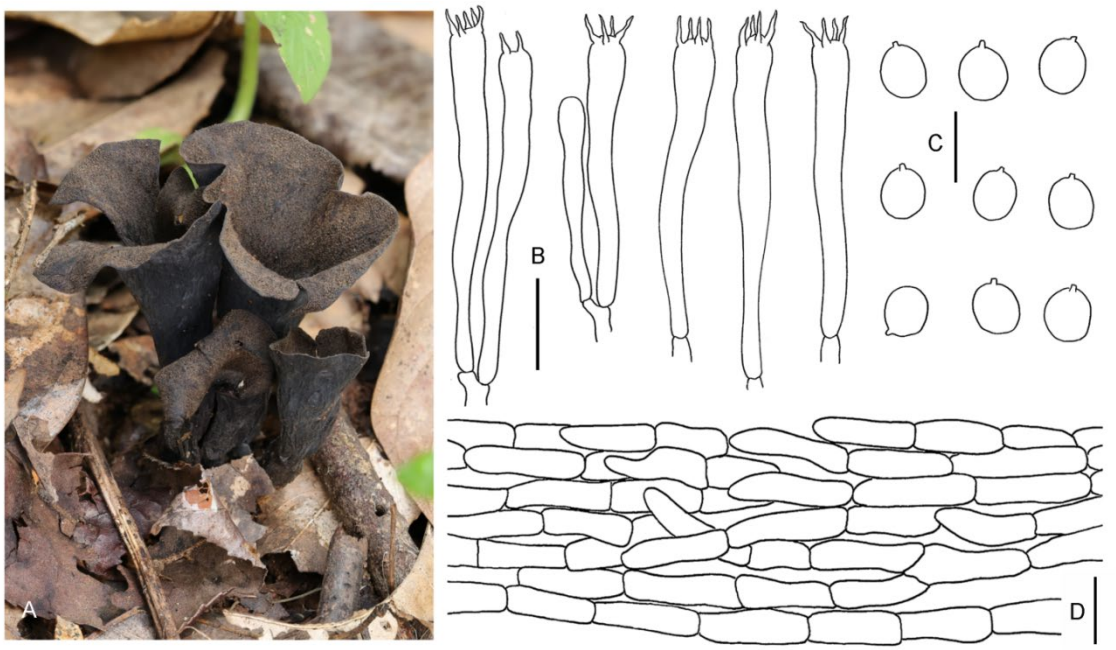


Figure 59 – Morphology of *Craterellus parvopullus*. A. Basidiomata. B. Basidia. C. Basidiospores. D. Pileipellis. Scale bars: B, D = 20 µm; C = 10 µm.

Craterellus sinensis Ming Zhang, C.Q. Wang & T.H. Li, sp. nov. Fig. 60

Chinese name:中华喇叭菌

Fungal Name: FN573135; Facesoffungi number: FoF 19039

Etymology – "*sinensis*" means Chinese, referring to the species described from China.

Diagnosis – Similar to *Cr. badiogriseus* in small basidiomata, yellowish brown to dark brown pileus, white to pastel gray hymenophore, but differs in narrower basidiospores with a larger Q value, and different DNA sequences.

Type – China. Sichuan Province, Garze Tibetan Autonomous Prefecture, Daofu County, Longdeng village, under mixed forests mainly dominated by *Betula* sp. and *Quercus* spp. mixed with a small amount of *Abies* sp., alt. 3432 m, 15 Aug 2024, M. Zhang (GDGM96693).

Basidiomata small-sized. Pileus 10–30 mm broad, convex with depressed centre when young, concave to subinfundibuliform at maturity, surface dry, glabrous, yellowish brown, brown, dark brown, grayish brown to dark gray (5E4–9E4; 5F4–9F4; 8F1–8F3), margin incurved at first, usually wavy and lobed when mature, slightly paler than centre, usually with a yellowish ring. Context thin, grayish white, unchanging when exposed. Hymenophore decurrent, poorly developed, smooth or wrinkly with very ill-defined veined, white, grayish white to pastel gray (1A1–1C1), unchanging in color when injured. Stipe 25–50 × 2–5 mm, central, subcylindrical, hollow, surface glabrous, concolorous with pileus. Odour none. Taste mild.

Basidiospores (7)8.5–10.5 (12)× (4.5)5–6(6.5) µm, [Lm × Wm = 8.89(±0.74) × 5.39(±0.35) µm, Q =(1.45)1.5–1.7(1.9), Q_m = 1.65 ± 0.13], elliptical to oblong, thin-walled, colourless in KOH. Basidia 40–80 × 5–10 µm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, 2–6-spored; sterigmata 6–9.5 µm long. Hymenophoral trama composed of subregular hyphae 3–6 µm in diam., thin-walled. Pileipellis composed of repent, thin-walled hyphae, 5–15 µm wide, colourless in KOH. Stipitipellis a cutis, composed of cylindrical, parallel hyphae, measuring 3.5–9 µm in diam. Clamp connections absent in all tissues.

Habitat and distribution – Scattered or gregarious under mixed forests in sub-alpine regions of southwest China. Only known from Sichuan and Xizang Provinces.

Specimen examined – China, Tibet Autonomous Region, Linzhi City, Lulang Town, alt. 3340 m, 23 Aug 2024, M. Zhang (GDGM96806).

Notes – *Craterellus sinensis* is distributed in the subalpine regions of southwest China, but can be distinguished from *Cr. subalpinus* by its dark brown to dark gray basidiomata with smooth hymenophore, and oblong basidiospores with a larger Q value (Q_m= 1.65). *Craterellus badiogriseus* resembles *Cr. sinensis* in the small and similar colored basidiomata, but differs by its relatively broader basidiospores with a smaller Q value (Q_m = 1.37).

Phylogenetic analyses showed that *Cr. sinensis* formed a distinct monophyletic group in Clade III (*Cr.* subg. *Imperforati*), and can be easily separated from other species with known sequences.

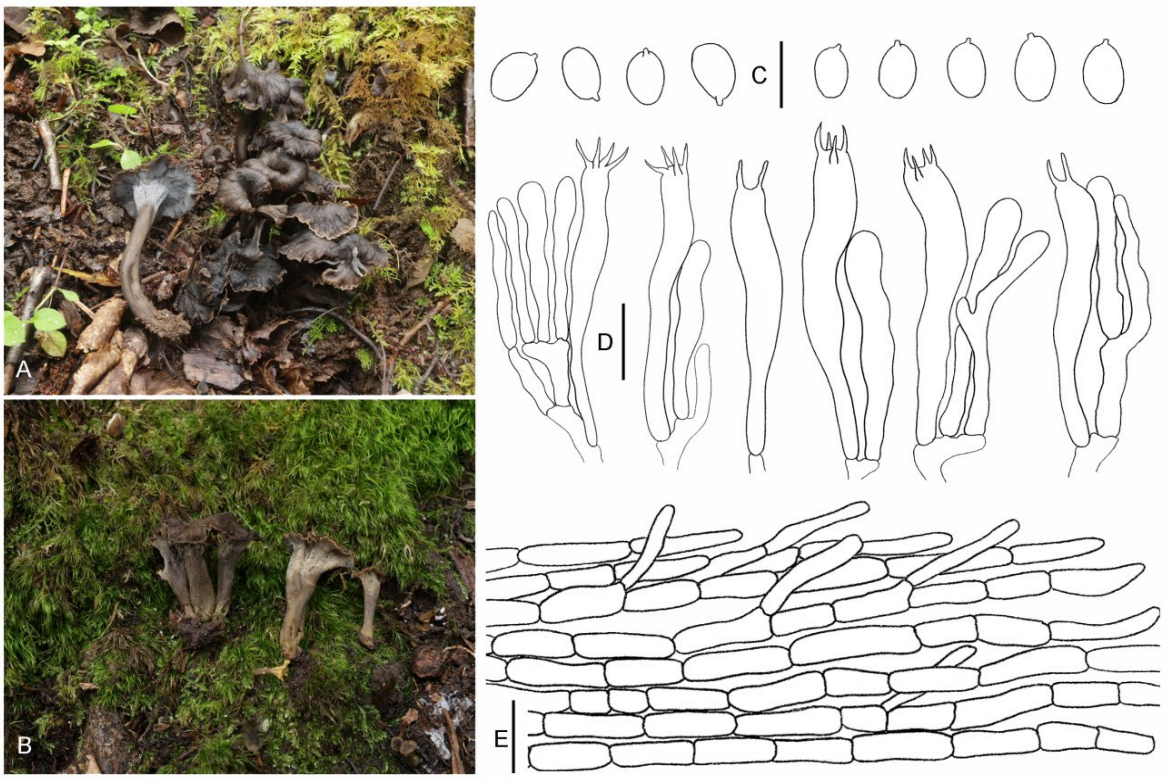


Figure 60 – Morphology of *Craterellus sinensis*. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C = 10 µm; D, E = 20 µm.

Craterellus sinocornucopioides Ming Zhang, C.Q. Wang & T.H. Li, sp. nov. Fig. 61

Chinese name:中华灰喇叭菌

Fungal Name: FN573145; Facesoffungi number: FoF 19045

Etymology – "*sino-*" means Chinese; "*sinocornucopioides*" refers to the type locality in China and its appearance similar to *Cr. cornucopioides*.

Diagnosis – Distinguished from *Cr. cornucopioides* by its grayish yellow to yellowish brown pileus, longer stipes, Asia distribution and unique DNA sequences.

Type – China. Xizang Autonomous Region, Bomi County, Zulonggou, at N 29°49′02.55″, E95°45′02.83″, alt. 3200 m, in mixed forests, 18 Sep 2016, T.Z. Wei 7539 (HMAS0254856).

Basidiomata small to medium-sized. Pileus 25–70 mm broad, deeply depressed in the center and perforation continuous with hollow stipe, infundibuliform, surface dry, velutinate, grayish yellow, grayish orange, yellowish brown to brown (4B4–6B4, 5E5–6E5) background covered with yellowish brown to dark brown scales (5F5–6F5), slightly changing to brown to dark brown when old or drying (5F6–6F6, 6E6); margin incurved at first, usually wavy and lobed when mature. Context thin, 0.3–0.5 mm thick, grayish white, unchanging when exposed. Hymenophore decurrent, poorly developed, smooth or wrinkly with very ill-defined veins, white, grayish white to

pastel gray (1B1–1C1), unchanging in color when injured. Stipes indistinct, confluent with pileus, 20–60 mm long, 5–10 mm wide, hollow, surface glabrous, concolorous with hymenophore; basal mycelium grayish white. Odour fruity. Taste mild.

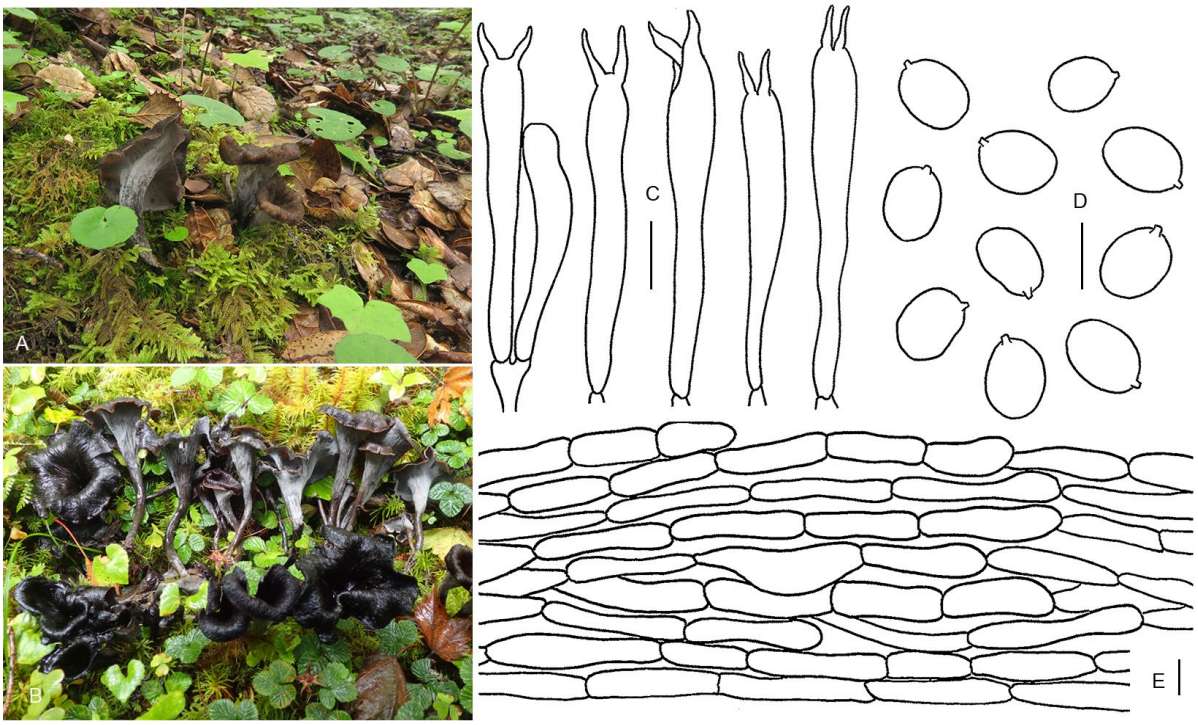


Figure 61 – Morphology of *Craterellus sinocornucopioides*. A, B. Basidiomata. C. Basidia. D. Basidispores. E. Pileipellis. Scale bars: C– E= 10 µm.

Basidiospores 10–13.5 × 8–10.5 µm [Lm × Wm = 12.11(±0.86) × 9.25(±0.78) µm, Q = (1.05)1.2–1.57(1.62), Q_m = 1.31 ± 0.12], elliptical to oval, thin-walled, colourless in KOH usually with granular contents. Basidia 50–75 × 8–10 µm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, mostly 2-spored; sterigmata 6–10 µm long. Pileipellis a cutis, composed of repent to occasionally erect hyphae, thin to slightly thick-walled, subparallel, rarely branched, hyaline to contain brownish pigment in KOH, terminal elements swollen, 6–15 µm wide, rounded at apex. Hymenophoral trama subregular, thin-walled, composed of cylindrical hyphae 5–12 µm in diam. Stipitipellis a cutis, composed of cylindrical, parallel hyphae, measuring 4–10 µm in diam. Cystidia absent. Clamp connections absent.

Habitat and distribution – Solitary, scattered or caespitose under broad-leaved or mixed forests mainly dominated by *Rhododendron rubiginosum*, *Quercus* spp. and a small number of spruce in subalpine regions. Only known from southwest China.

Specimens examined – China. Xizang, Bomi County, alt. 3200 m, 18 Sep 2016, T.Z. Wei (HMAS0280813, HMAS0247100); Same loaction, alt. 2672 m, 19 Sep 2016, Z.X. Wu 432 (HMAS0281036); Linzhi City, LuLang Town, alt. 3400 m, 23 Sept 2016, T.Z. Wei 8059 (HMAS0254991). Yunnan Province, Diqing Tibetan Autonomous Prefecture, Shangri-la County, Bitahai National Nature Reserve, alt. 3200 m, 2 Sep 2020, M. Zhang (GDGM83074).

Notes – Phylogenetic analyses showed that several samples from China are well clustered together, forming a monophyletic lineage within Clade VI (*Cr.* subg. *Craterellus*), and closely related to *Cr. croceialbus*. However, *Cr. croceialbus* can be easily distinguished by its brownish orange to light brown pileus, and smaller basidiospores measuring 8.5–11.5 × 6.5–8 µm (Cao et al. 2021). *Cr. croceialbu*s is mainly distributed in low-altitude regions of central and southwestern China, under broad-leaved forests (Cao et al. 2021a). In contrast, *Cr. sinocornucopioides* is found in subalpine regions of southwestern China, under broad-leaved and mixed forests.

Morphologically, *Cr. sinocornucopioides* closely resembles *Cr. involutus*, *Cr. macrosporus*, and *Cr. squamatus*, which were frequently misidentified as *Cr. cornucopioides* in the past. However, *Cr. involutus* can be distinguished by its small basidiospores (8–10.5 × 6.5–8 μm), 2–4-spored basidia, and distribution in tropical to subtropical regions of south China (Jiang et al. 2025). *Cr. macrosporus* differs in having glabrous pileus, larger basidiospores measuring (12.5)12.8–14.5(15) × (8.8)9–11(11.5) μm, longer basidia up to 105 μm in length, and distributed in temperate regions of northeastern China (Cao et al. 2021a). *Cr. squamatus* differs by its small basidiomata (pileus 5–15 mm broad) and short basidia (35–62 × 5–7.5 μm) with four sterigmata up to 5 μm long (Cao et al. 2021a).

Craterellus sordidus (Corner) Ming Zhang & C.Q. Wang, com. nov. Fig. 62

≡ *Cantharellus sordidus* Corner 1966, Monogr. Cantharelloid Fungi: 73 (1966)

= *Craterellus fulviceps* N.K. Zeng, Y.Z. Zhang, P. Zhang & Zhi Q. Liang, Frontiers Microbiol. 13(no. 906296): 8 (2022)

Chinese name: 晦暗喇叭菌

Fungal Name: FN573115

Basidiomata small to medium sized. Pileus 2.5–7 cm broad, more or less convex when young, gradually applanate, depressed to perforate in the center when mature, margin incurved when young, with a wavy or irregular when mature, obscure striate on surface, membranous; surface dry or slightly sticky when wet, glabrous to subtomentous, light yellow, grayish orange to brownish orange (3A5–5A5, 4C5–7C5), then fading to yellowish gray to brownish gray (3C2–6C2) with age; Context thin, 0.5–1 mm thick, fibrous, yellowish white to orange withe (3A2–5A2), unchanging when exposed. Hymenophore decurrent but with a clearly delimitation from the stipe surface, distant, as well-developed gill-like ridges, composed of bifurcate, less than 1 mm high vein-like folds, particularly towards pileus margin, grayish yellow to grayish orange (4B4–6B4) when young, brownish orange, dull red to grayish red (5C4–10C4) when mature, gray to medium gray when old (1D1–1E1). Stipe 30–70 mm long, 3–7 mm thick, subcylindrical, tapering downward, glabrous, hollow, light yellow (1A5–3A5), basal mycelium white. Odour and smell not distinct.

Basidiospores 8.5–10 × (6)7–9 μm [Lm × Wm = 9.21 (±0.53) × 7.73 (±0.76) μm, Q = (1.11)1.12–1.28(1.41), Qm = 1.19 ± 0.09], broadly elliptical, oval to suborbicular. Basidia 50–78 × 9–13 μm, clavate, thin-walled, 4–6-spored, sterigmata 5–8 μm long. Pileipellis a cutis, composed of repent and occasionally interwoven hyphae, 4–8 μm in diam., colourless, thin-walled. Hymenophoral trama composed of cylindrical hyphae 6–12 μm in diam. Stipitipellis a cutis, composed with thin-walled hyphae 4–8 μm in diam. Cystidia absent. Clamp connections common.

Habitat and distribution – Solitary or scattered under subtropical broadleaf forest dominated by *Castanopsis* spp. Known from Hunan Province, southern China.

Specimens examined – China, Hunan Province, Chenzhou City, Rucheng Town, Jiulongjiang National Forest Part, 425 m, N 25°26′46″ E 113°47′77″, 1 Aug 2013, M. Zhang (GDGM50482, GDGM 50496); 4 Sep 2016, B. Song (GDGM53511), Ming Zhang (GDGM53517, GDGM53447); 11 Jun 2020, M. Zhang (GDGM81384, GDGM81386); Anhui Province, Huangshan City, Huangshan National Forest Park, 27 Aug 2021, T.Q. Yu (GDGM85141); Fujian Province, Nanping County, 2 Sep 2023, B. Ben (GDGM93271).

Notes – *Craterellus sordidus*, originally reported from Malaysia as *Cantharellus sordidus* Corner, is characterized by its light yellow to brownish orange pileus fading to yellowish gray to brownish gray with age, relatively well-developed gill-liked hymenophore, colored grayish yellow to grayish orange when young, brownish orange to grayish red when mature, light yellow stipe, and broadly elliptical basidiospores. Based on the description of morphological characters and colour photos given by Corner (1966), our samples fit well with *C. sordidus*; thus, a new combination is proposed here on the base of morphological and molecular data.

Phylogenetic analyses showed that samples of *Cr. sordidus* nested together with *Cr. fulviceps* and "*Cr. tubaeformis*", and formed a well supported major distinct clade. *Craterellus fulviceps*,

recently described from China, shows no significant morphological differences to *Cr. sordidus* (Zhang et al. 2022b). Thus, *Cr. fulviceps* is a synonym of *Cr. sordidus.* Besides, two samples (2A4 and 1D3) named as "*Cr. tubaeformis*" from Japan, could represent the same species of *Cr. sordidus*. Thus, *Cr. sordidus* represents an Asian distributed species, which is different from the European species *Cr. tubaeformis*.

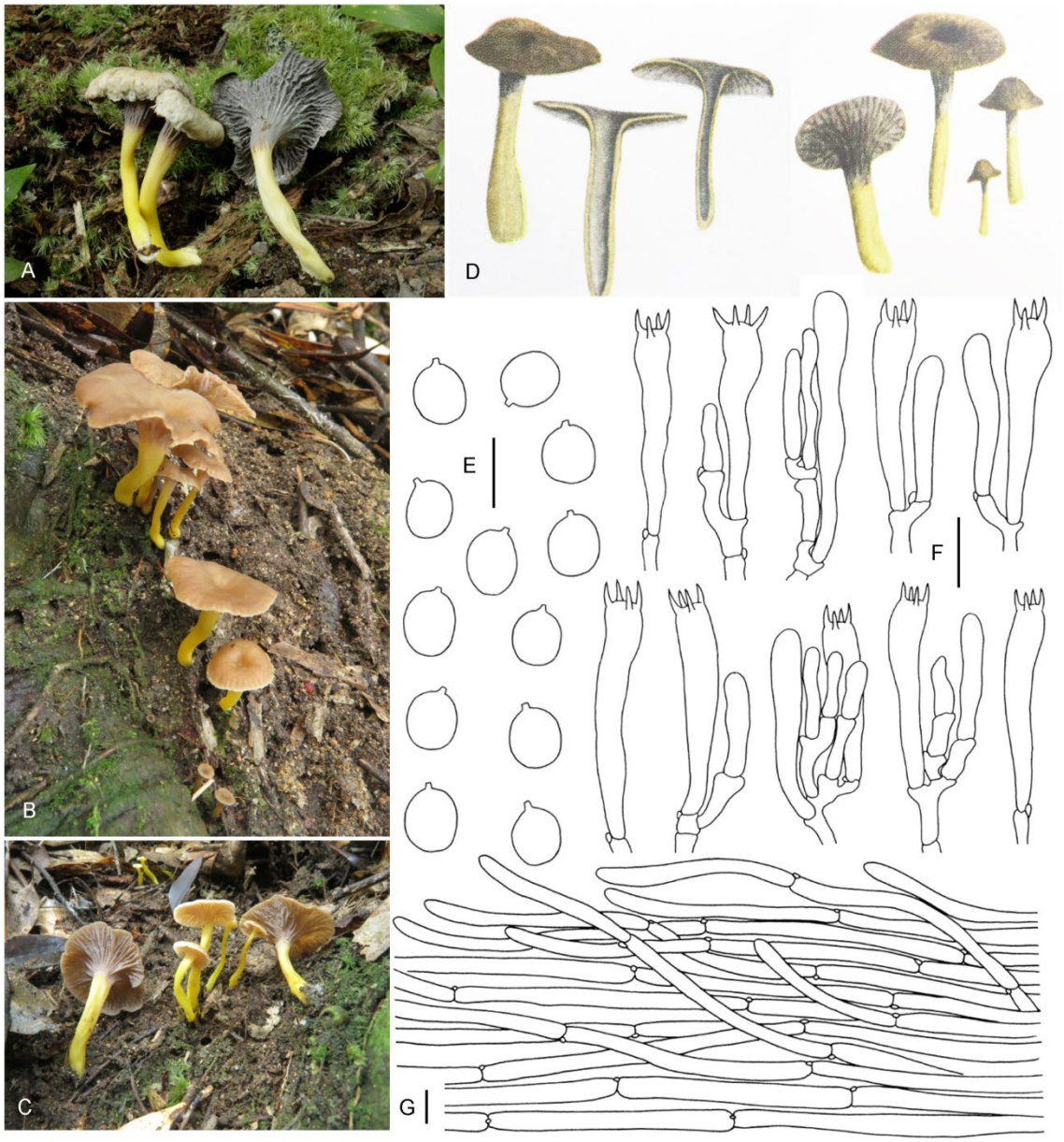


Figure 62 – Morphology of *Craterellus sordidus*. A–D. Basidiomata (D from Corner 1966). E. Basidiospores. F. Basidia. G. Pileipellis. Scale bars: E, G = 10 µm; F = 20 µm.

Craterellus squamatus T. Cao & H.S. Yuan, Stud. Mycol. 99(no. 100121): 45 (2021)

Chinese name:翘鳞喇叭菌

Notes – *Craterellus squamatus*, recently reported from northeast China, formed a well supported monophyletic lineage within Clade VI (*Cr.* subg. *Craterellus*) (Figs. 4, 5), and is closely related to *Cr. macrosporus*. However, it can be easily distinguished from *Cr. macrosporus* by its small basidiomata (with a pileus less than 15 mm in diameter) and relatively narrower basidiospores (measuring 12–13.8 × 8.5–9.5 µm) (Cao et al. 2021a). Phylogenetic analyses showed that four samples labelled as *Cr. fallax* from North America closely related to *Cr. squamatus*, and

cannot be separated by their short genetic distance. However, *Cr. fallax* differs by its large basidiomata (pileus up to 50 mm broad), yellowish to orange spores print, relatively narrower basidiospores (10–13 × 7–9 μm), and the presence of clamp connections (Matheny et al. 2010, Cao et al. 2021a). Besides, specimens named as *Cr. fallax* formed two distinct lineages in our phylogenetic trees (Figs. 4, 5).

For more information of *Cr. squamatus*, please see the description of Cao et al. (2021a).

Craterellus subalpinus Ming Zhang & C. Q. Wang, sp. nov. Fig. 63

Chinese name:亚高山喇叭菌

Fungal Name: FN573136; Facesoffungi number: FoF 19040

Etymology – "*subalpinus*" refers to the species distributed in subalpine regions.

Diagnosis – Similar to *Cr. minor* especially in the blackish discoloration, but differs in less obvious reddening discoloration of the context, brownish orange to light brown pileus when young, smaller basidiospores, subalpine distribution and different associated plants.

Type – China. Sichuan Province, Aba Tibetan and Qiang Autonomous Prefecture, Li County, Miallo Town, alt. 2700 m, 5 Aug. 2020, C.Q. Wang (GDGM81825).

Basidiomata small-sized. Pileus 2.5–5 cm broad, more or less convex when young, gradually applanate, depressed in the center when mature, non-perforated at centre, margin incurved when young, wavy or irregular when mature, membranous; surface dry, glabrous to subtomentous, brownish orange to light brown (5C5–7C5, 5D5–7D5) when young, then fading to grayish yellow to pale yellow (2C4–4C4, 2A3–4A3) with age; Context thin, 1 mm thick, fibrous, yellowish white, nearly unchanged to slightly discoloring to grayish to smoky gray where injured, then to blackish. Hymenophore decurrent, distant, as poorly-developed gill-like ridges, composed of bifurcate vein-like folds, particularly towards pileus margin, yellowish white when young (1A2–4A2), yellowish white to yellowish gray (1A2–4A2, 2B2–4B2) when mature. Stipe 30–70 mm long, 3–7 mm thick, subcylindrical, tapering downward, glabrous, hollow, pale yellow (1A3–4A3), grayish yellow (1B3–4B3), pastel yellow to light yellow (1A4–4A4), basal mycelium white. Odour and smell not distinct.

Basidiospores 8.5–10.5 × 6.5–8 μm [Lm × Wm = 9.77(±0.57) × 7.27(±0.45) μm, Q =1.25–1.5, Qm = 1.34 ± 0.07], broadly elliptical to oval, thin-walled. Basidia 64–85 × 8–15 μm, clavate, thin-walled, with 4–6 sterigmata, 6-10 μm long. Pileipellis a cutis, composed of repent and occasionally interwoven hyphae, 8–17 μm in diam., colourless, thin-walled. Hymenophoral trama composed of cylindrical hyphae 5–16 μm in diam. Stipitipellis a cutis, composed with thin-walled, paralleled hyphae 5–13 μm broad. Cystidia absent. Clamp connections common.

Habitat and distribution – Solitary, scattered or caespitose under broad-leaved or mixed forests mainly dominated by *Rhododendron rubiginosum*, *Quercus aquifolioides* and *Q. pannosa* in subalpine regions. Only known from southwest China.

Specimens examined – China. Sichuan Province, Aba Tibetan and Qiang Autonomous Prefecture, Li County, Miallo Town, alt. 3200 m, 5 Aug 2020, C.Q. Wang (GDGM81821); same location, alt. 3500 m, 25 Aug 2024, Amateur (GDGM94586). Yunnan Province, Diqing Tibetan Autonomous Prefecture, Shangrila County, Bitahai National Nature Reserve, alt. 3700 m, 2 September 2020, M. Zhang (GDGM83076).

Notes – *Craterellus subalpinus* is distributed in the subalpine regions of southwest China and may form symbiotic relationships with Ericaceae and Fagaceae trees. *Craterellus subalpinu*s is similar to *Cr. aprilis*. However, the later differs by its deeply depressed pileus usually perforated at centre, grayish white to brownish white hymenophore usually with purplish gray tinge, and mainly distributed in subtropical mixed forests at low-altitude regions of south China. Besides, *Cr. aprilis* can only be found in April, while *Cr. subalpinus* can be seen from August to September.

Phylogenetic analyses supported *Cr. subalpinus* as a distinct species, nested in Clade I (*Cr*. subg. *Lamelles*) (Fig. 4, 5), and closely related to *Cr. aprilis*, *Cr. minor* and *Cr. melanoxeros*. *Craterellus minor*, recently reported from China, differs by its grayish-yellow pileus, white to pale hymenophore, slightly shorter basidia, thick-walled pileipellis, and distributed in low elevation

region of Central China (Zhang et al. 2022b). *Craterellus melanoxeros*, originally reported from Europe, differs by its saffron yellow pileus usually blackening when bruised, rose pink to violet hymenophore, stout and solid stipe, relatively narrower basidiospores, and endemic to Europe (Breitenbach and Kränzlin 1986, Pegler et al. 1997, Akata and Kumbaşli 2014).



Figure 63 – Morphology of *Craterellus subalpinus*. A–C. Basidiomata. D. Basidiospores. E. Basidia. F. Pileipellis. Scale bars: D = 10 µm; E, F = 20 µm.

Craterellus sublutescens Ming Zhang & C.Q. Wang, sp. nov. Fig. 64

Chinese name:近变黄喇叭菌

Fungal Name: FN573137; Facesoffungi number: FoF 19041

Etymology – "*sub*-" means somewhat; "*sublutescens*" refers to the species is similar to *Cr. lutescens* in morphology

Diagnosis – Differs from *Cr. lutescens* by its smaller basidiomata, white hymenophore, smaller basidiospores (7–8.5 × 6–7 µm), and absence of clamp connections.

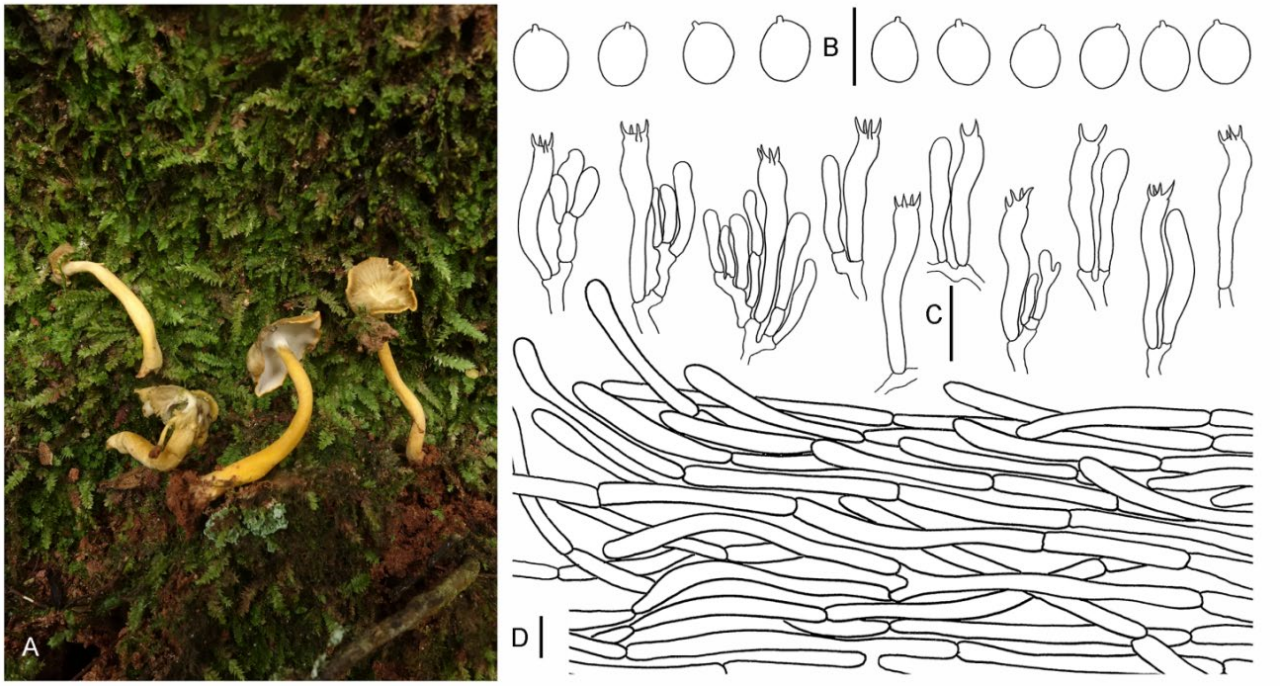


Figure 64 – Morphology of *Craterellus sublutescens*. A. Basidiomata. B. Basidiospores. C. Basidia. D. Pileipellis. Scale bars: B, D = 10 μm; C = 20 μm.

Type – China. Yunnan Province, Puer City, Simao District, Taiyanghe National Forest Park, alt. 1450 m, N 22°36′15.2″ E 101°03′48.6″, 24 Sep 2019, M. Zhang (GDGM78931).

Basidiomata very small-sized. Pileus 5–15 mm broad, more or less convex when young, gradually applanate with a depressed center, not perforated when mature; surface dry, tomentose, with obscure striate toward margin, grayish yellow to grayish orange (3B5–5B5); margin thin, wavy or irregular when mature. Context thin, 0.5 mm thick, yellowish withe, unchanging when exposed. Hymenophore decurrent, poorly-developed, smooth, sometimes wrinkly or very ill-defined veins, white to whitish. Stipe 20–40 mm long, 2–4 mm thick, subcylindrical, glabrous, hollow, pale yellow, light yellow to pale orange (3A5–4A5; 3A3–5A3); basal mycelium white. Odour and smell not distinct.

Basidiospores 7–8.5(9) × 6–7 μm [Lm × Wm = 7.98 (±0.52) × 6.6 (±0.36) μm, Q = 1.07(1.14)–1.30(1.33), Q_m =1.21 ± 0.09], broadly elliptical, oval to suborbicular. Basidia 45–72 × 7–10 μm, clavate, thin-walled; 2–4-spored, sterigmata 3–7 μm long. Pileipellis a cutis, composed of repent and occasionally erect hyphae, 3–8 μm in diam., colourless, thin-walled. Hymenophoral trama composed of cylindrical hyphae 3–5 μm in diam. Stipitipellis a cutis, composed with thin-walled hyphae 3–6 μm in diam. Clamp connections absent.

Habitat and distribution – Solitary or scattered in tropical broad-leaved forest. Known from southwest China.

Notes – *Craterellus sublutescens* is characterized by its small basidiomata, grayish yellow to grayish orange pileus not perforated at centre, smooth and white hymenophore, light yellow to pale orange stipe, and broadly elliptical basidiospores (7–8.5 × 6–7 μm). Morphologically, *Cr. sublutescens* resembles *Cr. lutescens* in sharing a similar colored pileus and stipe, but the latter has a larger basidiomata (up to 50 mm broad), yellow to orange hymenophore, and larger basidiospores (9–11 × 6.5–9 μm) (Petersen 1969, Zhang et al. 2022b; present study). In China, *Cr. lutescens* can be found only in coniferous or mixed forests in subalpine areas of southwest regions, while *Cr. sublutescens* grows under broad-leaved forests at low-altitude areas of tropical region.

Phylogenetic analyses proved that *Cr. sublutescens* nested within Clade III (*C.* subg. *Imperforati*) (Fig. 5), is close to two unnamed samples *Cr.* sp. 16450 and *Cr.* sp. MMCR00308, and can be easily separated from other species.

Craterellus tengii Ming Zhang & T.H. Li, sp. nov. Fig. 65

Chinese name:邓氏喇叭菌

Fungal Name: FN573138; Facesoffungi number: FoF 19042

Etymology – "*tengii*" is in honor to the great Chinese mycologist Shu-Chün Teng for his contributions in the field of mycology, who was the founder of the Institute of Microbiology, Guangdong Academic of Science.

Diagnosis – Differs from *Cr. aprilis* by its discolored basidiocarps, grayish yellow to brownish orange pileus non-perforated at center, longer decurrent hymenophore, and DNA sequences.

Type – China, Guangdong Province, Zhaoqing City, Dinghushan National Nature Reserve, alt. 300 m,11 Apr 2024, M. Zhang (GDGM94459).

Basidiomata small-sized. Pileus 2–5 cm broad, more or less convex when young, gradually applanate, depressed in the center when mature, non-perforated; margin wavy or strongly irregular upturned when mature; surface dry, membranous, tomentose, grayish yellow to brownish orange (3C3–5C3), with grayish lilaceous tinge, slightly changing to blackish when bruised; context thin, 1–1.5 mm thick, grayish white (1A2), changing to blackish when exposed. Hymenophore long decurrent, as poorly developed gill-like ridges, distant, composed of bifurcate, less than 1.5 mm high vein-like folds, particularly towards pileus margin, orange white to pinkish white (8B2–12B2), usually with purplish gray tinge when young and gradually paler to gray when mature, changing to blackish when bruised. Stipe 20–30 mm long, 3–5 mm thick, subcylindrical, glabrous, hollow, concolorous with pileus, changing to blackish when bruised; basal mycelium white. Odour milk flavor. Taste mild.

Basidiospores 7–10 × 6–8 μm [Lm × Wm = 8.5(±0.7) × 6.85(±0.54) μm, Q = (1.12)1.14–1.33, Q_m = 1.24 ± 0.08], broadly elliptical to oval, thin-walled. Basidia 60–80 × 8–11 μm, clavate, thin-walled, 2–6-spored, sterigmata 5–7 μm long. Pileipellis a cutis, composed of repent and occasionally erect hyphae, 8–17 μm in diam., colourless to yellowish brow in 5% KOH, thin to slightly thick walled. Hymenophoral trama composed of cylindrical hyphae 5–13 μm in diam. Stipitipellis a cutis, composed with thin-walled, paralleled, hyphae 4–12 μm broad. Cystidia absent. Clamp connections common.

Habitat and distribution – Scattered or gregarious under mixed forests in subtropical regions dominated by Fagaceae trees. Known from southern China.

Specimens examined – China. Guangdong Province, Zhaoqing City, Dinghushan National Nature Reserve, alt. 285 m, 11 Apr 2024, M. Zhang (GDGM94462); same location and date, G.R. Zhong (GDGM94461).

Notes – *Craterellus tengii* is a rare species and can be easily distinguished in field by its grayish yellow to brownish orange basidiomata changing to blackish when bruised. *Craterellus aprilis* is a morphologically similar and molecularly related species, but differs by its basidiocarps without colour change when bruised, greenish gray to brownish gray pileus usually perforated at center, much shorter decurrent hymenophore, and an independent phylogenetic position. *Craterellus grisellonigricans* is another discoloring species described in this study, which can be easily distinguished by its pinkish white to orange gray pileus, pinkish white to reddish lilac hymenophore, light yellow stipe, and larger basidiospores measuring 9.5–12(14) × (8.5)9–10 μm.

Phylogenetic analyses showed that three specimens of *Cr. tengii* formed a distinct monophyletic lineage in Clade I, and can be separated from other species by the genetic distance.

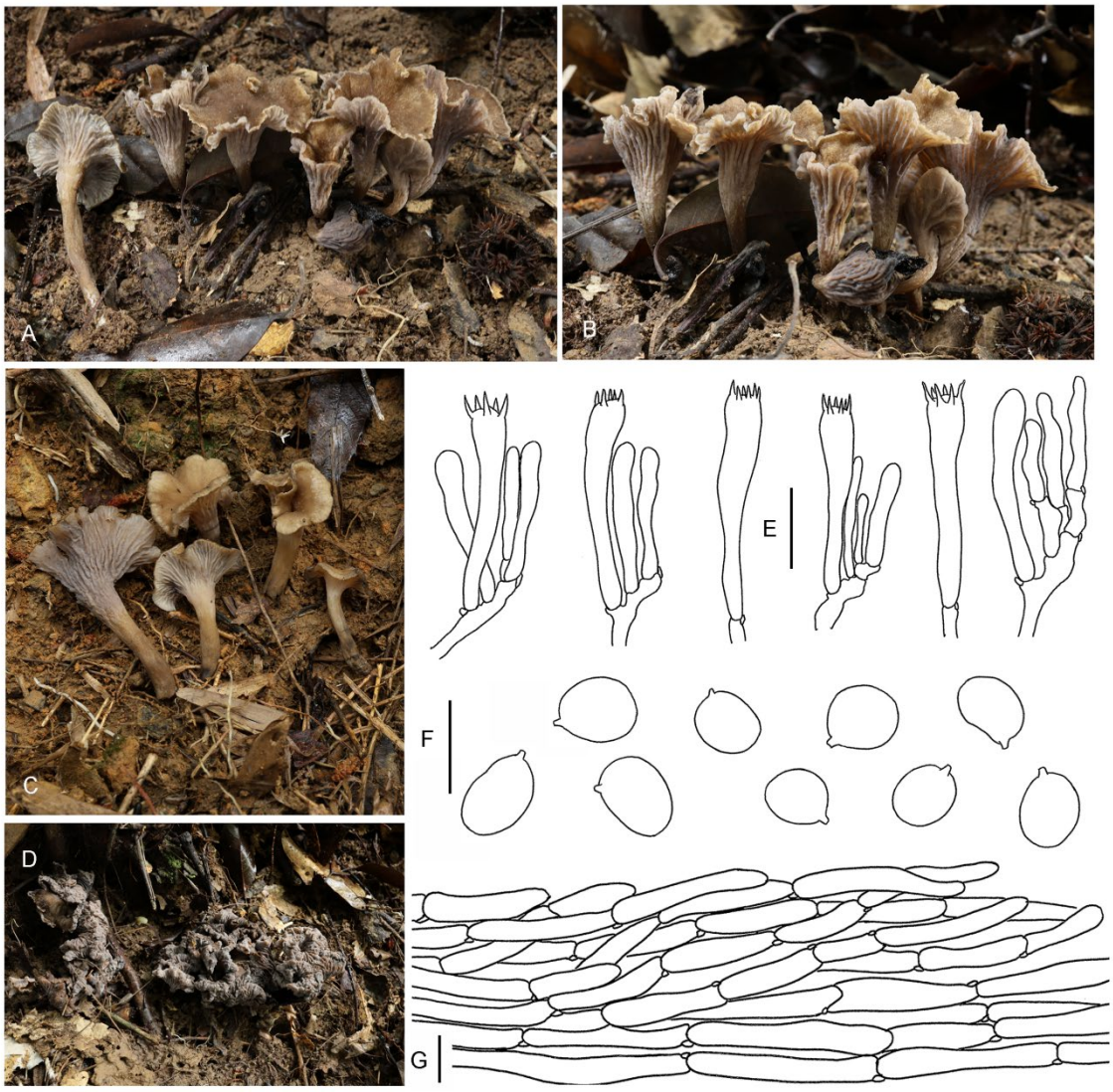


Figure 65 – Morphology of *Craterellus tengii*. A–D. Basidiomata. E. Basidia. F. Basidiospores. G. Pileipellis. Scale bars: E, G = 20 µm; F = 10 µm

Craterellus tropicus Ming Zhang & C.Q. Wang, sp. nov. Fig. 66

Chinese name:热带喇叭菌

Fungal Name: FN573139; Facesoffungi number: FoF 19043

Etymology – "*tropicus*" refers to its tropical distribution regions in China.

Diagnosis – Similar to *C. aprilis,* but differs in smaller basidiomata, grayish yellow to olive brown pileus non-perforated at center, relatively narrower basidiospores, tropical distribution, and unique DNA sequences.

Type – China. Hainan Province, Wuzhishan City, Wuzhishan National Natural Reserve, alt. 1414 m, 16 Jul 2021, M. Zhang (GDGM79152).

Basidiomata small-sized. Pileus 15–25 mm broad, more or less convex when young, gradually applanate, depressed in the center when mature, usually non-perforated when mature, margin incurved when young, wavy or irregular when mature; surface dry, glabrous to subtomentous, grayish yellow, olive to olive brown (3C3–5–3E3–5, 4C3–5–4E3–5). Context thin, 1 mm thick, fibrous, grayish white, unchanging when exposed. Hymenophore decurrent, as poorly-developed gill-like ridges, distant, composed of bifurcate vein-like folds, particularly towards pileus margin, yellowish white to pale yellow (3A2–3–4A2–3) when young, yellowish gray to pale gray (3B1–4B1) when mature, sometimes with lilaceous tinge. Stipe 20–40 mm long, 3–5 mm

thick, subcylindrical, tapering downward, glabrous, hollow, concolorous with pileus or paler to pale yellow (3A3), basal mycelium white. Odour and smell not distinct.

Basidiospores 7.5–9.5 × 6–7(7.5) µm [L_m × W_m = 8.48(±0.62) × 6.80(±0.31) µm, Q = (1.12)1.14–1.38(1.42), Q_m = 1.24 ± 0.09], broadly elliptical to oval, thin-walled. Basidia 50–75 × 7–11 µm, clavate, thin-walled, 4–6-spored, sterigmata 5–7 µm long. Pileipellis a cutis, composed of repent and occasionally interwoven hyphae, 8–15 µm in diam., colourless, thin-walled. Hymenophoral trama composed of cylindrical hyphae 5–10 µm in diam. Stipitipellis a cutis, composed with thin-walled, paralleled, hyphae 4–12 µm broad. Cystidia absent. Clamp connections present.

Habitat and distribution – Scattered or gregarious under broad-leaved forests in tropical regions of southern China. Known from Hainan and Yunnan Provinces.

Additional specimen examined – China. Yunnan Province, Puer City, Taiyanghe National Forest Park, alt. 1500 m, 28 Jul 2022, M. Zhang (GDGM89869).

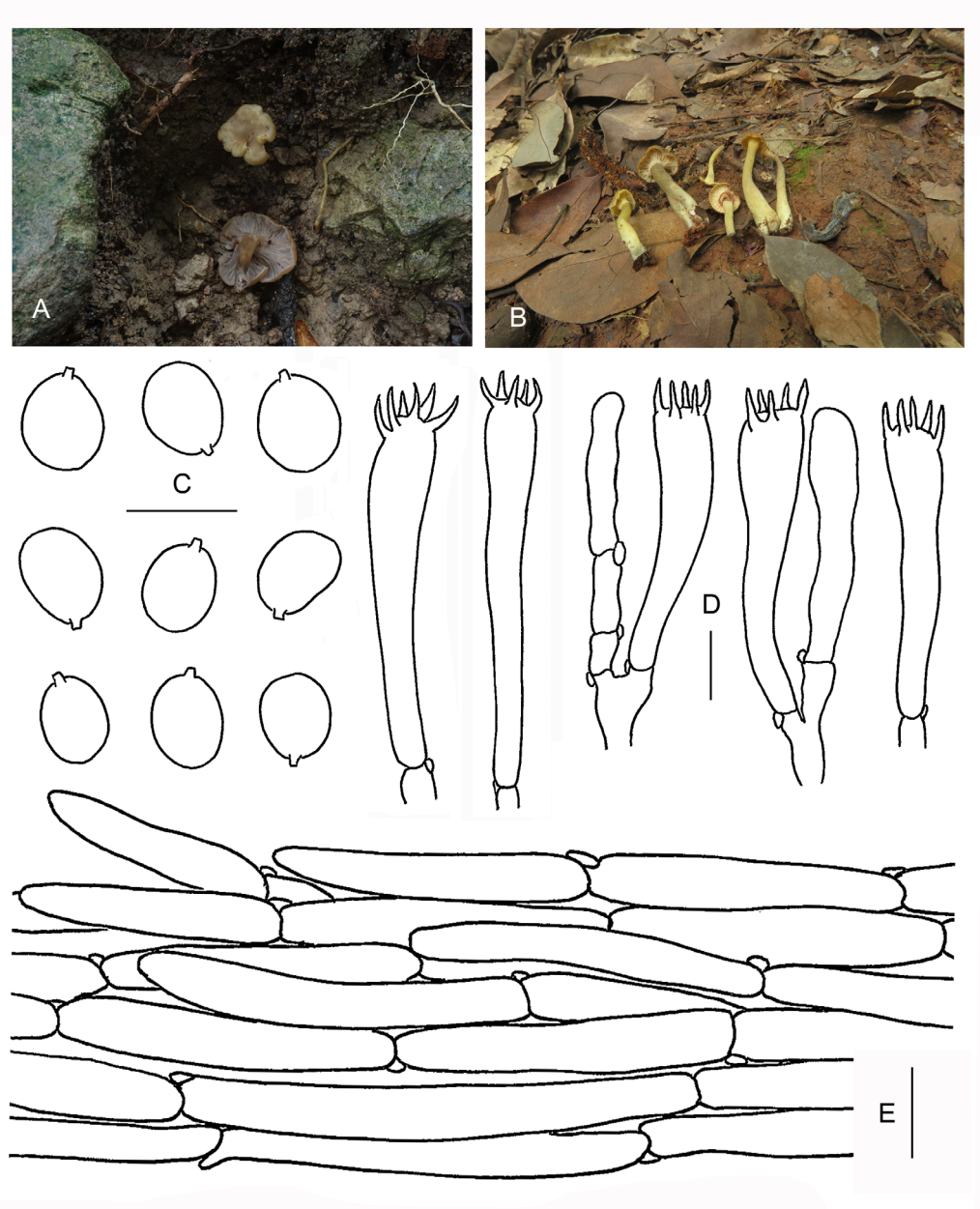


Figure 66 – Morphology of *Craterellus tropicus*. A–B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C, D = 10 µm; E = 20 µm.

Notes – Phylogenetic analyses showed that four samples from China formed a well-supported distinct lineage in the multi-gene tree (Fig. 5), including a sample named "*Cr. tubaeformis* HKAS11183" from the tropical region of Yunnan Province. *Craterellus aprilis* is morphologically similar and molecularly closely related to *Cr. tropicus*. However, *Cr. aprilis* differs in having larger basidiomata, a greenish gray to brownish gray pileus usually perforated at the center, and relatively broader basidiospores (7.5–10 × 6.5–7.5 μm). *Cr. aprilis* is only observed in April in the subtropical regions of southern China, whereas *Cr. tropicus* is distributed in the tropical regions of southern China, and can be seen in July.

Craterellus viridifuscus Ming Zhang, C.Q. Wang & T.H.Li, sp. nov. Fig. 67

Chinese name:青褐喇叭菌

Fungal Name: FN573134; Facesoffungi number: FoF 19038

Etymology – "*viridi-*" means greenish; "*viridifuscus*" refers to the greenish fuscous pileus colour.

Diagnosis – Morphologically and molecularly similar to *Cr. albimarginatus,* especially in the paler pileus margin, but differs in greenish pileus, yellowish gray hymenophore, often paler stipe and larger basidiospores and basidia.

Type – China. Hainan Province, Ledong County, Jianfengling National Nature Reserve, alt. 840 m. 19 Jun 2017, M. Zhang (GDGM60559).

Basidiomata very small-sized. Pileus 10–30 mm broad, applanate with depressed centre when young, concave to subinfundibuliform, usually perforated at maturity, surface dry, hygrophanous when wet, glabrous at centre, tomentose at margin, olive, olive brown, brown to pinkish brown (2E4–8E4), sometimes partially with pinkish tinge; margin incurved at first, usually wavy when mature, slightly to brownish gray at margin (4D2–7D2). Hymenophore decurrent, poorly developed, smooth or wrinkly with very ill-defined veins, yellowish gray, pale gray to light gray (2B2, 1B1–1C1), unchanging in color when injured, without a clearly delimitation from the stipe surface. Stipe 20–50 × 2–7 mm, central, subcylindrical expending toward base, irregularly grooved or wrinkled, hollow, surface glabrous, concolorous with pileus or with hymenophore, often paler to yellowish gray to brownish gray downward the base; basal mycelium white. Odour none. Taste mild.



Figure 67 Morphology of *Craterellus viridifuscus*. A, B. Basidiomata. C. Basidia. D. Basidiospores. E. Pileipellis. Scale bars: C = 20 μm; D, E = 10 μm.

Basidiospores 7.5–10 × (6)7–8 μm, [Lm × Wm = 9.4(±0.84) × 7.18(±0.44) μm, Q = 1.07(1.25)–1.42(1.45), Q_m =1.30 ±0.09], smooth, elliptical to oval thin-walled, colourless in KOH. Basidia 57–85 × 7–10 μm, slender, clavate to subcylindrical, thin-walled, colourless in KOH, 4-spored; sterigmata 4–7 μm long. Hymenophoral trama composed of subregular to slightly interwoven hyphae 5–8 μm in diam., thin-walled. Pileipellis composed of long, repent, branched, thin-walled hyphae, 5–13 μm wide, colourless in KOH. Stipitipellis a cutis, composed of cylindrical, parallel hyphae, measuring 4–10 μm in diam. Cystidia absent. Clamp connections absent.

Habitat and distribution – Scattered or gregarious under broad-leaved forests (dominated by Fagaceae and Dipterocaceae trees) in tropical regions. Known from southern China.

Additional specimens examined – China, Hainan Province, Ledong County, Jianfengling National Nature Reserve, alt. 840 m, 31 Jul 2014, M. Zhang (GDGM72957), S.H. Zhou (GDGM72934); Same location, 19 Jun 2017, M. Zhang (GDGM60560)

Notes – *Craterellus viridifuscus* can be easily distinguished from other species by its olive brown to reddish brown pileus usually perforated at center, irregularly wrinkled and hollow stipe, smooth hymenophore and elliptical to oval basidiospores. *Craterellus albimarginatus* N.K. Zeng, T. Jiang & Xu Zhang, recently reported from the tropical region of China, is similar to *Cr. viridifuscus,* but differs in its grayish-brown pileus with more distinct white margin on the pileus, slightly smaller and narrower basidiospores measuring 7–7.9–9(9.5) × 5–5.6–6.5 μm, and smaller basidia (46–65 × 5–7 μm) (Jiang et al. 2025). *Craterellus gypseus* also resembles *Cr. viridifuscus.* However, the former differs by its smaller basidiomata, white to pale gray hymenophore, and larger basidiospores (8.5)9–12 × 7–8.5 μm.

Phylogenetic analyses showed that two samples of *Cr. viridifuscus* formed a distinct lineage, nested within Clade III (*Cr.* subg. *Imperforati*), and closely related to an unnamed sample (GDGM97478) from China.

Craterellus yunnanensis (W.F. Chiu) Buyck, in Wang et al., Mycosphere 14(1): 171 (2023)

≡ *Cantharellus yunnanensis* W.F. Chiu, Acta Microbiologica Sinica 13(2): 129 (1973)

Chinese name:云南喇叭菌

Notes – This species was originally reported from China as *Cantharellus yunnanensis* W.F. Chiu in 1973 (Chiu 1973). After that, there were few reports on this species until Shao et al. (2021) concluded that samples extensively sold in southwestern markets are *C. yunnanensis*, and a new epitype was designated. However, Wang et al. (2023a) disagreed with Shao's findings, saying that the original description of spore size was inaccurate, likely due to contamination by mould spores. After examining the basidiospores and the hyphal extremities at the pileus surface, they concluded that the species should belong to *Craterellus*, and further proved that the widely consumed species in markets is *C. applanatus*. For more detailed information, please refer to the discussion under *C. applanatus*. Our study did not examine the type specimen and provisionally accepts the views of Wang et al. (2023a).

Furthermore, phylogenetic analyses conducted in this study led to the proposal of an unnamed species and several new combination names, as detailed below.

***Craterellus* sp.** Fig. 68

Basidiomata very small-sized. Pileus 5–18 mm broad, applanate when young, concave to subinfundibuliform at maturity, not-perforate, surface dry or hygrophanous, glabrous to subtomentose at center, villose at margin, olive, olive brown to brown (3E4–7E4), slightly paler to grayish yellow to grayish orange toward margin, margin even, usually wavy and lobed when mature. Hymenophore decurrent, poorly developed, smooth, sometimes wrinkly or very ill-defined veins, pale gray to gray, unchanging in color when injured. Stipe 20–45 × 1–2 mm, central,

subcylindrical, solid, hollow, surface glabrous, concolorous with pileus; basal mycelium white. Odour none.

Basidiospores 7–10(11) × 6–7(8) µm, [$L_m \times W_m$ = 8.75(±0.89) × 6.67(±0.46) µm, Q = (1.14)1.21–1.42(1.5), Q_m = 1.31 ±0.11], smooth, elliptical to oval, thin-walled, with granular contents. Basidia 50–73 × 7–10 µm, slender, clavate to subcylindrical, thin-walled, with granular contents, 2–4-spored; sterigmata 5–7 µm long. Basidioles abundant, cylindrical, with finely granulose contents. Hymenophoral trama composed of subregular to slightly interwoven hyphae 3–6 µm in diam., thin-walled, colourless in KOH. Pileipellis composed of long, repent, branched, thin-walled hyphae, 5–10 µm wide, colourless in KOH. Stipitipellis a cutis, composed of parallel hyphae measuring 3–8 µm in diam., not secondarily septate. Clamp connections absent in all tissues.

Habitat and distribution – Solitary or scattered under mixed or broad-leaved forests mainly dominated by Fagaceae trees (*Castanopsis* spp.) in subtropical region, southern China. Known from Guangdong and Hunan Provinces.

Specimens examined – Guangdong Province, Shaoguan City, Shixing Town, Chebaling National Nature Reserve, alt. 367 m, 6 Jun 2020, M. Zhang (GDGM81311); Hunan Province, Chenzhou City, Rucheng Town, Jiulongjiang National Forest Park, 4 Sep 2016, M. Zhang (GDGM53453). Guangdong Province, Shaoguan City, Nanling National Nature Reserve, alt. 870 m, 8 Jul 2022, B. Song (GDGM88559); Same location, alt. 930 m, 9 Jul 2022, B. Song (GDGM88690).

Notes – Phylogenetic analyses showed that three Chinese specimens, GDGM81311, GDGM53453 and GDGM88559, are well nested within the *Cr. carolinensis*/*Cr. calyculus* lineage in Clade III (Figs. 4, 5), and there is nearly no genetic gap. Morphologically, *Cr. carolinensis* is similar to the Chinese samples, sharing similar sizes of basidiomata and basidiospores, but differs in having a darker pileus with finely to coarsely scaly on surface margin, longer basidia (60–100 × 6–8.4 µm), and growth on wood or deep woody humus (Petersen 1969). *Cr. calyculus* differs by its smaller basidiomata (pileus up to 7 mm broad) and larger basidiospores (9.7–12.1 × 6.8–9.1 µm) (Petersen 1969). The Chinese samples can be easily distinguished from the two molecularly closely related species by their morphological features, thus, they are treated as an uncertain species in present study. Further studies on a broader base of specimens and sequence fragments are needed to resolve their identification.

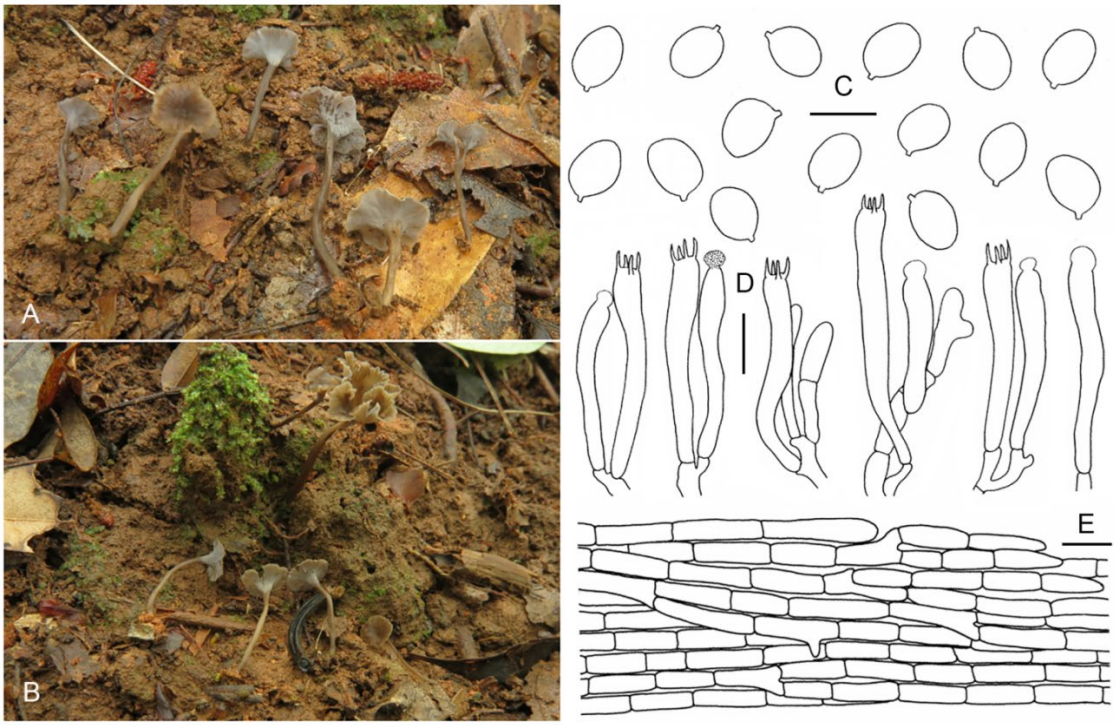


Figure 68 – Morphology of *Craterellus* sp. A, B. Basidiomata. C. Basidiospores. D. Basidia. E. Pileipellis. Scale bars: C, E = 10 µm; D = 20 µm.

Craterellus armeniacus (Corner) Ming Zhang & T.H. Li, comb. nov. Fig. 69

≡ *Pterygellus armeniacus* Corner 1966, *Monogr. Cantharelloid Fungi*: 168 (1966)

Chinese name:亚美尼亚喇叭菌

Fungal Name: FN573116

Basidiomata very small-sized. Pileus 5–20 mm broad, irregular, often divided to several separate spathulate from the base; surface dry, light yellow, yellow to yellowish orange (2A6–4A6), scales or strigose at margin, margin irregularly sharp with saw-like pattern, often cracked. Hymenophore decurrent, smooth, white to yellowish white, poorly developed, with radial blunt veins or ridges. Stipe 20–40 × 1–2 mm, central, subcylindrical, usually forked at the top, solid or hollow when mature, concolorous with pileus, surface covered with rough upward-pointing strigose squamules; basal mycelium white. Odour none.

Basidiospores (7)8–10 × 6–7(7.5) µm, [L_m × W_m = 8.51(±0.82) × 6.43(±0.55) µm, Q = (1.14)1.21–1.42(1.5), Q_m = 1.35 ±0.13], smooth, elliptical to oval, thin-walled. Basidia 55–65 × 7–8 µm, slender, clavate to subcylindrical, thin-walled, 3–6-spored; sterigmata 5–7 µm long. Hymenophoral trama composed of subregular to slightly interwoven hyphae 4–9 µm in diam., thin-walled, colourless in KOH. Pileipellis composed of long, repent, thin-walled hyphae, 5–8 µm wide, coluorless in KOH, terminal hyphae clavate, slightly thick-walled, usually with golden yellow content. Stipitipellis a trichoderm, composed of parallel hyphae measuring 4–7 µm in diam. Clamp connections absent in all tissues.

Habitat and distribution – Solitary or scattered under broad-leaved forests mainly dominated by Fagaceae trees (*Castanopsis* spp.) in subtropical region, southern China. Known from Guangdong and Hunan Provinces.

Specimens examined – Vietnam. Lam Dong Province, Da Lat City, Bi Doup Nui Ba National Park, alt. 1700 m, 14 Oct 2017, M. Zhang (GDGM70945).

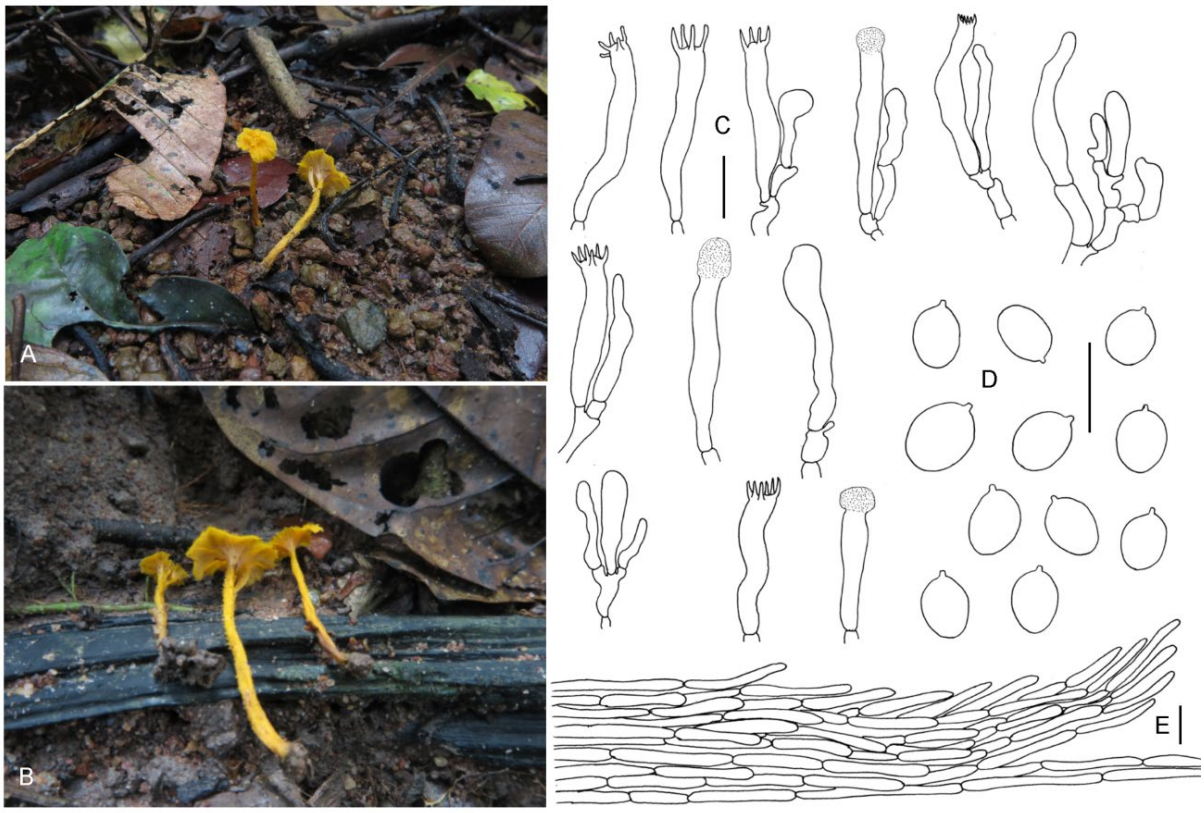


Figure 69 – Morphology of *Craterellus armeniacus* A, B. Basidiomata. C. Basidia. D. Basidiospores. E. Pileipellis. Scale bars: C–E = 10 μm.

Notes – *Craterellus armeniacus* can be easily recognized by its light yellow basidiomata, pileus usually caespitose from the base, smooth hymenophore with radial blunt veins, and slender stipe surface covered with rough upward-pointing strigose squamules.

Phylogenetic analyses (Figs. 4, 5) showed that a sample labelled as *Cr. armeniacus* is well nested within *Craterellus*, forming a monophyletic lineage in Clade V (Fig. 4, 5). This confirms that *Cr. armeniacus* is a member of *Craterellus*. *Pterygellus armeniacus* Corner (= *Cr. armeniacus*) is the type species of *Pterygellus*, rendering *Pterygellus* a synonym of *Craterellus*. Consequently, species currently classified under *Pterygellus* should be transferred to *Craterellus.* Several new combination names are proposed below.

Craterellus funalis (Henn.) Ming Zhang & T.H. Li comb. nov.
≡ *Pterygellus funalis* (Henn.) D.A. Reid 1976, *Nova Hedwigia* 27(1-2): 336 (1976)
≡ *Cladoderris funalis* Henn. 1905, *Bot. Jb.* 38(1): 120 (1905) [1907]
Fungal Name: FN573117

Craterellus polymorphus (Corner) Ming Zhang & T.H. Li comb. nov.
≡ *Pterygellus polymorphus* Corner 1966, *Monogr. Cantharelloid Fungi*: 169 (1966)
Fungal Name: FN573118

Craterellus spiculosus (Corner) Ming Zhang & T.H. Li comb. nov.
≡ *Pterygellus spiculosus* Corner 1966, *Monogr. Cantharelloid Fungi*: 171 (1966)
Fungal Name: FN573119

DISCUSSION

Species diversity of chanterelles in China

A remarkable level of species diversity of chanterelle fungi in China was revealed in this study, with 72 species-level lineages identified. Four of the lineages remain undescribed due to insufficient material. Among the identified species, 42 belong to the genus *Cantharellus*, including eight newly described species, and 28 species are classified under the genus *Craterellus*, with 12 new species and two newly recorded species for China. In addition, five new taxonomic combinations are made and four species are placed into synonymy based on phylogenetic analyses; one ambiguous taxon was tentatively described as *Craterellus* sp. Among the accepted species, 36 well known species have been redescribed and briefly introduced based on new collections; while 9 species, for which there is a shortage of available specimens were reviewed only according to descriptions in references.

Several taxa, including *C. ferruginascens*, *C. lateritius*, *C. minor*, and *Cr. cornucopioides*, which were previously recorded from China, were not discovered during the present study. Some of these seem highly unlikely to exist in China, although they have been reported in the literature (Tai 1979, Bi et al. 1993, Shao & Xiang 1997). For instance, *C. minor* has been reported in most regions of China, but recent studies have shown that specimens previously named as "*C. minor*" in the southern regions of China represent several different species, such as *C. austrosinensis*, *C. convexus*, *C. elongipes*, and *C. cirtinus*. Similarly, recent studies have found that studied samples of *Cr. cornucopioides* from southern China are *Cr. croceialbus* and *Cr. involutus*, and samples from the subalpine regions of southwest China are *Cr. sioncornucopioides*. Likewise, samples of "*C. lateritius*" in China are *C. hainanensis, C. laevihymeninus, C. magnus, C. pseudohainanensis* and *C. sinolateritius.* Of course, sampling efforts might be still inadequate in present study. Further investigation is essential to verify if any of these species are present in China, through more comprehensive field surveys, sample collection and molecular analysis.

The identified species of *Cantharellus* in China mainly belong to subgenera *Afrocantharellus*, *Cantharellus*, *Cinnabarinus*, *Magnus*, and *Parvocantharellus*. Subg. *Parvocantharellus* is the most species rich subgenus with 16 species identified, mainly distributed in subtropical to tropical regions of southern China; while only *C. curvatus* is distributed in the temperate regions of Shangdong and Heilongjiang Provinces (Wang et al. 2023a), and *C. zangii* is distributed in the subalpine regions of southwestern China. Some species of this subgenus are distinct. For example, *C. albus* and *C. minioalbus* can be easily distinguished by their white basidiomata, while *C. neopersicinus* differs by its pastel red to pink pileus and white to pinkish hymenophore. *C. roseocastaneus* can be distinguished by its grayish red to reddish lilac pileus covered with minute fibrils. However, several species within the subgenus display similar morphological features, making it difficult to distinguish them from each other. However, they can be effectively differentiated through molecular data and geographical distribution.

In *C*. subg. *Cantharellus*, 13 species are reported from China, and they are mainly characterized by their large and yellow to orange basidiomata. However, in this subgenus, *C. albopileatus* is the only white species discovered from China, and can be easily distinguished from others. *C. macrocarpus* can be distinguished by its large basidiomata, while *C. hainanensis*, *C. laevihymeninus*, *C. pseudohainanensis* and *C. sinolateritius* are mainly characterized by smooth hymenophores, which were easily misidentified as *C. lateritinus* in the past, but can be clearly distinguished through phylogenetic analyses. The typically "golden chanterelles" species, *C*. *cibarius*, *C. tuberculosporus* and *C. applanatus* share similar morphological features, making it challenging to distinguish them based on morphological features alone. However, each species has a distinct ecological distribution. *C. cibarius* is found exclusively in northeastern China, while *C. tuberculosporus* is distributed in the subalpine areas of southwestern China, and *C. applanatus* is widely found in southern China. *C. versicolor,* a subalpine species, can be commonly seen in the Himalayan-Hengduan mountains of southwestern China, and differs by its striking colour variations and unique habitat preference. Additionally, *C. chuiweifanii*, *C. pinetorus* and *C. vaginatus*, which are mainly distributed in southern China, are difficult to distinguish from each other, However, *C. vaginatus* has pale yellow to light yellow pileus covered with olive brown to reddish brown squamules, *C. chuiweifanii* differs by its tropical distribution, while *C. pinetorus* grows under coniferous forest.

Six species were identified from China in *C*. subg. *Cinnabarius*. They are mainly characterized by their small basidiomata tinged with orange red to reddish orange colour, thin-walled pileipellis and absences of clamp connections. Among them, *C. phloginus* and *C. sinocinnabarinus* might have been misidentified as *C. cinnabarinus* in the past, by their reddish orange basidiomata. However, it has been proven that it is most unlikely for *C. cinnabarinus* to occur in China, and samples of "*C. cinnabarinus*" from subalpine regions of southwest China could be *C. sinocinnabarinus*, while samples from tropical to subtropical regions of southern China may be *C. phloginus. Cantharellus citrinus* is mainly characterized by its small greenish yellow pileus, yellowish white hymenophore, hollow stipe, and is only seen in Guizhou Province.

In *C*. subg. *Afrocantharellus*, three species were recorded in China. They can be easily distinguished by their variable-colored basidiomata, well-developed hymenophore with few veins at margin, relatively fragile context and absences of clamp connections. Two species, *C. cineraceus* and *C. cerinoalbus*, are morphologically similar and phylogenetically closely related, and were difficult to distinguish from each other. The present phylogenetic analyses indicated that samples of these two species clustered together and formed a major species clade. which exhibited diverse morphological characteristics. However, due to a lack of definitive sequences for *C. cerinoalbus*, relationships between the two species are unclear. Thus, *C. cineraceus* and *C. cerinoalbus* together with *C. cuticulatus* were treated as a species complex in present study. The remaining species, *C. hygrophoroides* can be easily distingusihed by its *Hygrophorus*-like basidiomata, and variable coloration of the pileus ranging from light yellow to vivid red.

In *C*. subgenus *Magni*, three species have been reported from China. However, *C. laevigatus* was verified as a synonymy of *C. magnus* in present study. *Cantharellus magnus* is characterized

by large basidiomata with a smooth hymenophore, which is similar to those species in *C.* subg. *Cantharellus* with a smooth hymenophore. The other species, *C. bellus* is distinguished by its orange-yellow pileus and relatively well-developed hymenophore, which morphologically resembles species in section *Cantharellus* of subg. *Cantharellus*. However, they can be separated through molecular data.

Species diversity of *Craterellus* in China is also very abundant, and 26 species were identified in the present study. The well known species *Cr. cornucopioides* has been widely reported in China in past decades (Mao 1998, Bi et al. 1993, Li et al. 2015). However, recent studies have revealed that *Cr. cornucopioides* is a "species complex", comprising multiple independent species in China, including *Cr. croceialbus*, *Cr. involutus*, *Cr. macrosporus*, *Cr. parvopullus, Cr. squamatus* and *Cr. sinocornucopioides* (Cao et al. 2021a, Jiang et al. 2025). Similarly, *Cr. tubaeformis*, which has been widely reported in Asia, North America and Europe, is also proved to be a species complex (Dahlman et al. 2000, Zhou et al. 2011, https://gbif.org/species/2554536). The present phylogenetic analyses showed that samples of *Cr. tubaeformis* mainly formed three distinct clades, all specimens are from North America and Europe, and there is no sample from Asia that nested within the three *Cr. tubaeformis* clades. It is probable that *Cr. tubaeformis* does not occur in China (or Asia), and past records may represent several different species, such as *Cr. sordidus* or *Cr. tropicus*, etc.

Within the genus *Craterellus*, multiple species exhibit similar morphological traits, including *Cr. albimarginatus*, *Cr. badiogriseus*, *Cr. brunneus*, *Cr. guizhouensis*, *Cr. gypseus*, *Cr. parvogriseus* and *Cr. viridifuscus*. Nonetheless, these species can be effectively distinguished by their morphological characteristics. For instance, colour of the pileus and hymenophore, shape and size of basidiospores, structure of pileipellis hyphae, and presence or absence of clamp connections. Additionally, geographical distribution and host plants can also provide important information for accurately identifying species. Certainly, specific gene fragments are essential for species identification, including ITS, *tef*1, LSU, or *rpb*2, etc.

Phylogeny and systematic treatment of chanterelles

Phylogenetic analyses effectively aid in understanding and elucidating species diversity and evolutionary relationships of chanterelles in China. The ITS sequence serves as an effective gene fragment for distinguishing species, which are difficult to distinguish based solely on their morphological characteristics. For instance, species within the "*C. cibarius* complex" and "*C. vaginatus* complex" can be distinctly separated from one another in the ITS phylogenetic tree (Fig. 3). However, due to varying evolutionary rates of ITS sequences among chanterelle species, there are significant differences in the lengths of sequences between different species (Feibelman et al. 1994). This is particularly evident in the ITS1 region, which results in uneven branch lengths among different species on the phylogenetic tree. Additionally, the high polymorphism of ITS sequences makes successful amplification difficult, which hampers phylogenetic studies (Hillis & Dixon 1991, Olariaga et al. 2016). The nrLSU sequence has also been used for phylogenetic studies, and several new species have been reported based on LSU phylogenetic analyses (Dunham et al. 2003, Kumari et al. 2011, Shao et al. 2014). However, this region exhibits limited resolution in differentiating closely related species within *Cantharellus*, rendering it inadequate for species delineation on its own.

The *tef1* sequence has been proven to be the most appropriate gene locus for distinguishing species in *Cantharellus* and can serve as a barcode for species delimitation (Buyck & Hofstetter 2011). However, in some closely related species, such as species in the "*C. cibarius* complex" and "*C. vaginatus* complex", the *tef*1 sequences are highly similar and cannot effectively distinguish species from one another. This indicates that relying on a single gene fragment has limitations for species identification. Therefore, incorporating additional gene markers, such as ITS, LSU, *rpb*2, etc. which are commonly used in large-scale studies of *Cantharellus* and other fungal groups, such as *Hygrophorus* and boletes (Buyck et al. 2013, 2014, Olariaga et al. 2016, Zhang et al. 2021a, 2022d, Wang et al. 2023c), can enhance the accuracy and reliability of classification results.

Currently, phylogenetic analysis based on multiple genes is the most effective approach for resolving interspecific and generic phylogenetic relationships.

In the present study, *Cantharellus* was well divided into seven major clades, which are consistent with previous studies (Buyck et al. 2014, Cao et al. 2021a), and each clade exhibited distinct genetic and morphological traits, representing unique evolutionary paths. This clear separation underscores the genetic diversity within *Cantharellus*, and validating the necessity of multi-gene approaches for precise species delineation. The phylogenetic tree topology mirrors morphological variations, reinforcing the synergy between genetic and phenotypic data in accurate classification.

For *Craterellus*, phylogenetic analyses were performed based on ITS sequences and multi-gene ITS+LSU+*tef*1+*rpb*2+mtSSU, separately. Six main clades were identified, which partially correspond to the results in Cao et al. (2021a). In the multi-gene tree, Clade I encompasses *Cr*. subg. *Lamelles* and *Cr.* subg. *Cariosi*, as per Cao et al. (2021a), where five new lineages and a new combination species were discovered, and *Cr. fulviceps* was confirmed to be a synonym of *Cr. sordidus*. Clade II consists of samples from South America, forming a distinct regional clade. Clade III corresponds to the boundary of *Cr.* subg. *Imperforati* (Cao et al.2021a), with the addition of six new species lineages. Most samples within Clade III are from Asia, except for the two basal branches, one from South America and one from North America. In Clade IV, all samples collected from South America and West Africa, including six unnamed lineages, exhibited unique tropical distribution. Clade V encompasses *Cr.* subg. *Ovoidei* and those branches with uncertain subgenus status as indicated by Cao et al. (2021a), including *Cr. atrobrunneolus*, *Cr. parvofuscus* and *Cr. murinus*. Samples in this clade are mainly from North America and Asia. Additionally, *Pterygellus armeniacus* is nested within Clade V, confirming that the genus *Pterygellus* is synonymous with *Craterellus*. Clade VI corresponds to *Cr*. subg. *Craterellus* and encompasses an uncertain lineage identified as *Cr*. cf. *cornucopiodes* in the present study.

To date, the species diversity of *Craterellus* in Asia is abundant and distributed in several different clades. In contrast, samples from South America and Africa exhibit distinct regional characteristics, primarily forming two unique clades (Clade II and IV). Although this study has divided the genus into six main clades, the classification status of some species remains unclear. To comprehensively resolve this issue, more samples and effective molecular markers for further in-depth research are needed.

In the present phylogenetic analyses, most species with related sequences were clearly delineated in the phylogenetic trees (Figs. 1–5), and some distinct new lineages were identified and described. However, there are still several undescribed lineages and species complexes that require further attention; additional samples and effective genetic markers are needed to resolve their ambiguous taxonomic statuses.

Distribution of chanterelles species in China

Chanterelle species are widely distributed throughout most parts of China. The subtropical and tropical regions have the highest species diversity. Southwest China, a hotspot for chanterelles, is home to approximately 30 known species.

Several *Cantharellus* species, *C. sinocinnabarinus*, *C. versicolor*, *C. tuberculosporus*, and *C. zangii* are mainly distributed in subalpine areas of the Himalayan-Hengduan Mountains. *Cantharellus versicolor* and *C. zangii* are commonly found in *Abies* forests at altitudes ranging from 3800 to 4200 meters. *C. tuberculosporus* is a rare species, distributed in Sichuan and Xizang Provinces, and only found in mixed or coniferous forests at elevations of about 3500 to 3700 meters, while *C. sinocinnabarinus* is distributed in mixed forests at elevations around 2500 meters.

The most common species, *C. applanatus*, is distributed in Eastern and Southeast Asia. In China, it has a wide distribution in mixed forests of subtropical regions, particularly in the provinces of Yunnan, Guizhou, Sichuan, Zhejiang, Henan, and Anhui, and it has also been also observed in Chongqing and Beijing. *Cantharellus cibarius*, once widely reported in China, has been proven to be strictly distributed in the mixed forests of northeastern China. It can be seen in local

markets in the Changbai Mountains and the Great and Small Hingan Mountains (Wang et al, 2023, present study). In the subtropical and tropical regions of south China, the commonly seen species are *C. austrosinensis*, *C. chuiweifanii*, *C. phloginus* and *C. pinetorus*. However, *C. austrosinensis* and *C. pinetorus* may be solely associated with coniferous plants, whereas *C. chuiweifanii* and *C. phloginus* are widely distributed in evergreen broad-leaved forests of Hainan, Guangdong, Hunan, Jiangxi, Anhui, and Fujian Provinces.

In *Craterellus*, the commonly observed species are *Cr. aureus* and those within the "*Cr. cornucopioides* complex". *Craterellus aureus* is widely distributed in the broad-leaved forests of southern China, and can be easily identified by its yellow to orange trumpet-shaped basidiomata. Species within the "*Cr. cornucopioides* complex", *Cr. croceialbus*, *Cr. squamatus* and *Cr. macrosporus* were originally reported from the temperate region of northeastern China, but *Cr. croceialbus* has also been found in Hubei and Sichuan Provinces in this study. *Cr. involutus* was proved to have a subtropical distribution, and is distributed in the provinces of Fujian, Guangdong, and Yunnan. *Cr. parvopullus* is only known from the tropical regions of Hainan and Yunnan Provinces, while *Cr. sinocornucopioides* is distributed in subalpine regions of southwest China.

Specimens named as "*Cr. tubaeformis*" have been widely reported in Asia, North America and Europe. However, the present phylogenetic analyses showed that these samples formed three distinct clades (Figs. 4, 5), and all specimens are from North America and Europe; no sequence from Asia nested into the three clades. It is probable that *Cr. tubaeformis* does not occur in Asia and records in the past may represent several different species, such as *Cr. sordidus*, *Cr. grisellonigricans*, *Cr. lutescens*, *Cr. aprilis*, *C. minor*, *Cr. subalpinus* or *Cr. tropicus.* *Craterellus aprilis* and *Cr. soridus* are primarily distributed in subtropical regions of China. *Cr. aprilis* is found in the provinces of Guangdong, Hunan, Zhejiang, and Fujian, but only around April each year. In contrast, *Cr. soridus* is distributed in the provinces of Anhui, Fujian, Hunan, Jiangxi, and Zhejiang, and can be found from June to September. A rare species, *Cr. tengii*, also found in Guangdong Province in April, is similar to *Cr. aprilis* in morphology, but can be distinguished by its discolored basidiomata when bruised. *Cr. lutescens*, *Cr. sinensis*, and *Cr. subalpinus* are only observed in subalpine regions of southwestern China. *C. lutescens* thrives under coniferous or mixed forests, whereas *Cr. sinensis* and *Cr. subalpinus* are found under broad-leaved forests. Phylogenetic analyses have shown that *Cr. lutescens* has an even broader Holarctic distribution (Zhou et al. 2011, Zhang et al. 2022b). *Cr. minor* is distributed in Hunan and Zhejiang Provinces and is also found in Chongqing. It can be observed from September to October annually under broad leaved forests. *Cr. tropicus* is only found in the tropical regions of southern China. Additionally, several species, including *Cr. albimarginatus, Cr. badiogriseus*, *Cr. brunneus*, *Cr. parvogriseus*, *Cr. guizhouensis*, *Cr. gypseus, Cr. sinensis*, and *Cr. viridifuscus*, exhibit quite similar morphological characteristics. However, these species can be distinguished from one another based on their distinct ecological distributions and phylogenetic positions.

Phylogenetic studies indicate that chanterelle species exhibit a relatively strict geographical distribution pattern, with each species occupying a unique ecological niche (Buyck et al. 2014, Cao et al. 2021a, present study). Currently, only *Cr. lutescens* has been shown to have a broader Holarctic distribution, whereas *C. cibarius* has been confirmed to be primarily distributed in Europe, as well as northeastern regions of China and Japan (Hall et al. 2023, Wang et al. 2023a, present study). Apart from these two species, most species reported in the present study are distributed in China or Asia; species with an Asian-North American and Asian-European distribution are rare. Furthermore, species in the Southern Hemisphere and those in the Northern Hemisphere are clearly geographically isolated in the phylogenetic trees, with the distribution of species in both hemispheres remaining undiscovered. This geographic separation suggests distinct evolutionary paths, likely influenced by climatic and ecological factors, and underscores the significance of regional climate and ecological niches in shaping biodiversity.

We have gathered a substantial collection of chanterelle samples from various regions across the country. However, there are no samples from the northwestern regions of China, including the provinces of Xinjiang, Qinghai, Gansu, Ningxia, and Shaanxi. The distinctive geological conditions

in northwestern China, such as aridity, saline soils, and specific vegetation patterns, may restrict the proliferation of chanterelles. Alternatively, it could be due to the limited exploration efforts in these areas. Further research and field surveys are necessary to uncover potential chanterelle habitats in these poorly studied regions.

Conclusions and future directions

China is rich in species diversity of chanterelles. The numbers of chanterelle species in China accounts for one-fifth of the known species worldwide, with most being endemic to the country, while those with transcontinental or widespread distribution are rare. One reason for the high species diversity in China might be the high biodiversity of plants and other organisms in China, and chanterelles can form symbiotic relationships with various plants. Research on the symbiotic relationships between chanterelles and their host plants may enhance our understanding of chanterelle species diversity and distribution patterns.

In terms of species differentiation, ITS sequences are the most effective gene fragment for distinguishing species. Additionally, ITS sequences vary significantly among different species, particularly in the ITS1 region. Furthermore, the *tef1* sequence can effectively differentiate most chanterelle species, however, combining morphological characteristics and ecological data is necessary to improve classification accuracy. Currently, multi-gene analysis is the most effective method for resolving interspecific relationships.

Phylogenetic studies have significantly advanced classification of chanterelles, enhancing accuracy of species identification and challenging traditional morphology-based taxonomy. However, many species described in early periods lack sequence data, which hinders a comprehensive understanding of phylogenetic relationships within the chanterelle group. Buyck et al. (2011, 2014, 2016e), Buyck (2012) and Wang et al. (2023a) have significantly contributed to the study of chanterelles by examining some type specimens, revising scientific names of some early reported species, and specifying some neotypes or epitypes with available sequences. These efforts have enhanced accurate understanding of these species and helped prevent redundant publications and synonymy. Sequencing the genomes of other early described species is crucial for precisely resolving their phylogenetic relationships.

In the present study, 68 chanterelle species have been confirmed in China, including 20 new species and 3 new records of species for the country. It has provided a substantial amount of reliable molecular sequences to GenBank datasets. The species number could represent at least 80% of the species diversity of chanterelles in China. However, the remaining 10% or 20% may still hold surprises, particularly in less-explored regions. Continuous fieldwork and advanced genetic analyses are crucial for uncovering these hidden species.

Key to the identified species of *Cantharellus* in China

1. Basidiomata white to nearly so 2
1. Basidiomata not white, obviously colored 4
2. Basidiocarps small sized; pileus usually less than 40 mm broad 3
2. Basidiomata medium to large sized; pileus 30–60 mm broad; hymenophore white to yellowish white, changing to yellowish when bruised; basidiospores 7–8 × 5–6 µm ..... *C. albopileatus*
3. Pileus 18–42 mm broad; basidiospores 5.5–7.5 × 4.5–6 µm ..... *C. albus*
3. Pileus 3–10 mm broad; basidiospores 4.5–7 × 4–5.5 µm ..... *C. minioalbus*
4. Basidiomata red, orange red or pink, not typically yellow or orange 5
4. Basidiomata typically yellow to yellowish orange 7
5. In subalpine regions in southwest China; pileus 5–15 mm broad, reddish orange to yellowish red; basidiospores 7–8 × 5–6 µm ..... *C. sinocinnabarinus*
5. In tropical to subtropical regions 6
6. Pileus 20–60 mm broad, reddish orange to pastel pink; basidiospores 7–9 × 5–6 µm; in southern China ..... *C. phloginus*

6. Pileus 15–45 mm broad, pastel red to pink; basidiospores 7–8.5 × 4.5–5.5 μm; under eucalyptus forests in southern China ..... *C. neopersicinus*
7. Hymenophore smooth or nearly so 8
7. Hymenophore with well-defined gill-like folds 12
8. Basidiomata large-sized; pileus up to 200 mm broad; basidiospores 9–11 × 6.5–7.5 μm; belonging to *C.* subg. *Magni* ..... *C. magnus*
8. Basidiomata small to medium-sized 9
9. Growing in tropical regions 10
9. Growing in subtropical regions 11
10. Pileus 25–55 mm broad; basidiospores 6–8 ×4.5–5 μm ..... *C. hainanensis*
10. Pileus 30–120 mm broad; basidiospores 6–7.8 × 4.3–5.5 μm ..... *C. sinolateritius*
11. Pileus 30–65 mm broad, pale orange to orange; basidiospores 7–8.8 × 5–6 μm; growing in mixed forests in southwest China ..... *C. laevihymeninus*
11. Pileus 50–120 mm broad, pastel yellow to light orange; basidiospores 7–9 × 5–6 μm; growing under broad-leaved forest in eastern and central China ..... *C. pseudohainanensis*
12. Pileus up to 150 mm broad 13
12. Pileus usually less than 100 mm broad 14
13. Pileus 100–160 mm broad, light yellow to orange; basidiospores 6.5–8 × 4–5 μm; growing in southern China; belonging to *C.* subg. *Cantharellus* ..... *C. macrocarpus*
13. Pileus 40–150 mm broad, light yellow to reddish orange; basidiospores 10–12 × 6.5–8 μm; belonging to *C.* subg. *Afrocantharellus* ..... *C. hygrophoroides*
14. Growing in temperate regions 15
14. Growing in tropical, subtropical or subalpine regions in southern China 16
15. Pileus 40–90 mm broad, glabrous or covered with white tomentum when young, pale yellow to light orange; basidiospores 6–8 × 4.5–5.5(6) μm ..... *C. cibarius*
15. Pileus 20–30 mm broad, dull yellow to orangish yellow; hymenophores pale yellow to dirty yellow; basidiospores 7.5–9 × 5–6 μm ..... *C. curvatus*
16. Growing in subalpine regions 17
16. Growing in tropical or subtropical regions 19
17. Growing in mixed forests at less than 3500 m; pileus 40–80 mm broad, pastel yellow to light orange; basidiospores 8.5–10 × 5–6 μm ..... *C. tuberculosporus*
17. Growing in fir forests above 3500 m 18
18. Pileus 3.5–10 mm broad, glabrous or tomentose, yellow to grayish orange, sometimes with brownish tinge; basidiospores 9–11 × 6–7 μm; belonging to *C.* subg. *Cantharellus* ..... *C. versicolor*
18. Pileus 10–40 mm broad, glabrous, brown to brownish orange; basidiospores 8–11 × 5.5–7 μm; belonging to *C.* subg. *Parvocantharellus* ..... *C. zangii*
19. Clamp connections absent; pileus 30–80 mm broad, yellow to light yellow at mass, mixed with light green to yellowish green tinge at first, then gradually fading to yellowish green to grayish green at mature; basidiospores 8.5–9.5 × 5–6 μm ..... *C. cineraceus*/*C. cerinoalbus*
19. Clamp connections present 20
20. Pileipellis hyphae thin to thick-walled 21
20. Pileipellis hyphae thin-walled 26
21. Growing in coniferous forests ..... *C. pinetorus*
21. Growing in broad-leaved or mixed forests 22
22. Pileus surface usually tomentose or finely scaly 23
22. Pileus surface glabrous 24
23. Pileus 20–70 mm broad, pale yellow to light yellow, covered with olive brown to reddish brown minute fibrils at center; basidiospores 6–7 × 5–5.5 μm. . ..... *C. vaginatus*
23. Pileus 20–40 mm broad, pale yellow to orange white, with a reddish brown to violet brown center; basidiospores 7–8 × 4.5–5.5 μm ..... *C. subvaginatus*
24. Growing in tropical region of southern China ..... *C. chuiweifanii*
24. Growing in subtropical regions 25

25. Pileus 3.5–80 mm broad, yellowish to grayish yellow; hymenophore creamy yellow to yellowish; basidiospores 6.5–7.5 × 4.5–5.5 μm ..... *C. ravus*
25. Pileus 30–100 mm broad, usually covered with white minute pubescence, yellow to yellowish orange; hymenophore yellowish white to light yellow; basidiospores 7–8.5 × 4.5–6 μm; widely growing in south China ..... *C. applanatus*
26. Pileus surface grayish red, grayish rose, rose, grayish magenta, purplish pink to reddish lilac at mass, grayish brown to grayish ruby at center, covered with minute fibrils ..... *C. roseocastaneus*
26. Pileus surface without reddish lilac tinge 27
27. Growing in coniferous forests, symbiosis with *Pinus massoniana* ..... *C. austrosinensis*
27. Growing in broad-leaved or mixed forests 28
28. Basidiomata with a typical orange to reddish orange hue 29
28. Basidiomata without orange or orange red hue 32
29. Growing in southwestern China ..... *C. citrinus*
29. Growing in southern China 30
30. Pileus up to 60 mm broad, orange to deep orange, usually with reddish orange hue in some specimens; basidiospores 7.5–9 × 5–6.5 μm ..... *C. chrysanthus*
30. Pileus usually less than 35 mm broad 31
31. Pileus 15–35 mm broad, orange to deep orange fading to light yellow to light orange when mature; basidiospores 7–8 × 5–6 μm ..... *C. chrysanthemoides*
31. Pileus 5–15 mm broad, yellowish orange to orange, hymenophore light yellow to grayish yellow; basidiospores broadly elliptical, 7–8 × 4.5–5 μm ..... *C. danxiashanensis*
32. Basidiomata relatively large, typically cantharelloid 33
32. Basidiomata small, easily misidentified as *C. minor* in the past 35
33. Hymenophore white to yellowish white; pileus pale yellow to light orange, usually with a brownish orange center; basidiospores 8–9.5× 5–5.5 μm ..... *C. albidohymenius*
33. Hymenophore pale yellow to yellowish orange 34
34. Pileus bright orange-yellow; stipe grayish yellow to fulvous, hollow when old; basidiospores 7.5–9.5 × 5–6.5 μm; in tropical regions of southern China ..... *C. bellus*
34. Pileus light orange to graysh orange; stipe solid; basidiospores 7–9 × 5–6 μm; in subtropical regions of south China ..... *C. aurantinus*
35. Stipe length 1.5 to 2 times pileus width 36
35. Stipe length less than 1.5 times pileus width 37
36. Pileus grayish yellow to grayish orange; stipe hollow, 30–50 mm long; basidiospores 6.5–8.5 × 5–6 μm ..... *C. elongatipes*
36. Pileus pale yellow to light orange; stipe solid, 25–45 mm long; basidiospores 6–8.5 × 5–6.5 μm ..... *C. subtilis*
37. Pileus surface covered with olive brown to dark brown fibrils; basidiospores 6–7 × 4.5–5.5 μm ..... *C. pseudoaustrosinensis*
37. Pileus surface glabrous or subtomentose, without obvious fibrils 38
38. Pileus convex, surface tomentose, yellowish white to pale orange at mass, usually with a olive brown to yellowish brown center; basidiospores 6–7 × 4.5–5 μm ..... *C. convexus*
38. Pileus depressed at center 39
39. Growing in tropical regions 40
39. Growing in subtropical regions 41
40. Pileus 5–10 mm broad, greenish yellow to grayish yellow; basidiospores 6–7.5 × 4.8–5.5 μm ..... *C. galbanus*
40. Pileus 20–32 mm broad, pastel yellow to light orange; basidiospores 7–8 × 5.2–6.5 μm ..... *C. parvoluteolus*
41. Pileus pale yellow to light yellow, with pale yellow to light brown center, basidiospores 5–8 × 4.5–6 μm ..... *C. koreanus*
41. Pileus pastel yellow to yellowish orange, usually with grayish yellow tint at center, basidiospores 6–7 × 4.8–5.5 μm ..... *C. luteovirens*

Keys to the identified species of *Craterellus* in China

1. Basidiomata typically trumpet-shaped, without obvious stipe 2
1. Basidiomata not typically trumpet-shaped, with obvious stipe 7
2. Pileus light yellow to light orange; hymenophore smooth, yellowish white to orange white; basidiospores 8–10 × 6–7 μm ..... *Cr. aureus*
2. Pileus light brown, brownish gray, brown to dark brown 3
3. Basidiomata small-sized; in tropical to subtropical regions 4
3. Basidiomata medium to large-sized; in temperate regions 5
4. Pileus 10–45 mm broad, brownish orange to dark brown, glabrous or velutinate; hymenophore pale gray to medium gray; basidiospores 8–10.5 × 6.5–8 μm ..... *Cr. involutus*
4. Pileus 18–48 mm broad, brownish gray, tomentose; hymenophore brownish gray to dark gray; basidiospores 7–8.5 × 6.5–7 μm ..... *Cr. parvopullus*
5. Basidiospores less than 12 μm long; pileus brownish orange to grayish brown, surface glabrous to velutinate; hymenophore white to gray ..... *Cr. croceialbus*
5. Basidiospores usually more than 12 μm long 6
6. Basidiospores 12.8–14.5 × 9–11 μm; pileus brownish gray to grayish brown, smooth; hymenophore gray to brownish gray ..... *Cr. macrosporus*
6. Basidiospores 12–13.8 × 8.5–9.5 μm; pileus gray to dark brown, scabrous with darker brown raised scales; hymenophore orange-gray ..... *Cr. squamatus*
7. Growing in subalpine or temperate regions in China 8
7. Not growing in the above regions 11
8. Basidiomata light-colored, from yellow to light brown to light orange 9
8. Basidiomata brown, dark brown or dark gray 10
9. Pileus usually brownish orange to light brown, grayish yellow to pale yellow in some specimens, hymenophore yellowish white to yellow, poorly developed gill-like ridges; stipe pale yellow to light yellow, basidiospores 8–10.5 × 6.5–8 μm ..... *Cr. subalpinus*
9. Pileus grayish orange to brown; hymenophore light yellow to light orange, nearly smooth; stipe yellow to orange; basidiospores 9–11 × 6.5–9 μm ..... *Cr. lutescens*
10. Pileus brown to dark gray; hymenophore grayish white to pastel gray, nearly smooth; stipe brown to dark gray; basidiospores 8.5–10.5 × 5–6 μm ..... *Cr. sinensis*
10. Pileus grayish yellow to dark brown; hymenophore white to grayish white, nearly smooth or with ill-defined veins; stipe grayish yellow to brown; basidiospores 8–10.5 × 6–7.5 μm ..... *Cr. badiogriseus*
11. Hymenophore with well developed gill-like veins 12
11. Hymenophore smooth or wrinkled with very ill-defined veins 17
12. Basidiomata discolored when bruised 13
12. Basidiomata without colour change when bruised 14
13. Pileus grayish yellow to grayish brown; hymenphore yellowish white to reddish yellow, changing to reddish pink to blackish when bruised; basidiospores 8.5–10.5 × 7–8.5 μm .... *Cr. minor*
13. Pileus grayish brown to brownish orange; hymenophore orange white to pinkish white, changing to blackish when bruised; basidiospores 7–10 × 6–8 μm ..... *Cr. tengii*
14. Stipe with light yellow to grayish yellow tinge 15
14. Stipe without yellow tinge 16
15. Basidiomata medium-sized; pileus light yellow to brownish orange; hymenophore grayish yellow to grayish orange, changing to dull red, grayish red to gray when mature or old; stipe light yellow; basidiospores 8.5–10 × 7–9 μm ..... *Cr. sordidus*
15. Basidiomata small sized; pileus grayish yellow to olive brown; hymenophore yellowish white to pale gray; stipe pale yellow to grayish yellow; basidiospores 7.5–9 × 6–7 μm ..... *Cr. tropicus*
16. Pileus grayish brown to purplish gray; hymenophore grayish white to purple gray; basidiospores 7–8.5 × 4.5–6 μm ..... *Cr. atrobrunneolus*

16. Pileus greenish gray to brownish gray; hymenophore white to grayish white; basidiospores 7.5–10 × 6.5–7.5 μm ..... *Cr. aprilis*
17. Basidiomata with light yellow, yellowish white tinge 18
17. Basidiomata mainly with brown to gray tinge 19
18. Pileus white to cream white, non-perforate; hymenophore concolorous; stipe light yellow to orange yellow; basidiospores 8–10 × 7–8 μm ..... *Cr. albidus*
18. Pileus grayish yellow to grayish orange; hymenophore white; stipe pale yellow to pale orange; basidiospores 7–8.5 × 6–7 μm ..... *Cr. sublutescens*
19. Clamp connections present; pileus olive brown to brown; hymenophore white to pale gray; stipe olive brown; basidiospores 8.5–10.5 × 6–7.5 μm ..... *Cr. brunneus*
19. Clamp connections absent 20
20. Growing in tropical regions 21
20. Growing in subtropical regions 22
21. Pileus grayish brown; hymenophore white, tinged with violet; basidiospores 7–9 × 5–6.5 μm ..... *Cr. albimarginatus*
21. Pileus olive brown to reddish brown; hymenophore yellowish gray to light gray; basidiospores 7.5–10 × 7–8 μm ..... *Cr. viridifuscus*
22. Basidia usually less than 65 μm 23
22. Basidia 68–93 × 7–13 μm; pileus yellowish gray to brownish gray; hymenophore white to grayish white; basidiospores 9.5–11 × 7–8.5 μm ..... *Cr. parvogriseus*
23. Basidia 48–63 × 7–9 μm; pileus olive brown to brown usually with pale yellow to pale orange circle at margin; hymenophore pale gray to pastel gray; basidiospores 7–9 × 6–7 μm *Cr. guizhouensis*
23. Basidia 55–65 × 7–10 μm; pileus olive brown to brown; hymenophore white to pale gray; basidiospores 9–12 × 7–8.5 μm ..... *Cr. gypseus*

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