**MYCOSPHERE 16(1): 3500-3582 (2025)** www.mycosphere.org ISSN 2077 7019
https://doi.org/ 10.5943/mycosphere/16/1/26

ARTICLE

# Unexpected diversity of family Boletaceae (Boletales) from subtropical and tropical China with three new genera and eighteen new species

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**Citation** – Qin HZ, Jiang T, Zhao RX, Hu LG, Chen YL, Wang J, Lan RG, Chen XR, Mu XD, Cheng HT, Liang ZQ, Lin WF, Zeng NK 2025 – Unexpected diversity of family Boletaceae from subtropical and tropical China with three new genera and eighteen new species. Mycosphere 16(1): 3500–3582, https://doi.org/ 10.5943/mycosphere/16/1/26

## Abstract

The family Boletaceae (Boletales) comprises ecologically and economically vital macrofungi with a global distribution in forest ecosystems. Although China is recognized as a biodiversity hotspot for Boletaceae due to its floristic and topographic complexity, its taxonomy remains incompletely understood with numerous new taxa awaiting discovery. Morphological examinations and multi-locus phylogenetic analysis (28S, *TEF*1, *RPB*1, and *RPB*2) were integrated using specimens collected from subtropical and tropical China. Studies have demonstrated that three novel genera (*Boletellopsis*, *Chenrenyua*, *Sudongpoa*) were established to accommodate four newly identified species (*C. longispora*, *C. verrucosa*, *S. rubicarpos*, *S. rubripes*) and one previously described taxon (*B. elata*). Twenty-two additional taxa were described, comprising fourteen new species in the genera *Aureoboletus* and *Hemileccinum*, viz. *A. applanatus*, *A. atrotomentosus*, *A. canceriformis*, *A. exiguisquamatus*, *A. hainanensis*, *A. macrocarpus*, *A. magniporus*, *A. pallidorubellus*, *A. phaeosquamus*, *A. urceopileus*, *H. brunneoalbum*, *H. dilutibrunneum*, *H. lutosum*, and *H. verrucatum*. Taxonomic clarifications resolved the *A. solus* complex into five species; confirmed the phylogenetic distinctness of *A. pallidorubellus* from *A. rubellus*; and synonymized *A. pseudorussellii* with *A. wusangongii* and *H. squamipes* with *H. parvum*. These findings significantly advance Boletaceae systematics, revealing substantial undocumented diversity in China and providing critical data for fungal conservation and sustainable resource utilization. Keys to accepted species of *Aureoboletus* and *Hemileccinum* in China were also provided.

**Keywords** – bolete – molecular phylogeny – morphology – new taxa – taxonomy

## INTRODUCTION

**Submitted:** 24 October 2025; **Accepted:** 12 December 2025; **Published:** 22 December 2025
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Accepted by: Eric McKenzie

The family Boletaceae Chevall. (Boletales, Agaricomycetes) is an ecologically and economically important macrofungal group, with a global distribution across diverse forest ecosystems (Henkel et al. 2016, Wu et al. 2016, 2023, Farid et al. 2021, Li & Yang 2021, Magnago et al. 2022, Ayala-Vásquez et al. 2023b, Mao et al. 2023, Xue et al. 2023, Tremble et al. 2024). Most boletes play pivotal roles in maintaining forest ecosystem stability and biodiversity conservation by forming ectomycorrhizae with dominant woody plants, including Fagaceae, Pinaceae, Myrtaceae, and Dipterocarpaceae (Husbands et al. 2013, Wu et al. 2014, 2016, 2022b, Tedersoo et al. 2020, Ayala-Vásquez et al. 2023b, Wang et al. 2023, Qin et al. 2024a). Furthermore, numerous Boletaceae species have long been valued in human societies as sources of food and medicine (Feng et al. 2012, Wu et al. 2014, Dimitrijević et al. 2017, Wu et al. 2019, Ayala-Vásquez et al. 2023b, Xue et al. 2023, 2024). Given these multifaceted values, taxonomic research on Boletaceae is essential for effective conservation planning and sustainable resource management (Sandall et al. 2023, Zhou & May 2023, Liu et al. 2024).

Recent advances in molecular phylogenetics combined with morphological assessments have provided robust approaches for resolving taxonomic complexities within the diverse family Boletaceae (Binder & Hibbett 2006, Nuhn et al. 2013, Zeng et al. 2013, Wu et al. 2014, Wu et al. 2023, Xue et al. 2023, Tremble et al. 2024, Qin et al. 2024a). Notably, phylogenomic analyses utilizing whole-genome sequencing data have facilitated taxonomic revision of Boletaceae, dividing it into the following subfamilies: Boletoideae Singer, Xerocomoideae Singer, Austroboletoideae G. Wu & Zhu L. Yang, Chalciporoideae G. Wu & Zhu L. Yang, Leccinoideae G. Wu & Zhu L. Yang, Zangioideae G. Wu et al., Phylloboletelloideae Dentinger et al., and Suillelloideae Dentinger et al. (Tremble et al. 2024). Globally, nearly 100 genera and 1200 species have been documented in Boletaceae, demonstrating remarkable species diversity (Zeng et al. 2013, Wu et al. 2023, Xue et al. 2023, Qin et al. 2024a).

China has witnessed a surge in Boletaceae research, with molecular phylogenetic evidence confirming approximately 57 genera and 400 species within its borders (Shi & Liu 2013, Zeng et al. 2013, 2016, Wu et al. 2014, 2015, 2016, Zhao et al. 2014b, Wu et al. 2021, Zhu et al. 2015, Li & Yang 2021, Zhang et al. 2022, Mao et al. 2023, Xue et al. 2023, 2024, Zhou et al. 2023, Qin et al. 2024a, Wang et al. 2024, Wang et al. 2025). It is now unequivocal that China constitutes a global biodiversity hotspot for Boletaceae. This biodiversity prominence arises from China's floristic richness, complex topographic configurations, and climatic variability (Zang et al. 2001, Yang et al. 2005, Sun et al. 2017, Mao et al. 2023, Wu et al. 2023, Xue et al. 2024). The synergistic interactions of these environmental factors enhance both the species diversity and endemism of Boletaceae fungi, particularly evident in subtropical and tropical regions (Chai et al. 2019, Wang et al. 2020, Xu et al. 2021, Deng et al. 2023, Wu et al. 2023, Xue et al. 2023, 2024, Zhou et al. 2023, Qin et al. 2024a, b).

Nevertheless, the taxonomic understanding of Boletaceae, particularly in the species-rich subtropical and tropical forests of China, remains incomplete. Ongoing discoveries of undocumented species and persistent ambiguities in phylogenetic relationships continue to impede the establishment of a robust and coherent classification system. To address this critical gap, we conducted an extensive study integrating field collections with morphological observations and multi-locus phylogenetic analyses, based on the 28S, *TEF*1, *RPB*1, and *RPB*2 gene regions. The objectives of this study were threefold: (1) to propose three new genera accommodating four new species and one new combination; (2) to describe or redescribe a total of twenty-two taxa, including 14 new species; and (3) to provide a clarified taxonomic foundation that will support the further development of a systematic framework for Boletaceae.

## MATERIALS AND METHODS

### Morphological studies

Research materials in this study were collected from tropical and subtropical China. Fresh specimens underwent 12 hours dehydration in a constant-temperature drying oven at 50–60 °C before

permanent deposition at the Hainan Biodiversity Science and Technology Museum (FHMU, China). Macroscopic characteristics were documented from freshly collected basidiomata, and color codes followed Kornerup & Wanscher (1981). Observations and color descriptions of the microstructure were performed in 5% KOH using an Olympus CX23 light microscope; 1% Congo Red stain was supplemented when required (Zeng et al. 2015, Zhang et al. 2022). All microstructures were drawn freehand. Pileipellis sections were excised from the medial zone (center-margin interface) of the pileus, while stipitipellis sections were sampled from the axial midsection of the stipe. A Zeiss Sigma 300 scanning electron microscope (SEM) was utilized for imaging the basidiospores. In the morphological descriptions "n" stands for the total number of basidiospores measured from "m" basidiomata of "p" collections, the number of measured basidiospores is expressed as n/m/p. Size ranges are expressed as (a–) b–e–c (–d), with "a" and "d" representing extremes, "e" the arithmetic mean, and "b–c" encompassing 90% of measurements (5th–95th percentiles). The Q value represents the length-to-width ratio of basidiospores, with Qm indicating mean Q with standard deviation. Statistical processing was executed using SPSS Statistics v17.0 (Xie et al. 2022).

**Molecular procedures**

Genomic DNA was isolated from dried collections using the Magnetic Beads Genomic DNA Extraction Kit (Magen, Guangzhou, China) in line with the manufacturer's guidelines. Amplification of the following gene regions was performed with the specified primer pairs: the nuclear ribosomal large subunit (28S) with LR0R/LR5 (Vilgalys & Hester 1990, James et al. 2006), the translation elongation factor 1-α (*TEF*1) with EF1-2F/EF1-2R (Zeng et al. 2013), the RNA polymerase II largest subunit (*RPB*1) with RPB1-B-F/RPB1-B-R (Wu et al. 2014), and the RNA polymerase II second largest subunit (*RPB*2) with bRPB2-6F/bRPB2-7.1R (Matheny 2005).

The PCR procedures adhered to the protocol of Zhang et al. (2022). Amplicons were separated by 1% (w/v) agarose gel electrophoresis. Products yielding a single sharp band were purified and subjected to direct sequencing on an ABI 3730xl DNA Analyzer (BGI, Guangzhou, China) using the original PCR primers. Assembly of all newly generated sequences was conducted in BioEdit v7.0.9 (Hall 1999), with subsequent deposition in GenBank (accession numbers provided in Table 1).

**Table 1** List of species, voucher specimens, collection localities, and GenBank ID for the novel sequences in this work.

| Species | Voucher specimen | Locality | GenBank ID | | | |
|---|---|---|---|---|---|---|
| | | | 28S | *TEF*1 | *RPB*1 | *RPB*2 |
| *Aureoboletus applanatus* | N.K. Zeng7601 (FHMU9189) * | China | PQ962519 | PQ963929 | — | — |
| *A. atrotomentosus* | N.K. Zeng1807 (FHMU1145) * | China | PV469788 | — | — | PV470485 |
| *A. canceriformis* | N.K. Zeng7904 (FHMU9190) * | China | PQ962520 | PQ963872 | — | PV014760 |
| *A. canceriformis* | N.K. Zeng7904-1 (FHMU9191) | China | PQ962521 | PQ963873 | — | PV014761 |
| *A. conicus* | N.K. Zeng7962 (FHMU9192) | China | PQ962522 | PQ963874 | — | PV014762 |
| *A. conicus* | N.K. Zeng7964 (FHMU9193) | China | PQ962523 | PQ963875 | — | PV014763 |
| *A. conicus* | N.K. Zeng7975 (FHMU9194) | China | PQ962524 | PQ963876 | — | PV014764 |
| *A. conicus* | N.K. Zeng7980 (FHMU9195) | China | PQ962525 | PQ963877 | — | PV014765 |
| *A. conicus* | N.K. Zeng7982 (FHMU9196) | China | PQ962526 | PQ963878 | — | PV014766 |
| *A. conicus* | N.K. Zeng8012 (FHMU9197) | China | PQ962527 | PQ963879 | — | PV014767 |

**Table 1** Continued

| Species | Voucher specimen | Locality | GenBank ID | | | |
|---|---|---|---|---|---|---|
| | | | 28S | *TEF*1 | *RPB*1 | *RPB*2 |
| *A. duplicatoporus* | N.K. Zeng7809 (FHMU9199) | China | PQ962529 | PQ963881 | — | — |
| *A. duplicatoporus* | N.K. Zeng8180 (FHMU9200) | China | PQ962530 | — | — | — |
| *A. exiguisquamatus* | N.K. Zeng7910 (FHMU9198) * | China | PQ962528 | PQ963880 | — | PV014768 |
| *A. formosus* | N.K. Zeng7669 (FHMU9201) | China | PQ962531 | PQ963882 | — | PV014769 |
| *A. formosus* | N.K. Zeng7691 (FHMU9202) | China | PQ962532 | PQ963883 | — | PV014770 |
| *A. formosus* | N.K. Zeng7706 (FHMU9203) | China | PQ962533 | PQ963884 | — | PV014771 |
| *A. glutinosus* | gui0008 (FHMU9204) | China | PQ962534 | PQ963885 | — | PV014772 |
| *A. hainanensis* | N.K. Zeng4954 (FHMU5542) * | China | PV469787 | PV470484 | — | — |
| *A. longicollis* | N.K. Zeng7788 (FHMU9205) | China | PQ962535 | PQ963886 | — | PV014773 |
| *A. longicollis* | N.K. Zeng7969 (FHMU9206) | China | PQ962536 | PQ963887 | — | PV014774 |
| *A. macrocarpus* | N.K. Zeng7893 (FHMU9207) | China | PQ962537 | PQ963888 | — | PV014775 |
| *A. macrocarpus* | N.K. Zeng7894 (FHMU9208) | China | PQ962538 | PQ963889 | — | PV014776 |
| *A. macrocarpus* | N.K. Zeng7895 (FHMU9209) | China | PQ962539 | PQ963890 | — | PV014777 |
| *A. macrocarpus* | N.K. Zeng7896 (FHMU9210) | China | PQ962540 | PQ963891 | — | PV014778 |
| *A. macrocarpus* | N.K. Zeng7989 (FHMU9211) * | China | PQ962541 | PQ963892 | — | PV014779 |
| *A. macrocarpus* | N.K. Zeng8002 (FHMU9212) | China | PQ962542 | PQ963893 | — | PV014780 |
| *A. macrocarpus* | N.K. Zeng8014 (FHMU9213) | China | PQ962543 | PQ963894 | — | PV014781 |
| *A. magniporus* | N.K. Zeng8212 (FHMU9214) * | China | PQ962544 | PQ963895 | — | PV014782 |
| *A. magniporus* | N.K. Zeng8214 (FHMU9215) | China | PQ962545 | PQ963896 | — | PV014783 |
| *A. miniatoaurantiacus* | N.K. Zeng7838 (FHMU9216) | China | PQ962546 | PQ963897 | — | PV014784 |
| *A. miniatoaurantiacus* | N.K. Zeng8193 (FHMU9217) | China | PQ962547 | — | — | — |
| *A. nanlingensis* | N.K. Zeng8293 (FHMU9218) | China | PQ962548 | PQ963898 | — | — |
| *A. ornatipes* | N.K. Zeng7860 (FHMU9219) | China | PQ962549 | PQ963899 | — | — |
| *A. ornatipes* | N.K. Zeng7860-1 (FHMU9220) | China | PQ962550 | PQ963900 | — | — |
| *A. ornatipes* | N.K. Zeng7913 (FHMU9221) | China | PQ962551 | PQ963901 | — | PV014785 |
| *A. pallidorubellus* | N.K. Zeng7869 (FHMU9222) * | China | PQ962552 | PQ963902 | — | PV014786 |
| *A. phaeosquamus* | N.K. Zeng7915 (FHMU9227) | China | PQ962557 | PQ963907 | — | PV014791 |
| *A. phaeosquamus* | N.K. Zeng7920 (FHMU9228) * | China | PQ962558 | PQ963908 | — | PV014792 |

**Table 1** Continued

| Species | Voucher specimen | Locality | GenBank ID | | | |
|---|---|---|---|---|---|---|
| | | | 28S | *TEF*1 | *RPB*1 | *RPB*2 |
| *A. raphanaceus* | N.K. Zeng7806 (FHMU9229) | China | PQ962559 | PQ963909 | — | PV014793 |
| *A. raphanaceus* | N.K. Zeng7924 (FHMU9230) | China | PQ962560 | PQ963910 | — | PV014794 |
| *A. raphanaceus* | N.K. Zeng7944 (FHMU9231) | China | PQ962561 | PQ963911 | — | — |
| *A. raphanaceus* | N.K. Zeng7949 (FHMU9232) | China | PQ962562 | PQ963912 | — | PV014795 |
| *A. raphanaceus* | N.K. Zeng8123 (FHMU9233) | China | PQ962563 | — | — | — |
| *A. raphanaceus* | N.K. Zeng8145 (FHMU9234) | China | PQ962564 | — | — | — |
| *A. raphanaceus* | N.K. Zeng8171 (FHMU9235) | China | PQ962565 | — | — | — |
| *A. raphanaceus* | N.K. Zeng8201 (FHMU9236) | China | PQ962566 | — | — | — |
| *A. raphanaceus* | N.K. Zeng8220 (FHMU9237) | China | PQ962567 | — | — | — |
| *A. raphanaceus* | N.K. Zeng8291 (FHMU9238) | China | PQ962568 | — | — | — |
| *A. sinobadius* | N.K. Zeng7783 (FHMU9239) | China | PQ962569 | PQ963913 | — | — |
| *A. sinobadius* | N.K. Zeng7796 (FHMU9240) | China | PQ962570 | PQ963914 | — | PV014796 |
| *A. sinobadius* | N.K. Zeng7825 (FHMU9241) | China | PQ962571 | PQ963915 | — | — |
| *A. sinobadius* | N.K. Zeng7985 (FHMU9242) | China | PQ962572 | PQ963916 | — | PV014797 |
| *A. sinobadius* | N.K. Zeng7987 (FHMU9243) | China | PQ962573 | PQ963917 | — | PV014798 |
| *A. sinobadius* | N.K. Zeng8001 (FHMU9244) | China | PQ962574 | PQ963918 | — | — |
| *A. sinobadius* | N.K. Zeng8017 (FHMU9245) | China | PQ962575 | — | — | — |
| *A. sinobadius* | N.K. Zeng8034 (FHMU9246) | China | PQ962576 | PQ963919 | — | PV014799 |
| *A. sinocyanescens* | N.K. Zeng7801 (FHMU9223) | China | PQ962553 | PQ963903 | — | PV014787 |
| *A. sinocyanescens* | N.K. Zeng7835 (FHMU9224) | China | PQ962554 | PQ963904 | — | PV014788 |
| *A. sinocyanescens* | N.K. Zeng7919 (FHMU9225) | China | PQ962555 | PQ963905 | — | PV014789 |
| *A. sinocyanescens* | N.K. Zeng8208 (FHMU9226) | China | PQ962556 | PQ963906 | — | PV014790 |
| *A. tenuis* | N.K. Zeng7663 (FHMU9247) | China | PQ962577 | — | — | — |
| *A. tenuis* | N.K. Zeng7798 (FHMU9248) | China | PQ962578 | PQ963920 | — | PV014800 |
| *A. tenuis* | N.K. Zeng7879 (FHMU9249) | China | PQ962579 | PQ963921 | — | PV014801 |
| *A. tenuis* | N.K. Zeng7882 (FHMU9250) | China | PQ962580 | PQ963922 | — | PV014802 |
| *A. tenuis* | N.K. Zeng8030 (FHMU9251) | China | PQ962581 | PQ963923 | — | PV014803 |

**Table 1** Continued

| Species | Voucher specimen | Locality | GenBank ID | | | |
|---|---|---|---|---|---|---|
| | | | 28S | *TEF*1 | *RPB*1 | *RPB*2 |
| *A. urceopileus* | N.K. Zeng7961 (FHMU9252) * | China | PQ962582 | PQ963924 | — | PV014804 |
| *A. urceopileus* | N.K. Zeng7961-1 (FHMU9253) | China | PQ962583 | PQ963925 | — | PV014805 |
| *A. velutipes* | N.K. Zeng8182 (FHMU9254) | China | PQ962584 | PQ963926 | — | PV014806 |
| *A. yunnanensis* | gui0001 (FHMU9255) | China | PQ962585 | PQ963927 | — | PV014807 |
| *A. yunnanensis* | N.K. Zeng7939 (FHMU9256) | China | PQ962586 | PQ963928 | — | PV014808 |
| *Boletellopsis elata* | Huligui1 (FHMU10550) | China | PV938578 | PV945441 | PV955745 | PV945456 |
| *B. elata* | Huligui2 (FHMU10551) | China | PV938579 | PV945442 | PV955746 | PV945457 |
| *B. elata* | Huligui3 (FHMU10552) | China | PV938580 | PV945443 | PV955747 | PV945458 |
| *Chenrenyua longispora* | Huligui0029 (FHMU8446) * | China | PV938583 | PV945447 | PV955755 | — |
| *C. longispora* | Zeng10314 (FHMU7986) | China | PV938584 | PV945448 | PV955756 | — |
| *C. verrucosa* | N.K. Zeng10144 (FHMU8452) * | China | PV938581 | PV945444 | PV955748 | PV945459 |
| *C. verrucosa* | N.K. Zeng10144-1 (FHMU10545) | China | — | — | PV955749 | PV945460 |
| *C. verrucosa* | N.K. Zeng10144-2 (FHMU10546) | China | — | PV945445 | PV955750 | PV945461 |
| *C. verrucosa* | N.K. Zeng10144-3 (FHMU10547) | China | PV938582 | PV945446 | PV955751 | PV945462 |
| *Hemileccinum albidum* | N.K. Zeng10341 (FHMU7995) | China | — | — | — | PX123130 |
| *H. brevisporum* | N.K. Zeng10350 (FHMU8601) | China | PX057185 | PX123115 | PX123106 | PX123131 |
| *H. brevisporum* | N.K. Zeng10353 (FHMU8395) | China | PX057186 | PX123116 | PX123107 | PX123132 |
| *H. brunneoalbum* | JT-48 (FHMU8319) * | China | PX057187 | PX123117 | PX123108 | PX123133 |
| *H. brunneoalbum* | JT-48-3 (FHMU10540) | China | — | PX123118 | — | PX123134 |
| *H. dilutibrunneum* | JT-43 (FHMU8853) * | China | PX057190 | PX123120 | PX123111 | PX123137 |
| *H. dilutibrunneum* | JT-43-1 (FHMU10541) | China | PX057191 | PX123121 | — | PX123138 |
| *H. dilutibrunneum* | JT-43-2 (FHMU10542) | China | PX057192 | PX123122 | PX123112 | PX123139 |
| *H. dilutibrunneum* | JT-43-3 (FHMU10543) | China | PX057193 | PX123123 | PX123113 | PX123140 |
| *H. ferrugineipes* | Huligui0053-1 (FHMU9184) | China | PX057188 | PX123119 | PX123109 | PX123135 |
| *H. ferrugineipes* | Huligui0053-2 (FHMU10544) | China | PX057189 | — | PX123110 | PX123136 |
| *H. lutosum* | N.K. Zeng7620 (FHMU8142) * | China | PX057194 | PX123124 | — | PX123141 |
| *H. lutosum* | N.K. Zeng7620-1 (FHMU11636) | China | — | PX123125 | — | — |
| *H. parvum* | N.K. Zeng7984 (FHMU7728) | China | PX057196 | PX123128 | — | — |
| *H. parvum* | N.K. Zeng8003 (FHMU7727) | China | PX057197 | PX123129 | — | — |
| *H. verrucatum* | N.K. Zeng7731 (FHMU10025) * | China | PX057195 | PX123126 | PX123114 | PX123142 |
| *H. verrucatum* | N.K. Zeng7731-1 (FHMU11637) | China | — | PX123127 | — | PX123143 |
| *Sudongpoa rubicarpos* | N.K. Zeng10297 (FHMU9171) * | China | PV938585 | PV945449 | PV955752 | PV945463 |

**Table 1** Continued

| Species | Voucher specimen | Locality | GenBank ID | | | |
|---|---|---|---|---|---|---|
| | | | 28S | *TEF*1 | *RPB*1 | *RPB*2 |
| *S. rubicarpos* | N.K. Zeng10297-1 (FHMU10548) | China | PV938586 | PV945450 | PV955753 | PV945464 |
| *S. rubicarpos* | N.K. Zeng10297-3 (FHMU10549) | China | PV938587 | PV945451 | PV955754 | PV945465 |
| *S. rubripes* | N.K. Zeng7834 (FHMU9661) | China | PV938589 | PV945453 | — | PV945466 |
| *S. rubripes* | N.K. Zeng10181 (FHMU8529) | China | PV938590 | PV945454 | — | PV945467 |
| *S. rubripes* | N.K. Zeng10185 (FHMU8771) * | China | PV938588 | PV945452 | — | — |

Holotype specimens are denoted by asterisks (*).

**Dataset assembly**

For this study, we constructed three separate multilocus phylogenetic datasets. The Boletaceae dataset included 51 new sequences (28S: 13, *TEF*1: 14, *RPB*1: 12, *RPB*2: 12) from 15 specimens representing three new genera, combined with reference sequences from literature and GenBank (Supplementary Table 1). Following Qin et al. (2024a), *Phlebopus portentosus* (Berk. & Broome) Boedijn and *Boletinellus merulioides* (Schwein). Murrill were designated as the outgroup. The *Aureoboletus* dataset comprised 179 new sequences (28S: 70, *TEF*1: 59, *RPB*2: 50) from 70 specimens, alongside published sequences (Supplementary Table 1), with *Phylloporus imbricatus* N.K. Zeng et al., *Xerocomus* aff. *subtomentosus* (L.) Quél., and *Xerocomus* sp. (N.K. Zeng3180) as outgroups according to Xue et al. (2023) and Qin et al. (2024b). The *Hemileccinum* dataset contained 51 new sequences (28S: 13, *TEF*1: 15, *RPB*1: 9, *RPB*2: 14) from 17 specimens and published sequences (Supplementary Table 1), using *Aureoboletus erythraeus* N.K. Zeng et al. as the outgroup following Wang et al. (2020) and Zhao et al. (2025). All new sequence data are summarized in Table 1.

To evaluate phylogenetic incongruence in the combined dataset, phylogenetic trees were analyzed using the maximum likelihood method to identify any conflicting topologies among the employed genes. The results indicated no conflict among the different gene fragments. Subsequent sequence alignment of all datasets was performed using MUSCLE v3.6 (Edgar 2004), and manually adjusted in BioEdit v7.0.9 (Hall 1999) where required. Concatenation of gene fragments for further analyses was conducted using SequenceMatrix v1.7.8 (Xue et al. 2024).

**Phylogenetic analysis**

In the phylogenetic analyses using multi-gene datasets, both maximum likelihood (ML) and Bayesian inference (BI) approaches were employed. RAxML v7.2.6 was used to perform ML tree generation and bootstrap analyses, incorporating 1000 bootstrap replicates combined with ML search procedures (Stamatakis 2006). BI was executed using MrBayes v3.2.7 via the CIPRES Science Gateway Portal (Huelsenbeck & Ronquist 2005, Miller 2010), with parameters and best-fit substitutional models determined a priori through MrModeltest v2.3 (Nylander 2004). The Boletaceae combined dataset exhibited GTR + I + G, GTR + I + G, HKY + I + G, and SYM + I + G as the best-fit likelihood models for the 28S, *TEF*1, *RPB*1, and *RPB*2 genes, respectively; the *Aureoboletus* combined dataset exhibited GTR + I + G, HKY + I + G, and SYM + I + G as the best-fit likelihood models for the 28S, *TEF*1, and *RPB*2 genes, respectively; the *Hemileccinum* combined dataset exhibited GTR + I + G, SYM + G, HKY + G, and K80 + I as the best-fit likelihood models for the 28S, *TEF*1, *RPB*1, and *RPB*2 genes, respectively. BI analyses were performed on the three combined nuclear datasets for 45, 30, and 30 million generations, respectively, with a sampling frequency of every 100 generations. The initial 25% of sampled trees were discarded as burn-in, and a majority-rule consensus tree was constructed from the remaining trees to calculate Bayesian

posterior probabilities (PP). A given run was halted only when the average standard deviation of split frequencies dropped below the threshold of 0.01.

## RESULTS

### Molecular data

Phylogenetic analyses were conducted on three concatenated datasets, with the alignments deposited in TreeBASE under submission numbers S32353 (Boletaceae), S32247 (*Aureoboletus*), and S32274 (*Hemileccinum*). The Boletaceae dataset (28S + *TEF*1 + *RPB*1 + *RPB*2), comprising 190 sequences and 3232 nucleotide sites, revealed that our new collections formed three distinct generic-level clades. The *Aureoboletus* dataset (28S + *TEF*1 + *RPB*2), with 247 sequences and 2174 sites, resolved the studied specimens into 16 species-level lineages. The *Hemileccinum* dataset (28S + *TEF*1 + *RPB*1 + *RPB*2), containing 71 sequences and 2497 sites, identified six species-level lineages. The tree topologies inferred from maximum likelihood (ML) and Bayesian inference (BI) were highly similar across all datasets, with only minor differences in statistical support (BS/PP) observed for some branches. The resulting phylograms, showing RAxML branch lengths and support values, are presented in Figs 1–3.

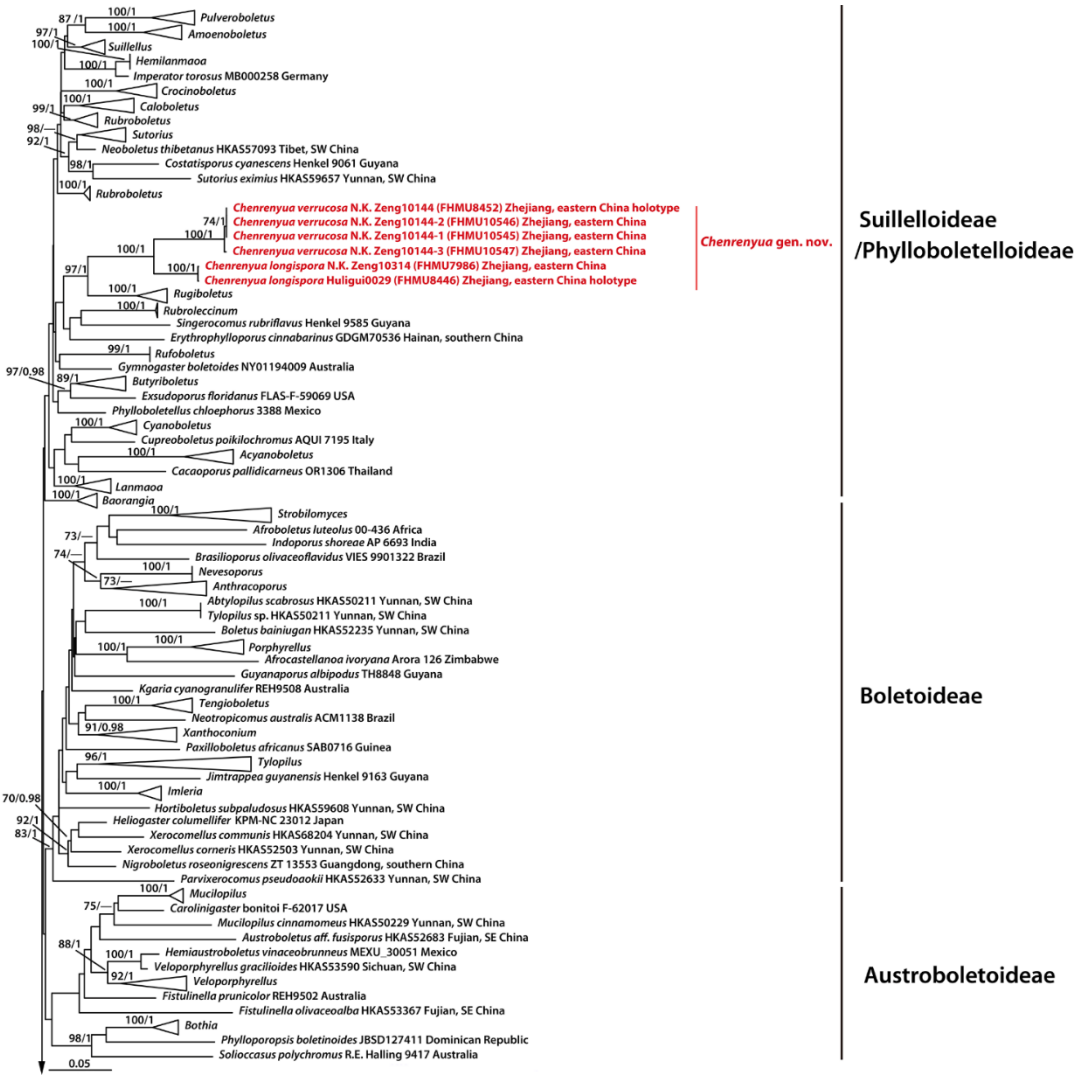


**Figure 1** – RAxML phylogram of Boletaceae based on 28S, *TEF*1, *RPB*1, and *RPB*2. Branch supports (BS ≥ 70%, PP ≥ 0.95) are shown. New sequences in color; SE represent southeastern, and SW represent southwestern.

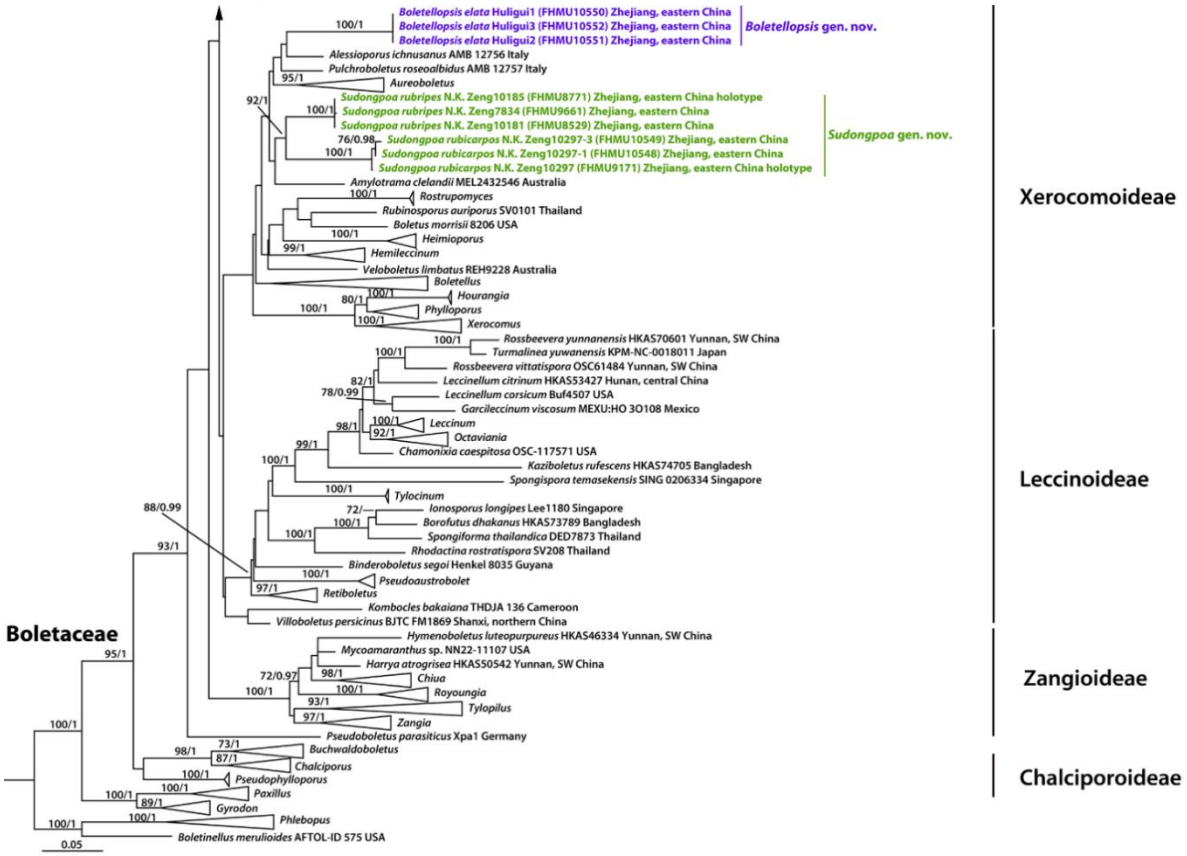


**Figure 1** – Continued.

**Taxonomy**

***Aureoboletus*** Pouzar, Česká Mykol. 11: 48, 1957.

MycoBank: MB 17129; Facesoffungi: FoF 19063

***Aureoboletus applanatus*** N.K. Zeng, H.Z. Qin & Zhi Q. Liang, sp. nov. Figs 4a–b, 7

MycoBank: MB 860289; Facesoffungi: FoF 19067

Etymology – Latin "*applanatus*" signifies the applanate pileus.

Diagnosis – This species can be diagnosed by a relatively small basidiocarp, a yellowish-brown, applanate and slightly sticky pileus, and a cutis-type pileipellis, which distinguish it from the closest *Aureoboletus* species.

Basidiomata ranging from very small to small in size. Pileus 2.1–3.7 cm across, initially convex to plano-convex, expanding to applanate with age; surface yellowish-brown (5A4–6), tomentose, slightly sticky when wet; margin decurved, entire; context at center 0.2–0.3 cm thick, pale yellowish-brown (4A4), no color change upon injury. Hymenophore poroid, adnate; pores angular to subcircular, pale yellow (1A4–5), no color change upon injury; tubes 0.2–0.3 cm deep, pale yellow (1A5), no color change upon injury. Stipe 2.4–2.8 × 0.4–0.8 cm, mid-positioned, subcylindric, consolidated, becoming hollow when old; surface whitish (3A1) tinged with pale brown (3B5–6), smooth, slightly sticky when wet; context white (2A1), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [60/3/2] 9–9.89–11 × 4–4.9–5 (–5.5) µm, Q = 1.8–2.2 (–2.25), Qm = 2.02 ± 0.11, smooth, elongate to cylindric, wall thickness 0.5–0.8 µm, yellowish-brown. Basidia 26–37 × 9–13 µm, 4-spored, subclavate to clavate, wall thickness approximately 0.5 µm, yellowish to achromatic; sterigmata 2–5 µm. Cheilocystidia 35–72 × 10–16 µm, subfusiform, numerous, wall thickness approximately 0.5 µm, achromatic, without incrustations. Pleurocystidia 40–70 × 13–17 µm, subfusiform, numerous, wall thickness approximately 0.5 µm, achromatic, without incrustations. Hymenophoral trama consists of hyphae 4–16 µm wide, wall thickness approximately 1 µm,

achromatic. Pileipellis a cutis-type, 200–350 μm thick, consists of hyphae 3–16 μm wide, wall thickness 0.5–1 μm, yellowish to achromatic, with cylindric apical cells 37–67 × 6–11 μm. Pileal trama consists of wall thickness 0.5–1 μm, 3–20 μm wide hyphae, achromatic. Stipitipellis 175–480 μm thick, consists of hyphae 3–12 μm wide, wall thickness 0.5–0.8 μm, achromatic, with subcylindric to cylindric apical cells 33–72 × 3–8 μm. Stipe trama consists of hyphae 4–18 μm wide, wall thickness 0.5–1 μm, yellow. Clamp connections not observed in any tissue.

Known distribution – Hainan Province of China.

Materials examined – China, Hainan Province, Ledong Li Autonomous County, Jianfengling of Hainan Tropical Rainforest National Park, 850 m elev., on soil in Fagaceae-dominated forests, solitary, 5 July 2012, N.K. Zeng1064 (FHMU715); Qiongzhong Li and Miao Autonomous County, Limushan of Hainan Tropical Rainforest National Park, 650 m elev., on soil in Fagaceae-dominated forests, scattered, 14 July 2023, N.K. Zeng7601 (FHMU9189, holotype).

Notes – *Aureoboletus applanatus* shares morphological similarities with Chinese *A. duplicatoporus* (M. Zang) G. Wu & Zhu L. Yang, *A. guangdongensis* N.K. Zeng et al., and *A. nanlingensis* Ming Zhang et al. However, *A. duplicatoporus*, with type locality in Yunnan, has a glabrous, reddish-brown and larger pileus, a sunflower yellow hymenophore, a longer and reddish-orange stipe, subfusiform and longer basidiospores 8–14 × 4–6 μm, pleuro- and cheilocystidia coated with a thin layer (< 1 μm) of material, and an ixotrichoderm-type pileipellis (Zang 1992, Wu etal. 2016); *A. guangdongensis*, with type locality in Guangdong, has a reddish-violet to reddish-brown pileus, a longer and pastel reddish-violet stipe, and smaller pleuro- and cheilocystidia (Zhang et al. 2022); *A. nanlingensis*, with type locality in Guangdong, has a grayish-yellow to brownish-orange pileus, a longer and pale yellow stipe, and ellipsoidal to broadly ellipsoidal and relatively smaller basidiospores 7–8.5 × 4.5–5 μm (Liu et al. 2024).

In China, *A. applanatus* was incorrectly identified as *A. solus* Ming Zhang & T.H. Li, a species with type locality in Guangdong of China (Xue et al. 2023); however, the latter species possesses a brownish-yellow to brownish-red pileus, a pale orange to pale red stipe, and a trichoderm-type pileipellis (Zhang et al. 2019). Phylogenetically, *A. applanatus* exhibits close affinity with *A. canceriformis*, *A. exiguisquamatus*, *A. magniporus*, and *A. solus* (Fig. 2). However, *A. canceriformis* has a greyish-yellow stipe and relatively larger basidiospores 9–12.5 × 4–6 μm (see below); *A. exiguisquamatus* has a stipe adorned with small and pale brown squamules when mature and a pileipellis ranging from an intricate trichoderm to a subcutis (see below); *A. magniporus* has a pale reddish-brown to reddish-brown pileus and relatively larger and sparser pores (see below); the morphological differences between *A. solus* and *A. applanatus* have been discussed above.

***Aureoboletus atrotomentosus*** N.K. Zeng, H.Z. Qin & Zhi Q. Liang, sp. nov. Figs 4c–d, 8

MycoBank: MB 860290; Facesoffungi: FoF 19068

Etymology – Latin "*atrotomentosus*" signifies the black and floccose to tomentose squamules covering the pileus.

Diagnosis – This species can be diagnosed by a pinkish-purple pileus, surface densely adorned with black and floccose to tomentose squamules, a hymenophore turning pale reddish-brown upon injury, cystidia coated with a layer of achromatic material, and a cutis-type pileipellis, which distinguish it from the closest *Aureoboletus* species.

Basidiomata small in size. Pileus 3–4.6 cm across, plano-convex to applanate; surface pinkish-purple (11B2–3) to flesh pink (10A2–3), pale green (26B4) in the center, and densely adorned with black (14F1), violet-black (15F1–2) to pale pink (13A2–B2), and floccose to tomentose squamules, dry; margin decurved when young, becoming uplift in age, entire; context at center 0.8–1 cm thick, white (1A1) to yellowish-white (3A2), no color change upon injury. Hymenophore poroid, adnate; pores angular, light yellow (1A7) to pale yellowish-green (30A3–5), changing pale reddish-brown (7C2–3) upon injury; tubes 0.2–0.3 cm deep, pale yellow (1A6–7), changing pale reddish-brown (7C2–3) upon injury. Stipe 3–3.5 × 0.4–1 cm, mid-positioned, subcylindric, consolidated; surface pale bluish-green (25B5–6), pale yellow (2B6) near the pileus, adorned with violet-black (15F2),

scattered and floccose squamules, dry; context white (1A1), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

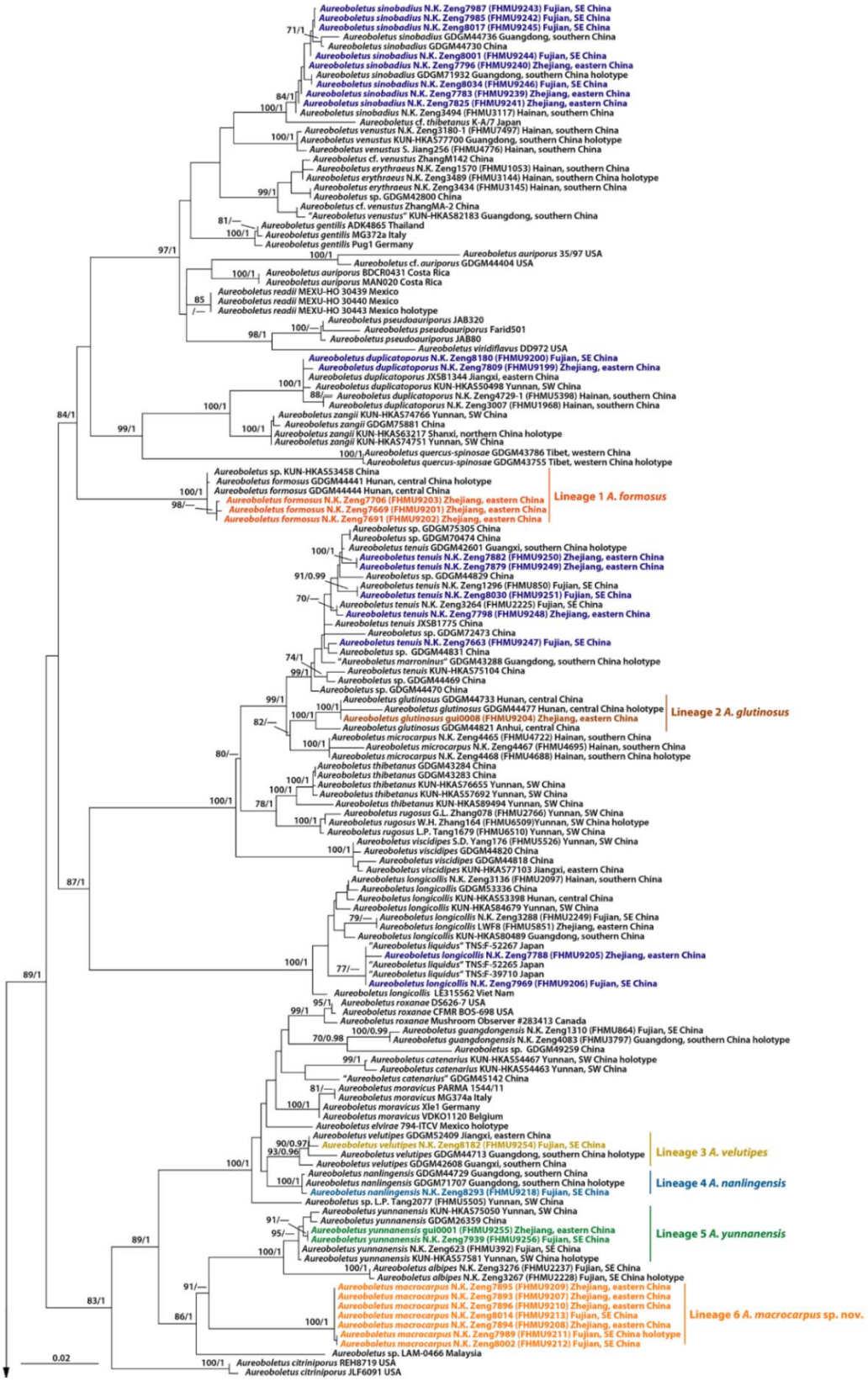


**Figure 2** – RAxML phylogram of *Aureoboletus* based on 28S, *TEF*1 and *RPB*2. Branch supports (BS ≥ 70%, PP ≥ 0.95) are shown. New sequences in color; SE represent southeastern, SW represent southwestern.

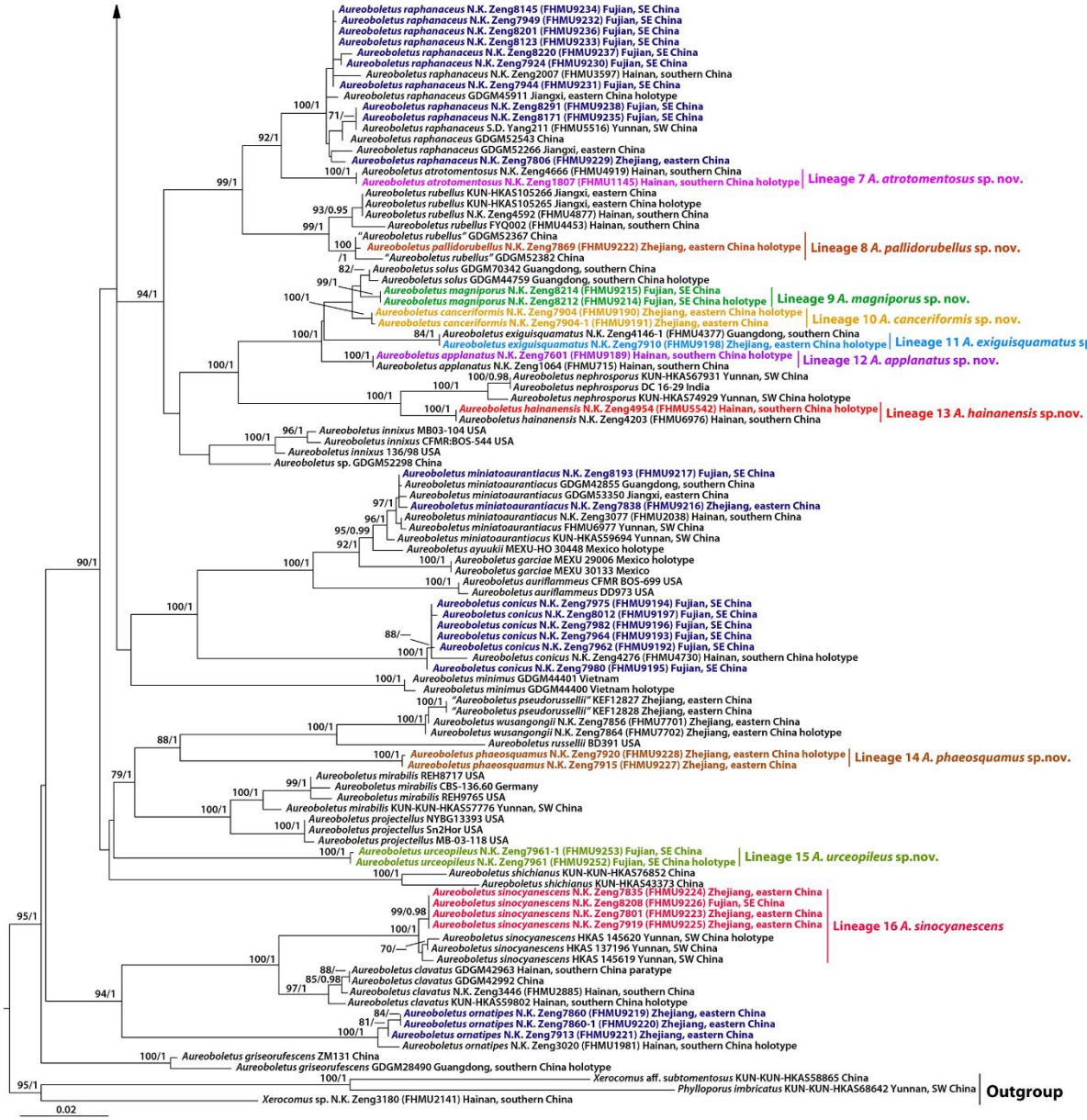


**Figure 2** – Continued.

Basidiospores [40/2/2] 7.5–8.04–9 (–10) × 4.5–5.2–6 (–6.5) µm, Q = (1.33–) 1.42–1.7, Qm = 1.55 ± 0.09, smooth, ellipsoid to elongate, wall thickness 0.5–1 µm, yellowish-brown. Basidia 27–38 × 9–15 µm, 4-spored, subclavate, wall thickness approximately 0.5 µm, yellowish to yellow, with inflated apex; sterigmata 4–7 µm. Cheilocystidia 28–53 × 8–13 µm, subfusiform, not numerous, wall thickness approximately 0.5 µm, yellowish, surface coated with a layer (1–4 µm thick) of achromatic material. Pleurocystidia 39–71 × 8–15 µm, subfusiform, not numerous, wall thickness approximately 0.5 µm, yellowish to yellow, surface coated with a layer (1–6 µm thick) of achromatic material. Hymenophoral trama consists of hyphae 2–18 µm wide, wall thickness 0.5–0.8 µm, achromatic. Pileipellis a cutis-type, 150–280 µm thick, consists of hyphae 4–12 µm wide, wall thickness approximately 0.5 µm, occasionally bifurcate, achromatic, with cylindric to subcylindric apical cells 37–90 × 4–8 µm. Pileal trama consists of hyphae 4–18 µm wide, wall thickness 0.5–1 µm, achromatic. Stipitipellis 130–320 µm thick, consists of hyphae 3–11 µm wide, wall thickness approximately 0.5 µm, pale yellow, with subcylindric apical cells 28–75 × 4–9 µm. Stipe trama consists of hyphae 4–15 µm wide, wall thickness approximately 1 µm, achromatic. Clamp connections not observed in any tissue.

Known distribution – Hainan Province of China.

Materials examined – China, Hainan Province, Changjiang Li Autonomous County, Bawangling of Hainan Tropical Rainforest National Park, 650 m elev., on soil in Fagaceae-dominated forests, solitary, 5 October 2014, N.K. Zeng1807 (FHMU1145, holotype); Baisha Li Autonomous County, Yinggeling of Hainan Tropical Rainforest National Park, 650 m elev., on soil in Fagaceae-dominated forests, solitary, 13 August 2020, N.K. Zeng4666 (FHMU4919).

Notes – Morphologically, *A. atrotomentosus* exhibits similarities with *A. ayuukii* Ayala-Vásquez et al. and *A. miniatoaurantiacus* (C.S. Bi & Loh) Ming Zhang et al., both with densely tomentose squamules. However, *A. ayuukii*, with type locality in Mexico, has a brownish-orange to cinnamon brown, and furfuraceous pileus, a context changing brownish-orange upon injury, a hymenophore unchanging or changing cinnamon to ochraceous upon injury, a furfuraceous stipe, and cystidia without incrustations (Ayala-Vásquez et al. 2023a); Chinese *A. miniatoaurantiacus* has a larger and orange to reddish-orange pileus, a light orange to orange hymenophore no color change upon injury, a orange to reddish-orange stipe, with distinct longitudinal bands or broad reticulations, cystidia without incrustations, and a pileipellis ranging from trichoderm to ixotrichoderm (Wu et al. 2016, Zhang et al. 2019).

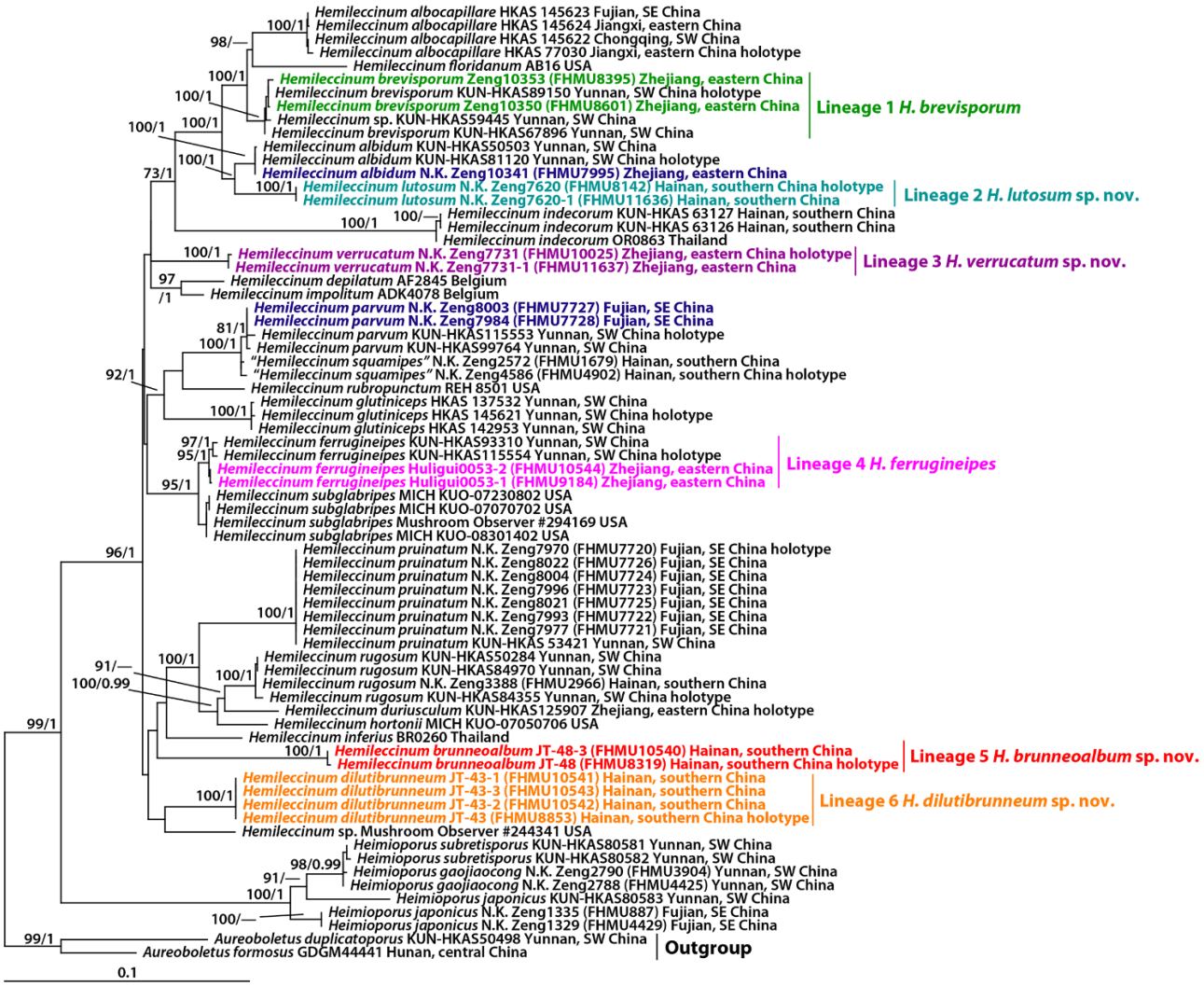


**Figure 3** – RAxML phylogram of *Hemileccinum* based on 28S, *TEF*1, *RPB*1, and *RPB*2. Branch supports (BS ≥ 70%, PP ≥ 0.95) are shown. New sequences in color; SE represent southeastern, SW represent southwestern.

Phylogenetically, *A. atrotomentosus* exhibits close affinity with *A. raphanaceus* Ming Zhang & T.H. Li (Fig. 2). However, *A. raphanaceus*, with type locality in Jiangxi of China, has a white to yellowish-white pileus, surface adorned with greenish-grey to yellowish-grey squamules, a

yellowish-white stipe with longitudinal bands and faintly pruinose or tomentose, cystidia without incrustations, and an ixotrichoderm-type pileipellis (Zhang et al. 2019).


**Figure 4** – Fresh basidiomata of *Aureoboletus* species. a–b *A. applanatus* (FHMU9189, holotype). c–d *A. atrotomentosus* (FHMU1145, holotype). e *A. cancerifformis* (FHMU9190, holotype). f *A. exiguisquamatus* (FHMU9198, holotype). g–i *A. formosus* (g from FHMU9202; h–i from FHMU9203). j–k *A. glutinosus* (FHMU9204). l–m *A. hainanensis* (FHMU5542, holotype). Scale bars represent 1 cm.


**Figure 5** – Fresh basidiomata of *Aureoboletus* species. a–d *A. macrocarpus* (a from FHMU9207; b from FHMU9210; c from FHMU9211, holotype; d from FHMU9212). e–h *A. magniporus* (e–f from FHMU9215; g–h from FHMU9214, holotype). i–j *A. nanlingensis* (FHMU9218). k–l *A. pallidorubellus* (FHMU9222, holotype). Scale bars represent 1 cm.

***Aureoboletus canceriformis*** N.K. Zeng, H.Z. Qin, W.F. Lin & L.G. Hu, sp. nov. Figs 4e, 9

MycoBank: MB 860291; Facesoffungi: FoF 19069

Etymology – Latin "*canceriformis*" signifies the similarity in color and shape between the pileus and a crab shell.

Diagnosis – This species can be diagnosed by a relatively small basidiocarp, a reddish-brown and subtomentose pileus, and a cutis-type pileipellis, which distinguish it from the closest *Aureoboletus* species.

Basidiomata small in size. Pileus 3–3.9 cm across, plano-convex to nearly plane with age; surface reddish-brown (7D7) to pale brown (6B5–7), subtomentose, dry; margin slightly decurved to straight, entire; context 0.2–0.4 cm at center, yellowish-white (5A3), no color change upon injury. Hymenophore poroid, decurrent; pores angular to subcircular, yellowish-white (30A3–4) to pale yellow (1A4), no color change upon injury; tubes 0.2–0.4 cm deep, pale yellow (1A5), no color change upon injury. Stipe 4.5–6.5 × 0.5–0.6 cm, cylindric, mid-positioned, consolidated; surface

greyish-yellow (2B4–5) smooth, dry; context yellow (2A4), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

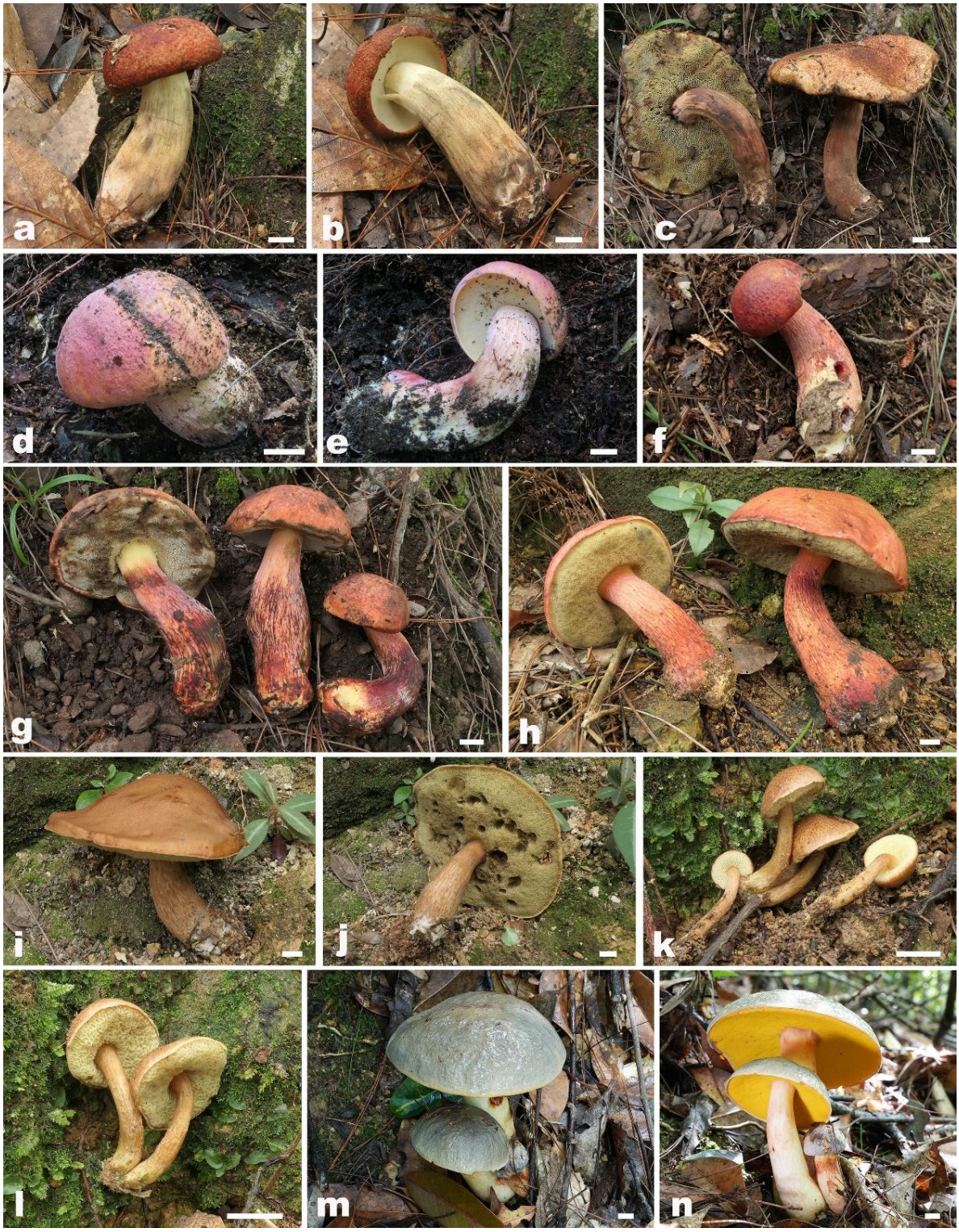


**Figure 6** – Fresh basidiomata of *Aureoboletus* species. a–c *A. phaeosquamus* (f–g from FHMU9227; h from FHMU9228, holotype). d–h *A. sinocyanescens* (d–e from FHMU9223; f from FHMU9224; g from FHMU9225; h from FHMU9226). i–j *A. urceopileus* (FHMU9252, holotype). k–l *A. velutipes* (FHMU9254). m–n *A. yunnanensis* (FHMU9255). Scale bars represent 1 cm.

Basidiospores [60/3/2] (9–) 9.5–10.9–12.5 × 4–5.08–5.5 (–6) µm, Q = (1.8–) 1.82–2.44 (–2.75), Qm = 2.15 ± 0.18, smooth, wall thickness 0.5–1 µm, elongate to cylindric, pale yellowish-

brown. Basidia 21–38 × 7–10 μm, 4-spored, subclavate to cylindric, wall thickness approximately 0.5 μm, yellowish; sterigmata 2–9 μm. Cheilocystidia 53–75 × 10–15 μm, subfusiform, not numerous, wall thickness 0.5–0.8 μm, yellowish to achromatic, without incrustations. Pleurocystidia 51–74 × 11–16 μm, subfusiform, not numerous, wall thickness 0.5–1 μm, pale yellow to yellow, without incrustations. Hymenophoral trama consists of hyphae 5–11 μm wide, wall thickness approximately 0.5 μm, yellowish. Pileipellis a cutis-type, 120–300 μm thick, consists of hyphae 4–13 μm wide, wall thickness 0.5–1 μm, pale yellow to yellow, with subcylindric to cylindric apical cells 14–75 × 7–12 μm. Pileal trama consists of hyphae 5–20 μm wide, wall thickness 0.5–1 μm, yellowish to achromatic. Stipitipellis 60–90 μm thick, consists of hyphae 3–8 μm wide, wall thickness 0.5–0.8 μm, yellowish to achromatic, with subcylindric to subclavate apical cells 22–57 × 5–11 μm. Stipe trama consists of hyphae 4–18 μm wide, wall thickness approximately 1 μm, yellowish to achromatic. Clamp connections not observed in any tissue.

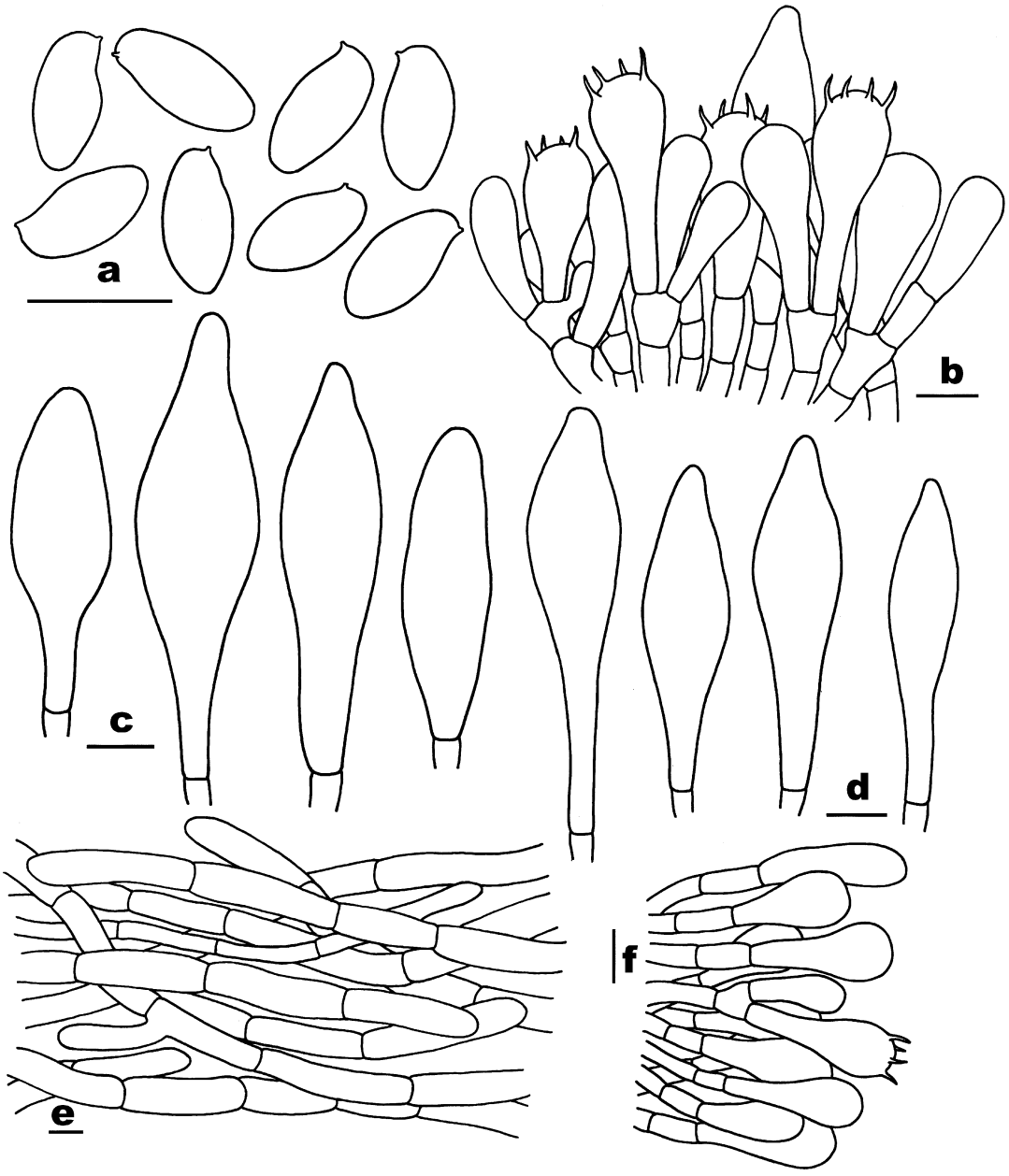


**Figure 7** – Microscopic characters of *Aureoboletus applanatus* (FHMU9189, holotype). a Basidiospores. b Basidia and pleurocystidium. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

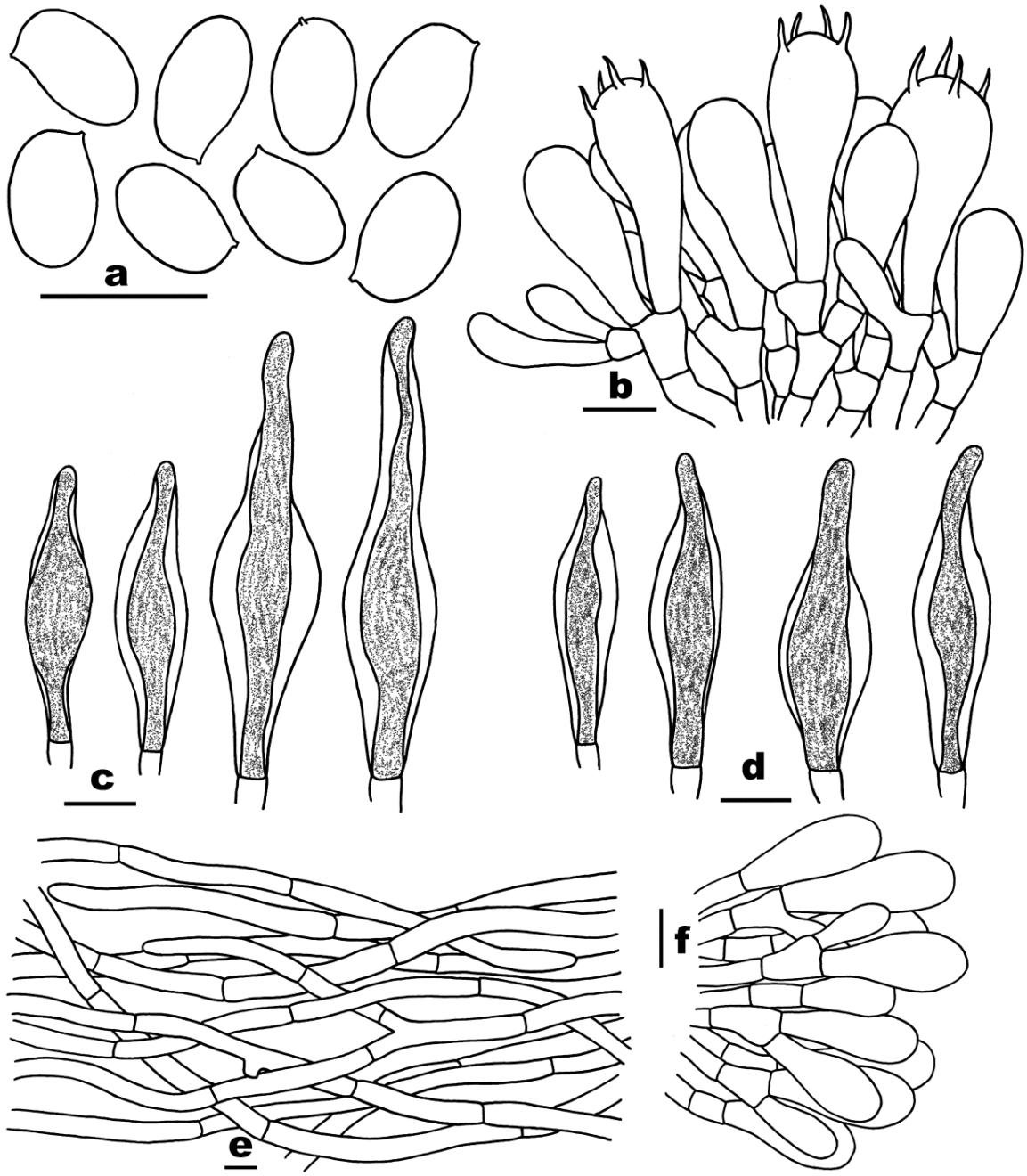


**Figure 8** – Microscopic characters of *Aureoboletus atrotomentosus* (FHMU1145, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Known distribution – Zhejiang Province of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1200 m elev., on soil in Pinaceae and Fagaceae mixed forests, solitary or scattered, 14 August 2023, N.K. Zeng7904 (FHMU9190, holotype); same locality and date, N.K. Zeng7904-1 (FHMU9191).

Notes – *Aureoboletus canceriformis* shares morphological similarities with *A. duplicatoporus*, *A. minimus* Ming Zhang et al., and *A. readii* Ayala-Vásquez, et al. However, *A. duplicatoporus*, with type locality in Yunnan, has a larger, nearly glabrous and sticky pileus, a sunflower yellow to maize yellow hymenophore, a reddish-orange stipe, shorter pleuro- and cheilocystidia coated with a thin layer of material, and an ixotrichoderm-type pileipellis (Zang 1992, Wu et al. 2016); *A. minimus*, with type locality in Vietnam, has a grayish-red pileus, a pastel red stipe and relatively larger basidiospores 13–16 × 5–6 μm (Liu et al. 2024); *A. readii*, with type locality in

México, has a larger pileus, a golden yellow hymenophore, a pale red stipe, and an ixotrichoderm-type pileipellis (Ayala-Vásquez et al. 2023a).

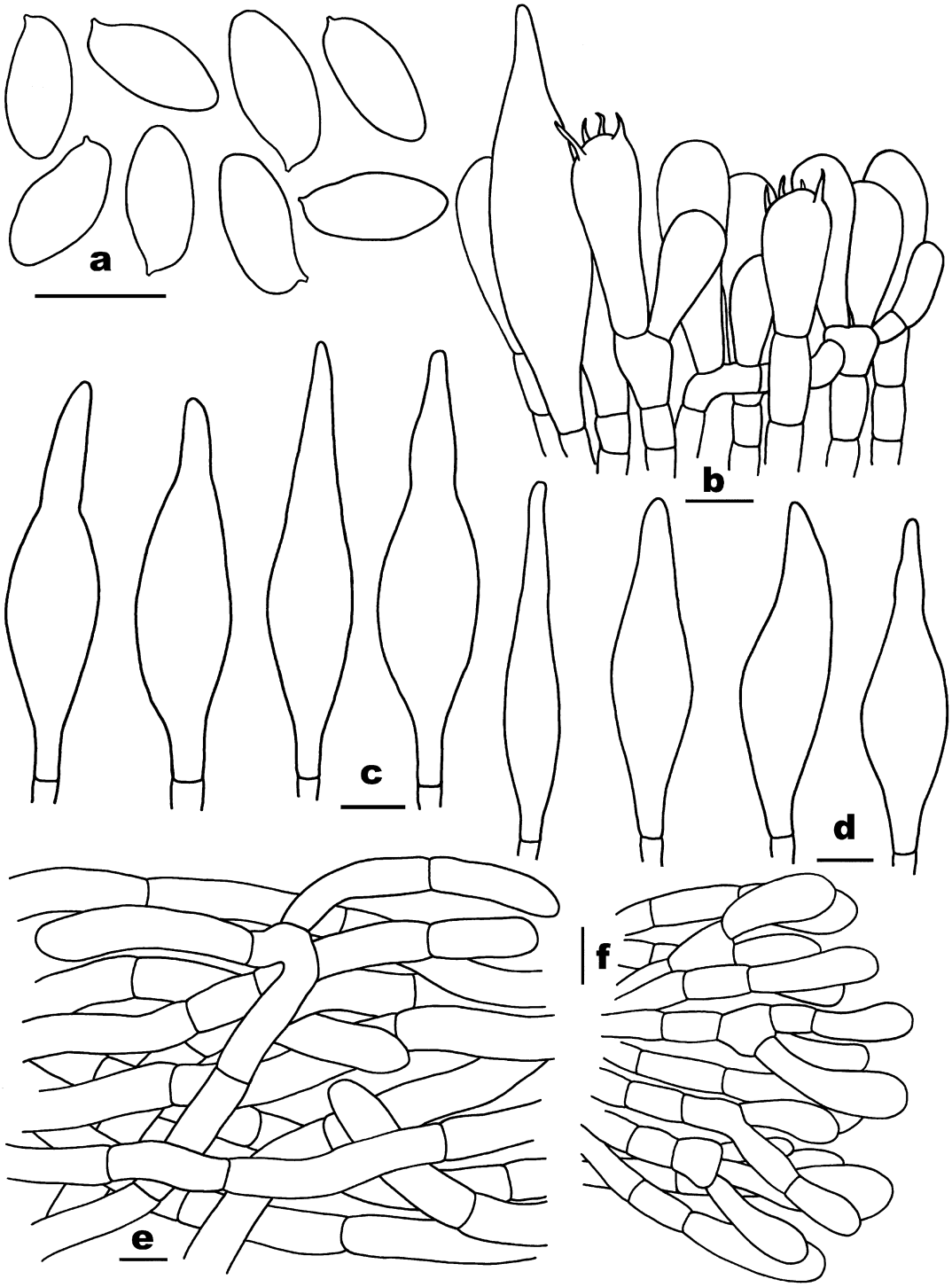


**Figure 9** – Microscopic characters of *Aureoboletus canceriformis* (FHMU9190, holotype). a Basidiospores. b Basidia and pleurocystidium. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Phylogenetically, *A. canceriformis* exhibits close affinity with *A. applanatus*, *A. exiguisquamatus*, *A. magniporus*, and *A. solus* (Fig. 2). The differences between *A. applanatus* and *A. canceriformis* have been discussed under *A. applanatus*; *A. exiguisquamatus* has a stipe adorned with small and pale brown squamules, relatively smaller basidiospores 8–10 × 4–5 μm, and a pileipellis ranging from an intricate trichoderm to a subcutis (see below); *A. magniporus* has a

darker reddish-brown pileus, a yellowish-white to reddish context, and a hymenophore with relatively larger and sparser pores (see below); *A. solus*, with type locality in Guangdong, has a brownish-yellow to greyish-red pileus, a pale orange to pale red stipe, relatively smaller basidiospores 8–10.5 × 4.5–5 μm, and a trichoderm-type pileipellis (Zhang et al. 2019).

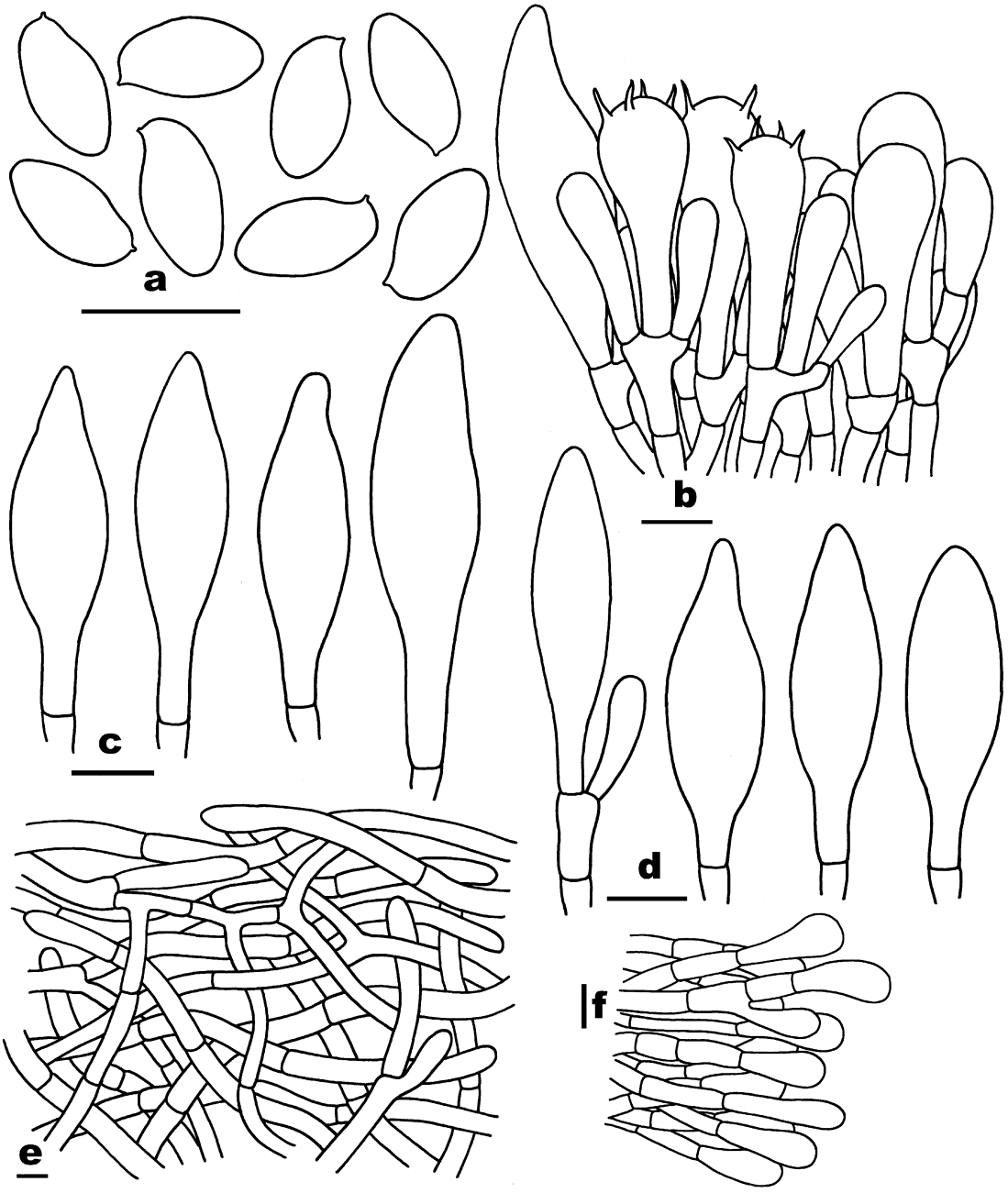


**Figure 10** – Microscopic characters of *Aureoboletus exiguisquamatus* (FHMU9198, holotype). a Basidiospores. b Basidia and pleurocystidium. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

***Aureoboletus exiguisquamatus*** N.K. Zeng, H.Z. Qin, W.F. Lin & L.G. Hu, sp. nov. Figs 4f, 10

MycoBank: MB 860292; Facesoffungi: FoF 19070

Etymology – Latin "*exiguisquamatus*" signifies the presence of dense, minute squamules on the stipe surface.

Diagnosis – This species can be diagnosed by a relatively small basidiocarp, a stipe adorned with small and pale brown squamules when mature, and a pileipellis ranging from an intricate trichoderm to a subcutis, which distinguish it from the closest *Aureoboletus* species.

Basidiomata very small in size. Pileus 1.7–2.2 cm across, plano-convex to nearly plane; surface yellowish-brown (5A4–5) to pale brown (6B5–6), subtomentose, dry; margin decurved, entire; context at center 0.1–0.25 cm thick, yellowish-white (1A2), no color change upon injury. Hymenophore poroid, sinuate to slightly decurrent; pores angular, yellowish-white (1A2–4), sometimes turning bluish (25A5) upon injury; tubes 0.2–0.3 cm deep, concolorous with pores, staining similarly. Stipe 2.5–4.3 × 0.2–0.5 cm, cylindric, mid-positioned, consolidated; surface greyish-yellow (2B4–5), adorned with small and pale brown (5C5–6) squamules when mature, dry; context white (2A1), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [40/2/1] 8–9.1–10 × 4–4.94–5 (–5.5) μm, Q = 1.6–2 (–2.25), Qm = 1.85 ± 0.12, smooth, elongate, slightly thick-walled (0.8–1 μm), yellowish-brown. Basidia 27–41 × 10–13 μm, 4-spored, subclavate to clavate, wall thickness approximately 0.5 μm, yellowish to achromatic, with inflated apex and granular contents; sterigmata 3–5 μm. Cheilocystidia 39–56 × 9–13 μm, subfusiform, numerous, wall thickness 0.5–1 μm, yellowish to achromatic, without incrustations. Pleurocystidia 37–55 × 8–13 μm, subfusiform, numerous, wall thickness 0.5–1 μm, yellowish to achromatic, without incrustations. Hymenophoral trama consists of hyphae 4–18 μm wide, wall thickness 0.5–1 μm, achromatic. Pileipellis an intricate trichoderm to a subcutis, 145–300 μm thick, consists of hyphae 5–10 μm wide, wall thickness approximately 1 μm, usually bifurcate, achromatic to pale yellow, with subcylindric to cylindric apical cells 25–77 × 5–10 μm. Pileal trama consists of hyphae 4–17 μm wide, wall thickness approximately 1 μm, achromatic. Stipitipellis 225–410 μm thick, consists of hyphae 3–14 μm wide, wall thickness approximately 1 μm, yellowish, with subcylindric to cylindric apical cells 30–80 × 5–10 μm. Stipe trama consists of hyphae 3–17 μm wide, wall thickness 0.5–0.8 μm, achromatic. Clamp connections not observed in any tissue.

Known distribution – Zhejiang and Guangdong Provinces of China.

Materials examined – China, Guangdong Province, Renhua County, Danxiashan National Nature Reserve, 300 m elev., on soil in Fagaceae-dominated forests, solitary, 27 July 2019, N.K. Zeng4146-1 (FHMU3750). Zhejiang Province, Qingyuan County, Baishanzu, 1200 m elev., on soil in Pinaceae and Fagaceae mixed forests, solitary or scattered, 14 August 2023, N.K. Zeng7910 (FHMU9198, holotype).

Notes – *Aureoboletus exiguisquamatus* shares morphological similarities with *A. conicus* N.K. Zeng et al. and *A. velutipes* Ming Zhang & T.H. Li. However, *A. conicus*, with type locality in Hainan of China, has an orangish-brown pileus, surface adorned with conical and brown squamules, a white stipe, surface adorned with light orangish-brown squamules, and a trichoderm-type pileipellis (Xue et al. 2023); *A. velutipes*, with type locality in Guangdong of China, has a reddish-brown to brownish-orange pileus, surface adorned with tomentose to fibrillose squamules, a context slightly turning to pastel red upon injury, relatively larger basidiospores 10–13 × 5–6 μm, and a trichoderm-type pileipellis (Zhang et al. 2019).

Furthermore, *A. exiguisquamatus* was misidentified as *A. solus* in a previous study (Xue et al. 2023). Further investigations revealed notable differences in both phylogeny and morphology between the two taxa. The latter differs based on a brownish-orange to brownish-yellow pileus, a glabrous, light orange to reddish stipe, and a trichoderm-type pileipellis (Zhang et al. 2019). In the phylogenetic analysis, *A. exiguisquamatus* exhibits close affinity with *A. applanatus*, *A. canceriformis*, *A. magniporus*, and *A. solus* (Fig. 2). The differences between *A. applanatus*, *A. canceriformis*, and *A. exiguisquamatus* have been discussed under *A. applanatus* and *A. canceriformis*; *A. magniporus* has a yellowish-white to reddish context, a hymenophore with relatively larger and sparser pores, a light yellowish-brown to brownish stipe without squamules, and longer basidiospores 9–12 × 4.5–5.5 μm (see below); the morphological differences between *A. solus* and *A. exiguisquamatus* have been discussed above.

***Aureoboletus formosus*** Ming Zhang & T.H. Li, Mycol. Progr. 14: 2, 2015 Figs 4g–i, 11

MycoBank: MB 813630; Facesoffungi: FoF 19071

Basidiomata ranging from very small to medium in size. Pileus 1.6–5.7 cm across, convex to plano-convex; surface pinkish (6A2) to pale salmon (7A2–3), smooth, sticky when wet; margin decurved, entire; context at center 0.2–0.7 cm thick, white (1A2) to yellowish-white (5A2), unchanging or changing to pale red (7A2) upon injury. Hymenophore poroid, slightly sinuate; pores angular to subcircular, vivid yellow (2A7–8), no color change upon injury; tubes 0.1–0.6 cm deep, yellow (2B7–8), no color change upon injury. Stipe 6.1–11.5 × 1.2–1.8 cm, cylindric, mid-positioned, consolidated; surface dusty pink (6B4) to grayish-yellow (2B5–6), smooth, dry; context white (2A1), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

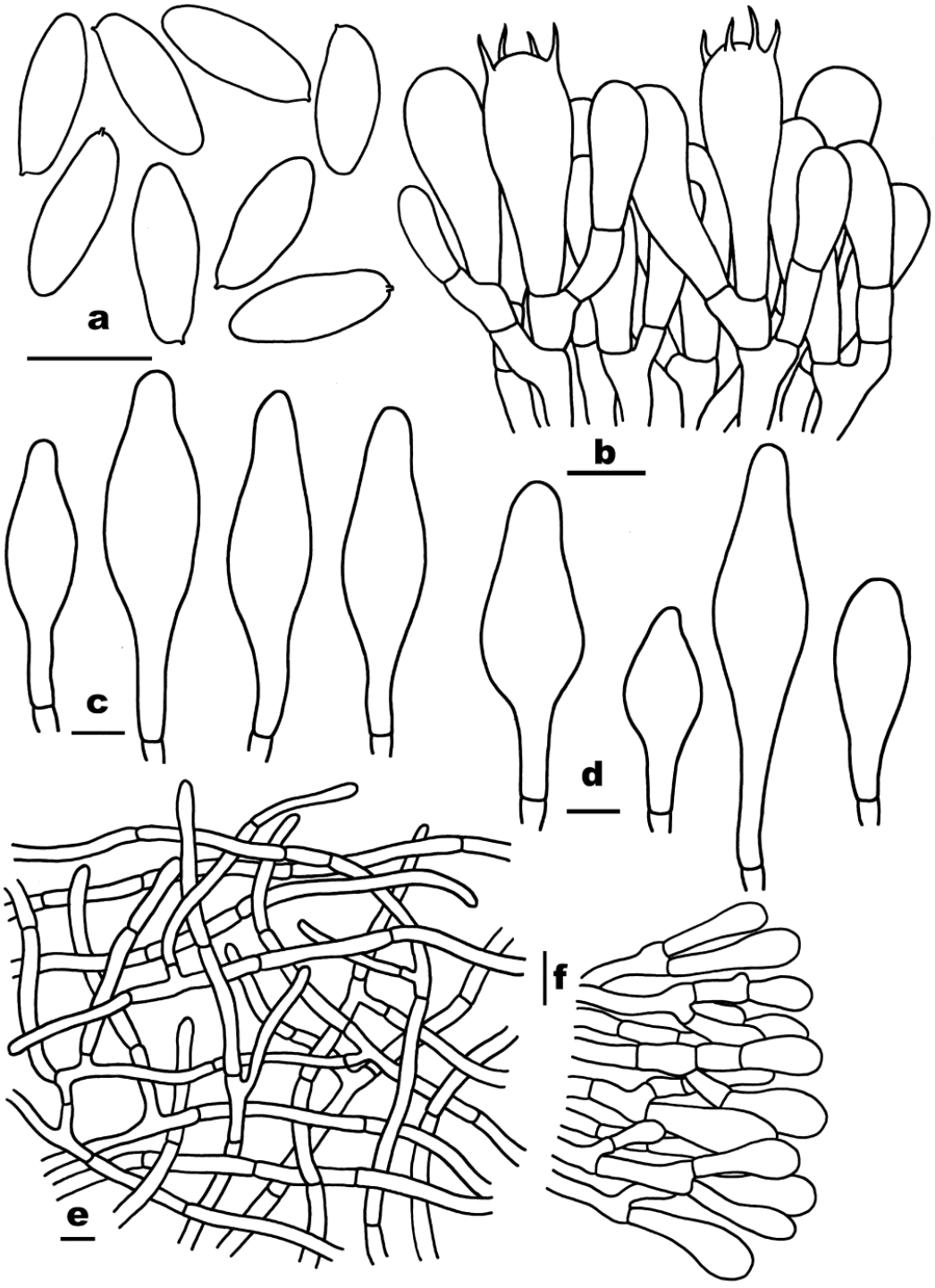


**Figure 11** – Microscopic characters of *Aureoboletus formosus* (FHMU9203). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Basidiospores [40/2/2] 11–12.8–14 (–15) × 4–4.99–5.5 (–6) μm, Q = 2.17–3 (–3.25), Qm = 2.58 ± 0.23, smooth, fusoid to cylindric, wall thickness approximately 1 μm, pale yellowish-brown. Basidia 29–39 × 9–12 μm, 4-spored, subclavate to subcylindric, wall thickness approximately 0.5 μm, achromatic, with inflated apex; sterigmata 2–6 μm. Cheilocystidia 38–82 × 12–20 μm, subfusiform, numerous, wall thickness 0.5–1 μm, achromatic, without incrustations. Pleurocystidia 45–74 × 10–19 μm, subfusiform, numerous, wall thickness approximately 1 μm, achromatic, without incrustations. Hymenophoral trama consists hyphae 3–12 μm wide, of wall thickness approximately 1 μm, achromatic. Pileipellis an intricate trichoderm-type, 280–410 μm thick, consists of hyphae 3–7 μm wide, wall thickness 0.5–1 μm, usually bifurcate, yellowish to achromatic, with cylindric to subclavate apical cells 26–70 × 3–6 μm. Pileal trama consists of hyphae 3–13 μm wide, wall thickness approximately 0.5 μm, yellowish to achromatic. Stipitipellis 250–570 μm thick, consists of hyphae 3–14 μm wide, wall thickness approximately 0.5 μm, achromatic, with subcylindric to cylindric apical cells 35–78 × 5–14 μm. Stipe trama consists of hyphae 2–18 μm wide, wall thickness approximately 1 μm, achromatic. Clamp connections not observed in any tissue.

Known distribution – Hunan and Zhejiang Provinces of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1200 m elev., on soil in Fagaceae-dominated forests, solitary, 12 August 2023, N.K. Zeng7669 (FHMU9201); same locality and date, N.K. Zeng7691 (FHMU9202); same locality and date, N.K. Zeng7706 (FHMU9203).

Notes – The type locality of *A. formosus* is situated in Hunan (Zhang et al. 2015). Our study documents its additional occurrence in Zhejiang. The species was redescribed using recently collected specimens, and features a pinkish to pale salmon pileus, a context unchanging or changing to pale red upon injury, a vivid yellow hymenophore, fusoid to cylindric basidiospores, and an intricate trichoderm-type pileipellis. Additionally, certain morphological differences have been documented among specimens identified as *A. formosus*. Notably, collections reported by Zhang et al. (2015) exhibit a grayish-ruby to pink pileus, surface adorned with tomentose to fibrillose squamules, a context no color change upon injury, relatively larger basidiospores 14.5–17 × 4.5‑5.5 μm, and an ixotrichoderm-type pileipellis.

***Aureoboletus glutinosus*** Ming Zhang & T.H. Li, MycoKeys 61: 121, 2019 Figs 4j–k, 12

MycoBank: MB 827103; Facesoffungi: FoF 19072

Basidiomata very small in size. Pileus 1–1.5 cm across, subhemispherical to convex; surface reddish-brown (10C5–6) to pale reddish-brown (7B5), distinctly wrinkled, irregular bump, sticky; margin decurved, entire; context at center 0.2–0.5 cm thick, reddish (7A2), no color change upon injury. Hymenophore poroid, sinuate to slightly decurrent; pores angular to subcircular, yellowish-white (2A2–3), no color change upon injury; tubes 0.1–0.3 cm deep, pale yellow (1A4), no color change upon injury. Stipe 2–3 × 0.2–0.3 cm, cylindric, mid-positioned, consolidated; surface grayish-brown (2B3) to pale brown (5B5), smooth, sticky when wet; context white (1A1), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [20/1/1] 9.5–11.3–12 (–13) × 4–4.48–5 μm, Q = 2.2–3 (–3.25), Qm = 2.55 ± 0.32, smooth, fusoid to cylindric, wall thickness approximately 1 μm, pale yellowish-brown. Basidia 24–29 × 8–11 μm, 4-spored, subclavate to subcylindric, wall thickness approximately 0.5 μm, yellowish to achromatic, with inflated apex and granular contents; sterigmata 2–6 μm. Cheilocystidia 32–52 × 8–10 μm, subfusiform, numerous, wall thickness approximately 0.5 μm, achromatic, without incrustations. Pleurocystidia 28–47 × 7–10 μm, subfusiform, numerous, wall thickness approximately 0.5 μm, achromatic, without incrustations. Hymenophoral trama consists of hyphae 3–13 μm wide, wall thickness approximately 1 μm, achromatic. Pileipellis an ixotrichoderm-type, 240–400 μm thick, consists of hyphae 4–15 μm wide, wall thickness approximately 1 μm, occasionally bifurcate, pale yellow to yellow, with subcylindric to subclavate apical cells 25–85 × 4–8 μm. Pileal trama consists of hyphae 3–15 μm wide, wall thickness 0.5–1 μm, achromatic. Stipitipellis 235–485 μm thick, consists of hyphae 2–10 μm wide, wall thickness approximately 0.5 μm, yellowish to achromatic, with subcylindric to cylindric apical cells 22–85 × 3–8 μm. Stipe trama

consists of hyphae 3–14 μm wide, wall thickness 0.5–1 μm, achromatic to pale yellow. Clamp connections not observed in any tissue.

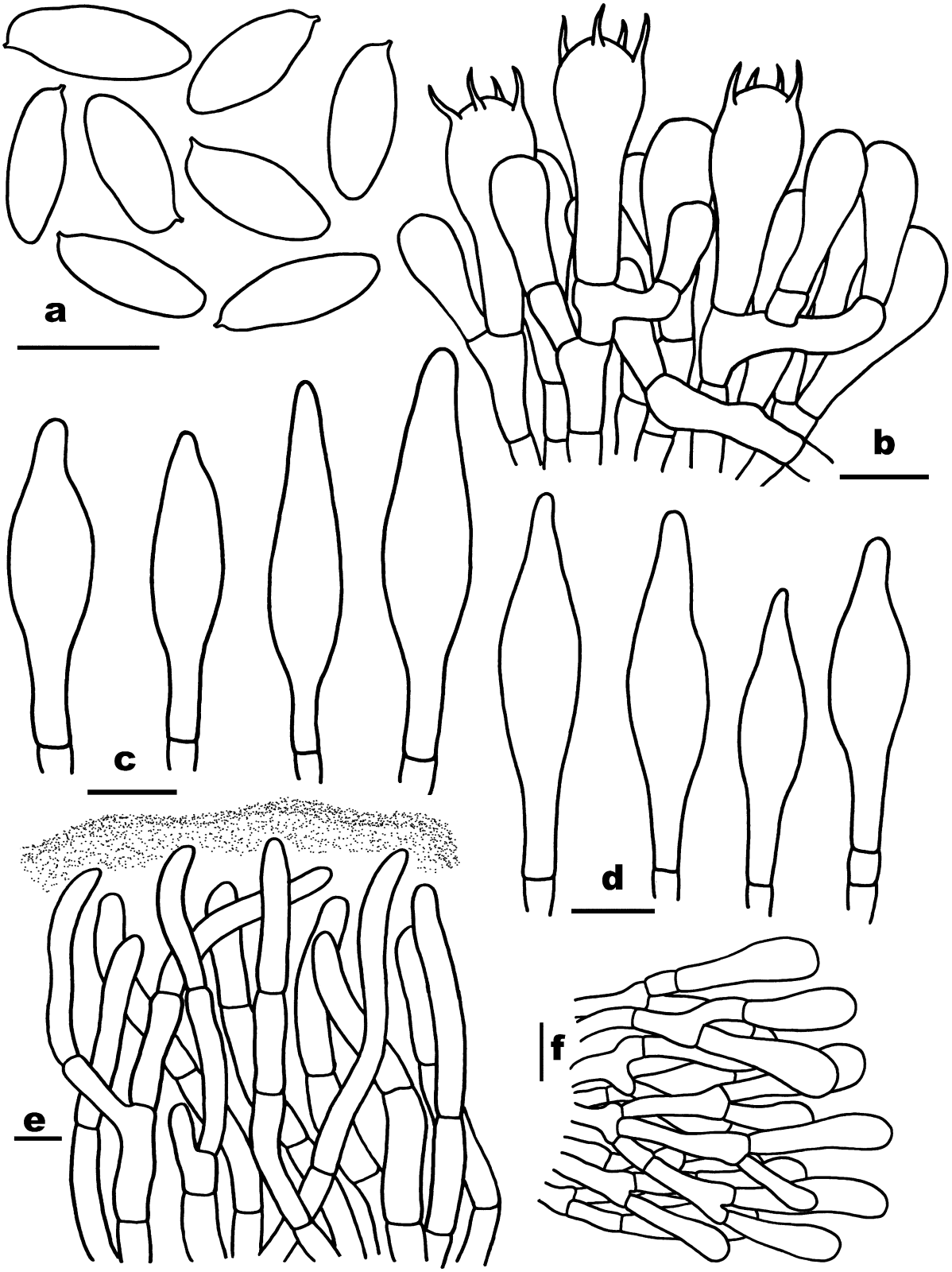


**Figure 12** – Microscopic characters of *Aureoboletus glutinosus* (FHMU9204). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Known distribution – Hunan, Anhui and Zhejiang Provinces of China.

Material examined – China, Zhejiang Province, Qingyuan County, Zuoxi Town, Yinjiang Village, 800 m elev., on soil in Pinaceae and Fagaceae mixed forests, solitary, 15 August 2023, gui0008 (FHMU9204).

Notes – The type locality of *A. glutinosus* is situated in Hunan, and has also been reported in Anhui (Zhang et al. 2019). Our study documents its additional occurrence in Zhejiang. The species was redescribed using recently collected specimen, featuring a small and glutinous basidioma, a distinctly wrinkled, irregular bump and reddish-brown pileus, a light brown to grayish-brown stipe, and a trichoderm-type pileipellis.

***Aureoboletus hainanensis*** N.K. Zeng, H.Z. Qin & Zhi Q. Liang, sp. nov. Figs 4l–m, 13

MycoBank: MB 860293; Facesoffungi: FoF 19073

Etymology – Latin "*hainanensis*" is derived from Hainan Province of China, the type locality.

Diagnosis – This species can be diagnosed by a relatively small basidiocarp, a pileus adorned with furfuraceous and yellowish-brown to pale pink scales, and cystidia coated with a layer of achromatic material, which distinguish it from the closest *Aureoboletus* species.

Basidiomata very small in size. Pileus 1–1.3 cm across, convex to plano-convex; surface yellowish-white (4A2–3) to pale yellow (3A4), adorned with furfuraceous and yellowish-brown (5B5–6) to pale pink (7A2–3) scales, slightly sticky when wet; margin decurved, entire; context at center 0.35–0.5 cm thick, white (1A1) to yellowish-white (2A2–3), no color change upon injury. Hymenophore poroid, sinuate; pores angular to subcircular, bright yellow (2A6) to pale yellow (1B6–7), no color change upon injury; tubes 0.1–0.3 cm deep, concolorous with pores, no color change upon injury. Stipe 1.5–2.2 × 0.2–0.5 cm, cylindric, mid-positioned, consolidated; surface pale yellowish-brown (3B4–5), with longitudinally streaked, slightly sticky when wet; context yellowish-white (2A2), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [20/1/1] 7.5–8.15–9 ×5–5.15–5.5 μm, Q = 1.45–1.64 (–1.7), Qm = 1.58 ± 0.06, smooth, ellipsoid to elongate, wall thickness approximately 0.5 μm, pale yellowish-brown. Basidia 26–35 × 11–15 μm, 4-spored, subclavate, wall thickness approximately 0.5 μm, yellowish, with inflated apex; sterigmata 3–5 μm. Cheilocystidia 39–56 × 9–14 μm, subfusiform, not numerous, wall thickness approximately 0.5 μm, yellowish, surface coated with a layer (1–5 μm) of achromatic material. Pleurocystidia 36–68 × 7–13 μm, subfusiform, not numerous, wall thickness approximately 0.5 μm, pale yellow, surface coated with a layer (1–3 μm) of achromatic material. Hymenophoral trama consists of hyphae 3–19 μm wide, wall thickness approximately 0.5 μm, achromatic. Pileipellis a trichoderm-type, 245–400 μm thick, consists of hyphae 3–9 μm wide, wall thickness 0.5–0.8 μm, occasionally bifurcate, yellowish, with subcylindric to subclavate apical cells 30–66 × 4–6 μm. Pileal trama consists of hyphae 3–13 μm wide, wall thickness approximately 0.5 μm, achromatic. Stipitipellis 140–200 μm thick, consists of hyphae 3–8 μm wide, wall thickness 0.5–1 μm, yellowish, with subcylindric apical cells 30–73 × 3–7 μm. Stipe trama consists of hyphae 3–19 μm wide, wall thickness approximately 1 μm, yellowish to achromatic. Clamp connections not observed in any tissue.

Known distribution – Hainan Province of China.

Materials examined – China, Hainan Province, Changjiang Li Autonomous County, Bawangling of Hainan Tropical Rainforest National Park, 650 m elev., on soil in Fagaceae-dominated forests, solitary, 31 August 2019, N.K. Zeng4203 (FHMU6976); same locality, 3 September 2020, N.K. Zeng4954 (FHMU5542, holotype).

Notes – *Aureoboletus hainanensis* shares morphological similarities with *A. ayuukii*, *A. minimus*, and *A. solus*. However, *A. ayuukii*, with type locality in Mexico, has a brownish-orange to cinnamon brown pileus, a context changing brownish-orange upon injury, a hymenophore changing cinnamon to ochraceous upon injury, a furfuraceous stipe, and cystidia without incrustations (Ayala-Vásquez et al. 2023a); *A. minimus*, with type locality in Vietnam, has a light orange to grayish-red pileus, surface adorned with tomentose to fbrillose squamules, a context slightly turning greyish-red or greyish-pink upon injury, a pastel red to grayish-red stipe, larger and subfusiform basidiospores 13–16 × 5–6 μm, and cystidia without incrustations (Liu et al. 2024);

Chinese *A. solus* has a brownish-red to brownish-yellow pileus, a pale orange to pale red stipe, and cystidia without incrustations (Zhang et al. 2019).

Phylogenetically, *A. hainanensis* exhibits close affinity with *A. nephrosporus* G. Wu & Zhu L. Yang (Fig. 2). However, the latter species, with type locality in Yunnan of China, has a larger, grayish-rose to brownish-red pileus, and a dark orange to yellow ochre stipe (Wu et al. 2016).

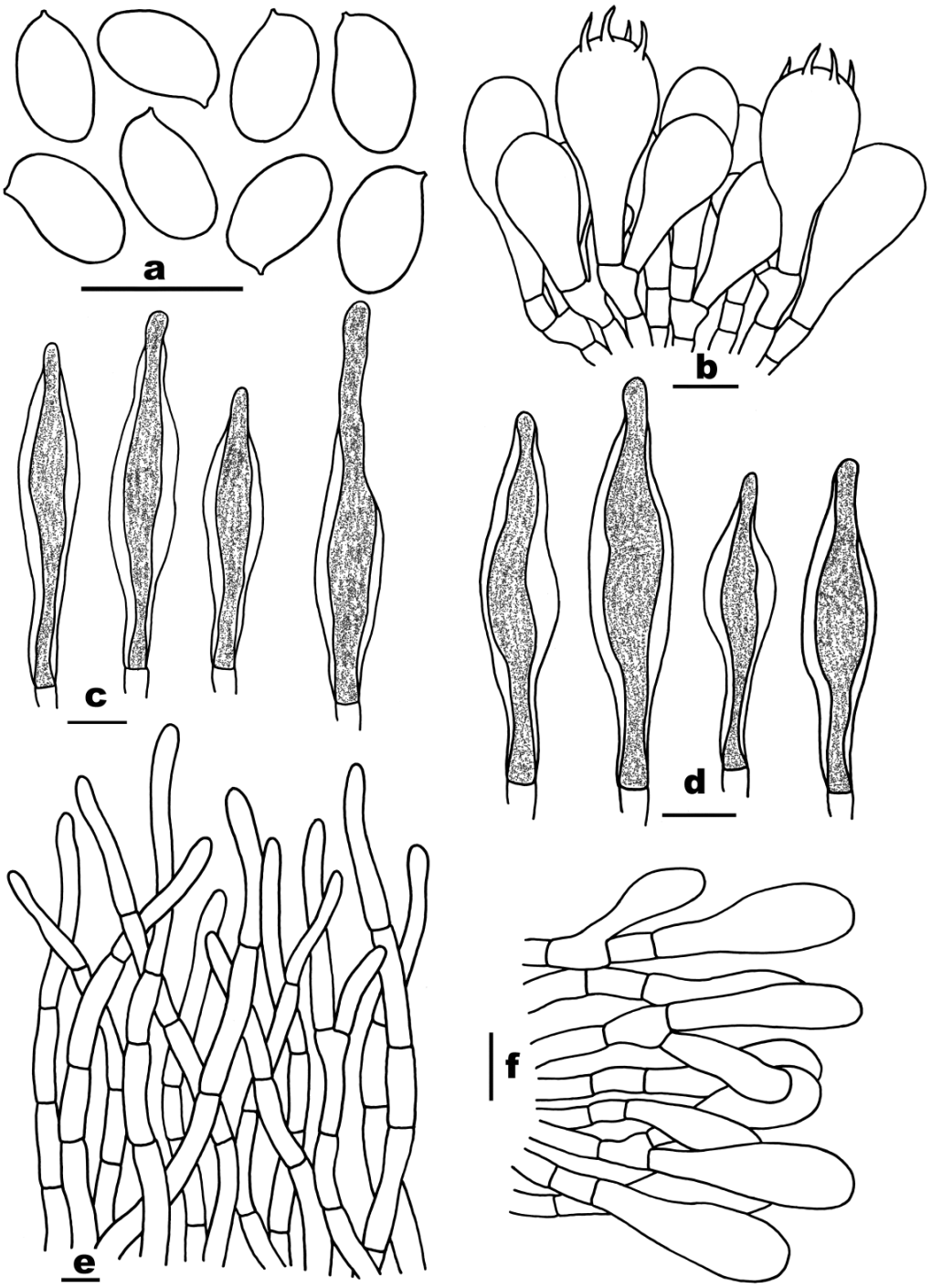


**Figure 13** – Microscopic characters of *Aureoboletus hainanensis* (FHMU5542, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Basidiomata ranging from small to large in size. Pileus 3.8–12 cm across, subhemispherical to plano-convex; surface yellowish-brown (5A5–6) to pale brown (6B6–7), smooth, sticky when wet; margin decurved, entire; context at center 0.4–2.2 cm thick, white (1A1) to yellowish-white (1A2–3), no color change upon injury. Hymenophore poroid, sinuate; pores angular to subcircular, pale

yellow (1A4–5) to pale yellowish-green (30A4–6), changing pale red (9A3–4) to red (9C5–6) slowly upon injury; tubes 0.3–1.3 cm deep, concolorous with pores, staining similarly. Stipe 8.5–15 × 1.4–3.3 cm, subcylindric, mid-positioned, consolidated; surface yellowish-brown (5A5–6), pale brown (6C6) to reddish-brown(7C6), with faintly longitudinal streaks, dry; context white (2A1) to yellowish-white (2A2), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [240/12/7] (8.5–) 9.5–11.21–12 (–14) × 4–4.88–5.5 (–6) μm, Q = (1.9–) 2–2.6 (–3), Qm = 2.31 ± 0.17, smooth, fusoid to cylindric, wall thickness approximately 1 μm, yellowish-brown. Basidia 20–32 × 9–11 μm, 4-spored, subclavate to cylindric, wall thickness 0.5–0.8 μm, yellowish to achromatic; sterigmata 3–6 μm. Cheilocystidia 25–59 × 8–13 μm, subfusiform, not numerous, wall thickness 0.5–1 μm, yellowish to achromatic, without incrustations. Pleurocystidia 25–65 × 8–15 μm, subfusiform, not numerous, wall thickness approximately 1 μm, yellowish to achromatic, without incrustations. Hymenophoral trama consists of hyphae 4–14 μm wide, wall thickness approximately 1 μm, achromatic. Pileipellis a trichoderm-type, 120–260 μm thick, consists of hyphae 3–6 μm wide, wall thickness approximately 0.5 μm, yellow, with clavate to cylindric apical cells 22–88 × 3–4 μm. Pileal trama consists of hyphae 3–15 μm wide, wall thickness approximately 1 μm, yellowish to achromatic. Stipitipellis 130–380 μm thick, consists of hyphae 3–8 μm wide, wall thickness approximately 0.5 μm, yellowish, with subcylindric to cylindric apical cells 25–57 × 3–8 μm. Stipe trama consists of hyphae 4–16 μm wide, wall thickness approximately 1 μm, yellowish to achromatic. Clamp connections not observed in any tissue.

***Aureoboletus macrocarpus*** N.K. Zeng & H.Z. Qin, sp. nov. Figs 5a–d, 14

MycoBank: MB 860294; Facesoffungi: FoF 19074

Etymology – Latin "*macrocarpus*" signifies the larger basidioma of the new species.

Diagnosis – This species can be diagnosed by a yellowish-brown to pale brown, large basidioma, a hymenophore turning red upon injury, and a trichodermal-type pileipellis consisting of narrow and clavate apical cells, which distinguish it from the closest *Aureoboletus* species.

Known distribution – Fujian and Zhejiang Provinces of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1200 m elev., on soil in Fagaceae-dominated forests, solitary or gregarious, 14 August 2023, N.K. Zeng7893 (FHMU9207); same locality and date, N.K. Zeng7894 (FHMU9208); same locality and date, N.K. Zeng7895 (FHMU9209); same locality and date, N.K. Zeng7896 (FHMU9210). Fujian Province, Wuyishan, 1100 m elev., on soil in Fagaceae-dominated forests, gregarious, 17 August 2023, N.K. Zeng7989 (FHMU9211, holotype); same locality and date, N.K. Zeng8002 (FHMU9212); same locality and date, N.K. Zeng8014 (FHMU9213).

Notes – *Aureoboletus macrocarpus* shares morphological similarities with *A. auriporus* (Peck) Pouzar, *A. duplicatoporus*, *A. gentilis* (Quél.) Pouzar, and *A. sinobadius* Ming Zhang & T.H. Li. However, *A. auriporus* has a pinkish-cinnamon to vinaceous brown pileus, a stipe adorned with yellow floccosity or pruina near the pileus, relatively larger basidiospores 11–16 × 4–6 μm, and it occurs in North America (Pouzar 1957, Smith & Thiers 1971, Klofac 2010, Zhang et al. 2019); *A. duplicatoporus*, with type locality in Yunnan, has a reddish-brown pileus, a maize yellow to sunflower yellow hymenophore, no color change upon injury, and an ixotrichoderm-type pileipellis (Zang 1992, Wu et al. 2016); *A. gentilis*, with type locality in Europe, has a pinkish-brown to flesh-colored pileus, a bright golden yellow hymenophore no color change upon injury, a bright chrome yellow stipe, relatively larger basidiospores 12–15 × 5–6.5 μm, and an ixotrichoderm-type pileipellis (Pouzar 1957, Klofac 2010); *A. sinobadius*, with type locality in Guangdong of China, has a reddish-brown to brownish-violet pileus, a context slightly turning to greyish-red upon injury, a greenish-yellow to light yellow hymenophore no color change upon injury, a pastel red stipe, and an ixotrichoderm-type pileipellis (Zhang et al. 2019).

Furthermore, *A. macrocarpus* is phylogenetically related to *A. albipes* N.K. Zeng et al. and *A. yunnanensis* G. Wu & Zhu L. Yang (Fig. 2). However, Chinese *A. albipes* has a brilliant yellow hymenophore, no color change upon injury, a white stipe, and an intricate trichoderm-type pileipellis

(Xue et al. 2023); *A. yunnanensis*, with type locality in Yunnan, has a brownish-orange to grayish-orange pileus, a maize yellow hymenophore no color change upon injury, a grayish-yellow stipe, and an ixotrichoderm-type pileipellis (Wu et al. 2016).

***Aureoboletus magniporus*** N.K. Zeng, H.Z. Qin & Zhi Q. Liang, sp. nov. Figs 5e–h, 15

MycoBank: MB 860295; Facesoffungi: FoF 19075

Etymology – Latin "*magniporus*" signifies the large pores of the new species.

Diagnosis – This species can be diagnosed by a relatively small basidiocarp, a reddish-brown pileus, a yellow to grayish-yellow hymenophore with relatively larger and sparser pores, and a cutis-type pileipellis, which distinguish it from the closest *Aureoboletus* species.

Basidiomata very small in size. Pileus 0.9–2.6 cm across, plano-convex to plane; surface reddish-brown (8E6–7) to pale reddish-brown (7C5), tomentose, dry; margin decurved, sometimes uplift, entire; context at center 0.05–0.2 cm thick, yellowish-white (3A2) to reddish (7A2), no color change upon injury. Hymenophore poroid, adnate to slightly decurrent; pores angular to subcircular, relatively larger and sparser, yellow (2A5) to grayish-yellow (2B6), no color change upon injury; tubes 0.05–0.25 cm deep, yellow (2A6), no color change upon injury. Stipe 1.5–2.2 × 0.1–0.35 cm, subcylindric, mid-positioned, consolidated; surface pale yellowish-brown (4B4–5) to pale brown (5B4–5), whitish (5A1), smooth, dry; context yellowish-white (3A2), no color change upon injury. Basal mycelium whitish (3A1). Odor unremarkable.

Basidiospores [40/2/2] 9–10.74–12 × (4–) 4.5–5.05–5.5 (–6) μm, Q = 1.8–2.4, Qm = 2.13 ± 0.17, smooth, elongate to cylindric, wall thickness approximately 1 μm, yellowish-brown. Basidia 22–34 × 9–13 μm, 4-spored, subclavate to clavate, wall thickness approximately 0.5 μm, yellowish to yellow, with inflated apex and granular contents; sterigmata 3–7 μm. Cheilocystidia 40–65 × 14–16 μm, subfusiform, slightly numerous, wall thickness approximately 1 μm, yellowish, without incrustations. Pleurocystidia 39–66 × 13–17 μm, subfusiform, slightly numerous, wall thickness approximately 1 μm, yellowish, without incrustations. Hymenophoral trama consists of hyphae 5–23 μm wide, wall thickness approximately 1 μm, achromatic to pale yellow. Pileipellis a cutis-type, 180–400 μm thick, consists of hyphae 5–19 μm wide, wall thickness approximately 1 μm, yellowish, with cylindric to subcylindric apical cells 35–125 × 5–15 μm. Pileal trama consists of hyphae 4–17 μm wide, wall thickness approximately 1 μm, achromatic. Stipitipellis 275–590 μm thick, consists of hyphae 4–19 μm wide, wall thickness approximately 0.5 μm, 2–14 μm wide hyphae, yellowish to yellow, with subcylindric to cylindric apical cells 50–156 × 3–17 μm. Stipe trama consists of hyphae 4–20 μm wide, wall thickness 0.5–0.8 μm, yellowish to achromatic. Clamp connections not observed in any tissue.

Known distribution – Fujian Province of China.

Materials examined – China, Fujian Province, Jiangle County, Longqi Mountain National Nature Reserve, 600 m elev., on soil in Pinaceae and Fagaceae mixed forests, solitary, 21 August 2023, N.K. Zeng8212 (FHMU9214, holotype); same locality and date, N.K. Zeng8214 (FHMU9215).

Notes – *Aureoboletus minimus* and *A. tenuis* T.H. Li & Ming Zhang share morphological similarities with *A. magniporus*. However, *A. minimus*, with type locality in Vietnam, has a pastel red to grayish-red pileus, surface adorned with tomentose to fbrillose squamules, a context slightly turning greyish-red or greyish-pinkish upon injury, a stipe adorned with white to yellowish-brown fibrils and tomentum, subfusiform and relatively larger basidiospores 13–16 × 5‑6 μm, and a trichoderm-type pileipellis (Liu et al. 2024); *A. tenuis*, with type locality in Guangxi of China, has a strongly glutinous and distinctly wrinkled pileus, a greyish-red to brownish-orange stipe, and an ixotrichoderm-type pileipellis (Zhang et al. 2014).

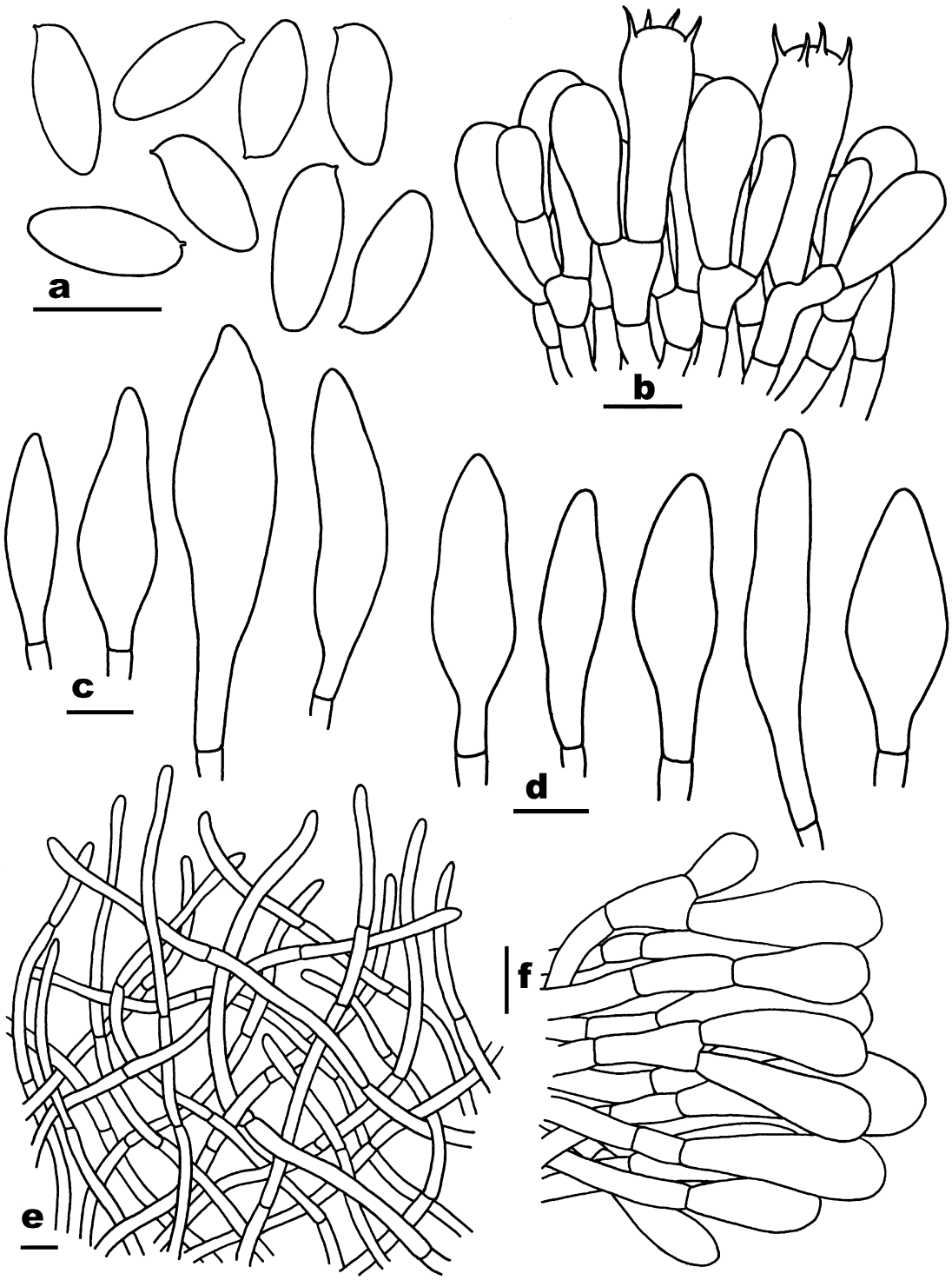


**Figure 14** – Microscopic characters of *Aureoboletus macrocarpus* (FHMU9211, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Phylogenetically, *A. magniporus* exhibits close affinity with *A. applanatus*, *A. canceriformis*, *A. exiguisquamatus*, and *A. solus* (Fig. 2). However, *A. solus*, with type locality in Guangdong, has a pale orange to pale red stipe, a vivid yellow to greenish-yellow hymenophore with relatively smaller and denser pores, oblong to ovoid and relatively smaller basidiospores 8–10.5 × 4.5–5 μm, and a trichoderm-type pileipellis (Zhang et al. 2019). The morphological distinctions among *A. applanatus*, *A. canceriformis*, and *A. exiguisquamatus* from *A. magniporus* have been discussed in their respective descriptions above.

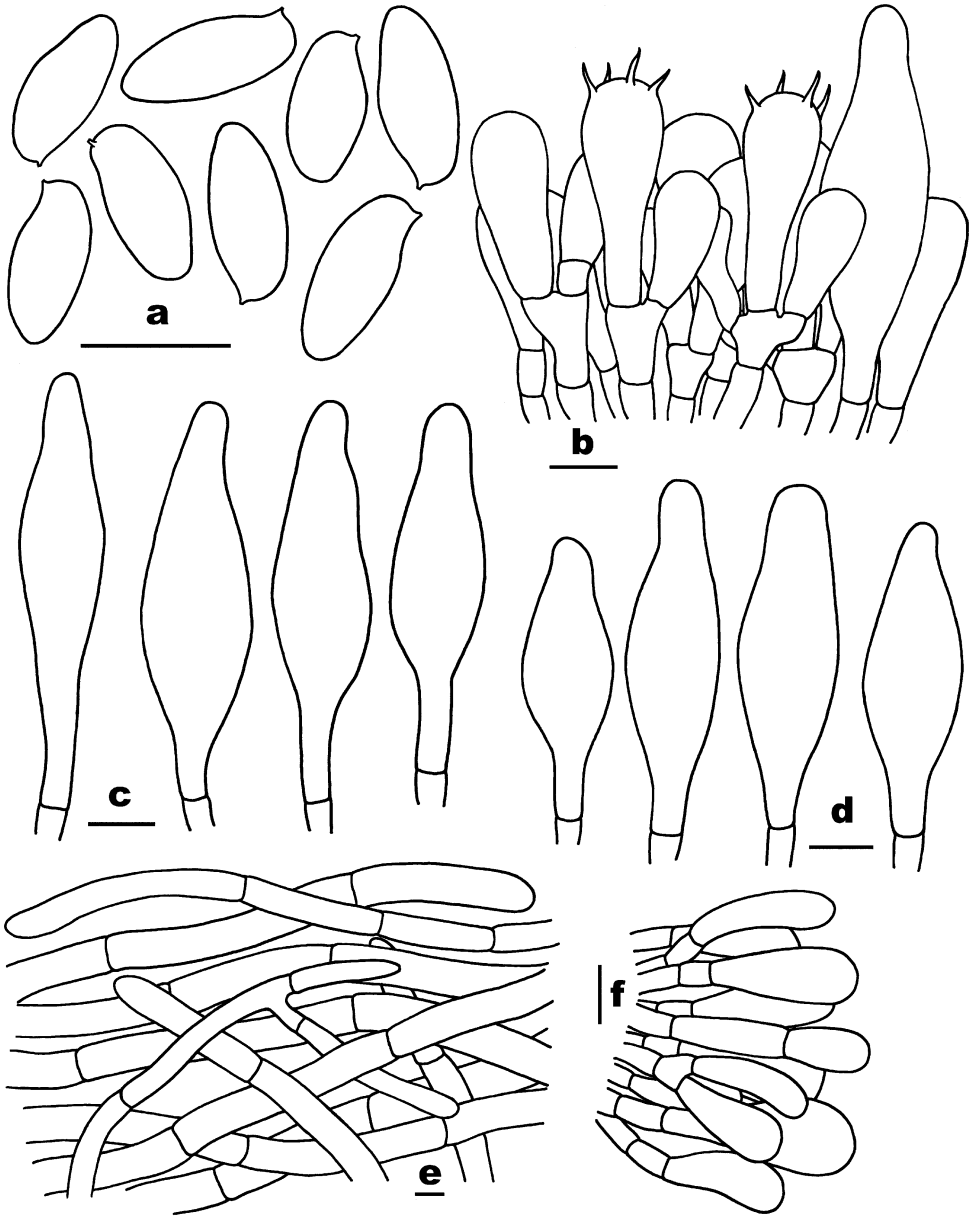


**Figure 15** – Microscopic characters of *Aureoboletus magniporus* (FHMU9214, holotype). a Basidiospores. b Basidia and pleurocystidium. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

***Aureoboletus nanlingensis*** Ming Zhang, C.Q. Wang & T.H. Li, Fungal Diversity 124: 123, 2024
Figs 5i–j, 16

MycoBank: MB 900315; Facesoffungi: FoF 14039

Basidiomata very small in size. Pileus 2–2.4 cm across, subhemispherical to plano-convex; surface brown (6D6–7) to yellowish-brown (5D5–6), subtomentose, dry; margin decurved, entire; context at center 0.2–0.5 cm thick, yellowish-white (1A2), no color change upon injury. Hymenophore poroid, adnate; pores angular to subcircular, grayish-yellow (3B3–5), no color change upon injury; tubes 0.1–0.5 cm deep, concolorous with pores, no color change upon injury. Stipe 2–4 × 0.2–0.4 cm, cylindric, mid-positioned, consolidated; surface pale brown (5B5–7), smooth, dry; context white (5A1), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [20/1/1] 6–7.82–9 × 4–4.85–5.5 μm, Q = 1.2–1.78 (–1.8), Qm = 1.62 ± 0.14, smooth, broadly ellipsoid to elongate, wall thickness 0.5–1 μm, pale yellowish-brown. Basidia 19–28 × 10–14 μm, 4-spored, subclavate to subcylindric, wall thickness approximately 0.5 μm,

achromatic, with granular contents; sterigmata 2–4 μm. Cheilocystidia 37–60 × 10–15 μm, subfusiform, numerous, wall thickness approximately 1 μm, achromatic, without incrustations. Pleurocystidia 40–65 × 11–17 μm, subfusiform, numerous, wall thickness 0.5–1 μm, achromatic, without incrustations. Hymenophoral trama consists of hyphae 2–15 μm wide, wall thickness approximately 1 μm, achromatic. Pileipellis a trichoderm-type, 330–500 μm thick, consists of hyphae 6–14 μm wide,wall thickness approximately 1 μm, achromatic, with cylindric apical cells 30–70 × 5–11 μm. Pileal trama consists of hyphae 2–16 μm wide, wall thickness approximately 1 μm, yellowish to achromatic. Stipitipellis 340–850 μm thick, consists of hyphae 2–14 μm wide, wall thickness approximately 1 μm, achromatic, with subcylindric to cylindric apical cells 31–106 × 4–10 μm. Stipe trama consists of hyphae 3–18 μm wide, wall thickness approximately 1 μm, achromatic. Clamp connections not observed in any tissue.

Known distribution – Guangdong and Fujian Provinces of China.

Material examined – China, Fujian Province, Tianbaoyan National Nature Reserve, 1600 m elev., on soil in Fagaceae-dominated forests, solitary, 23 August 2023, N.K. Zeng8293 (FHMU9218).

Notes – The type locality of *A. nanlingensis* is situated in Guangdong (Liu et al. 2024). Our study documents its additional occurrence in Fujian. The species was redescribed using a recently collected specimen, featuring its smaller basidiomata, a yellowish-brown to brown, subtomentose pileus, broadly ellipsoid to elongate basidiospores, and a trichodermal pileipellis. Additionally, certain morphological differences have been documented among specimens identified as *A. nanlingensis*. Notably, collections reported by Liu et al. (2024) exhibit a grayish-yellow to brownish-orange pileus, a yellowish-white to pale yellow stipe, and a context unchanging or slightly changing greyish-red upon injury.

***Aureoboletus pallidorubellus*** N.K. Zeng, H.Z. Qin, W.F. Lin & L.G. Hu, sp. nov. Figs 5k–l, 17

MycoBank: MB 860296; Facesoffungi: FoF 19076

Etymology – Latin "*pallidorubellus*" signifies the pale brownish-red pileal surface, and the new species shares morphological and phylogenetic affinities with *A. rubellus*.

Diagnosis – This species can be diagnosed by a relatively small basidiocarp, a pale brownish-red pileus, and cystidia coated with a layer of achromatic to pale yellow material, which distinguish it from the closest *Aureoboletus* species.

Basidiomata small in size. Pileus 3.1–4.3 cm across, convex to plano-convex; surface pale brownish-red (6A5–6), smooth, dry; margin decurved, entire; context at center 0.5–0.6 cm thick, yellowish-white (2A3), no color change upon injury. Hymenophore poroid, adnate to slightly decurrent; pores angular, somewhat relatively larger, bright yellow (2A7) to yellow (1B7), no color change upon injury; tubes 0.2–0.4 cm deep, concolorous with pores, no color change upon injury. Stipe 4.5–5.8 × 0.4–0.5 cm, subcylindric, mid-positioned, consolidated, becoming hollow when old; surface yellowish-green (2B6–7), smooth, dry; context yellow (1A6), no color change upon injury. Basal mycelium yellowish-white (1A3). Odor unremarkable.

Basidiospores [40/2/1] 8–9.73–11 (–12) × 5–6–6.5 (–7) μm, Q = 1.29–1.82 (–2), Qm = 1.63 ± 0.12, smooth, broadly ellipsoid to elongate, wall thickness approximately 1 μm, yellowish-brown. Basidia 28–43 × 11–15 μm, 4-spored, subclavate to clavate, wall thickness approximately 0.5 μm, yellowish to achromatic, with inflated apex and granular contents; sterigmata 2–7 μm. Cheilocystidia 60–115 × 2–16 μm, subfusiform, numerous, wall thickness 0.5–1 μm, yellow, surface coated with a layer (1–15 μm thick) of achromatic to pale yellow material. Pleurocystidia 49–108 × 2–14 μm, subfusiform, numerous, wall thickness approximately 0.5 μm, yellow, surface coated with a layer (1–16 μm thick) of achromatic to pale yellow material. Hymenophoral trama consists of hyphae 5–20 μm wide, wall thickness 0.5–0.8 μm, achromatic. Pileipellis a trichoderm-type, 300–560 μm thick, consists of hyphae 4–14 μm wide, wall thickness approximately 1 μm, yellowish to achromatic, with cylindric to subclavate apical cells 26–56 × 5–11 μm. Pileal trama consists of hyphae 3–17 μm wide, wall thickness approximately 1 μm, achromatic. Stipitipellis 320–795 μm thick, consists of hyphae 3–14 μm wide, wall thickness 0.5–1 μm, yellowish to achromatic, with subcylindric to cylindric apical

cells 55–130 × 5–14 μm. Stipe trama consists of hyphae 4–15 μm wide, wall thickness approximately 1 μm, achromatic. Clamp connections not observed in any tissue.

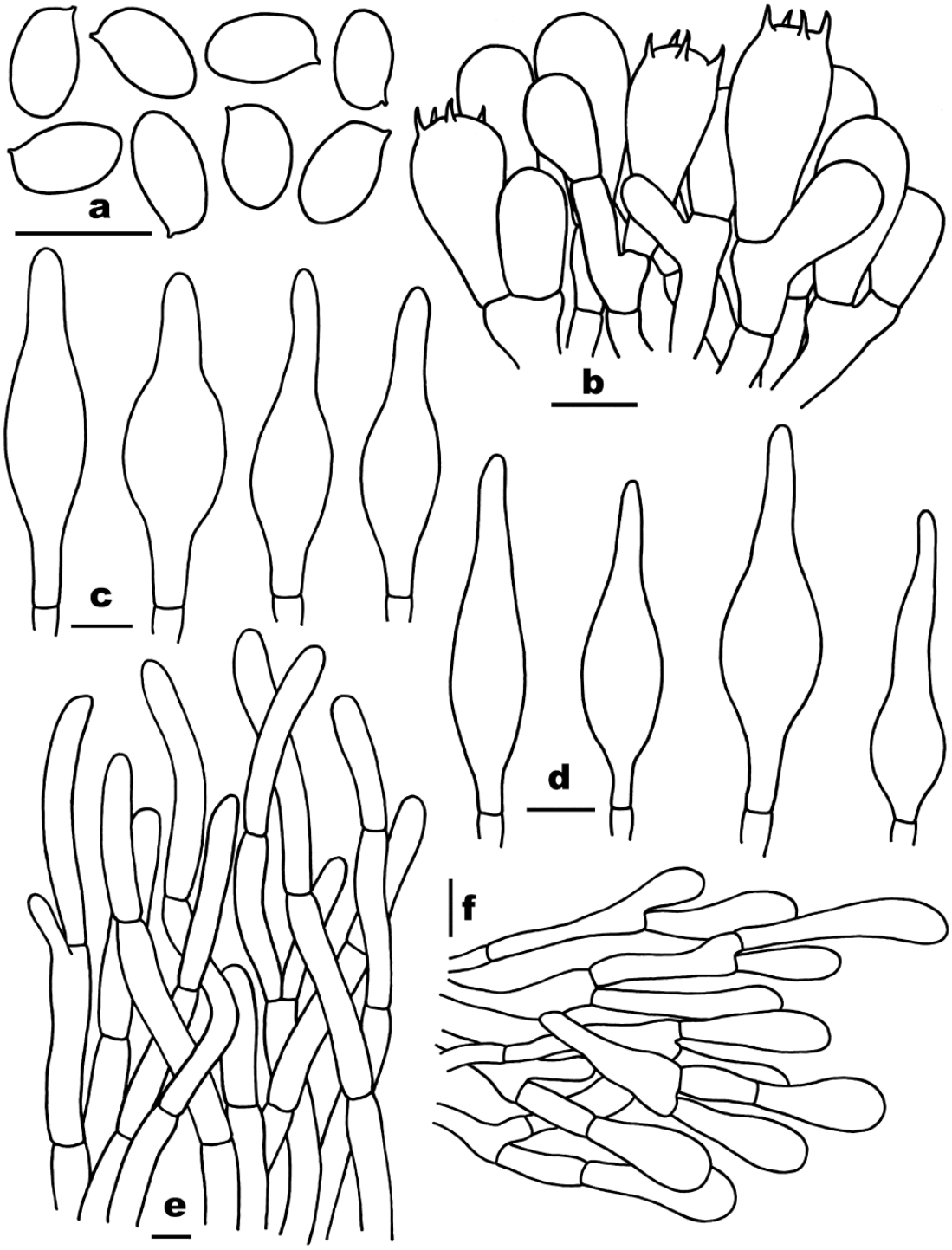


**Figure 16** – Microscopic characters of *Aureoboletus nanlingensis* (FHMU9218). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Known distribution – Zhejiang Province of China.

Material examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1200 m elev., on soil in Fagaceae-dominated forests, gregarious, 14 August 2023, N.K. Zeng7869 (FHMU9222, holotype).

Notes – *Aureoboletus pallidorubellus* shares morphological similarities with some taxa, viz. *A. nephrosporus*, *A. minimus*, *A. raphanaceus*, *A. readii*, and *A. venustus* Fang Li et al. However,

*A. nephrosporus*, with type locality in Yunnan, has a grayish-rose to brownish-red pileus and a dark orange stipe with furfuraceous scales and distinct longitudinal streaks (Wu et al. 2016); *A. minimus*, with type locality in Vietnam, has a pastel red to grayish-red pileus, surface adorned with tomentose to fbrillose squamules, a context slightly turning to greyish-red or greyish-pink upon injury, a grayish-red stipe, surface adorned with white to yellowish-brown fibrils and tomentum, subfusiform and longer basidiospores 13–16 × 5–6 μm, and cystidia without incrustations (Liu et al. 2024); *A. raphanaceus*, with type locality in Jiangxi, has a white to yellowish-white pileus adorned with yellowish-grey to brownish-grey squamules, a context no color change or slightly turning blue near the hymenophore upon injury, a light yellow hymenophore, a yellowish-white stipe, ovoid and relatively smaller basidiospores 7.5–9 × 5–6 μm, and an ixotrichoderm-type pileipellis (Zhang et al. 2019); *A. readii*, with type locality in México, has a sticky, larger and reddish-brown to red cinnamon pileus, a furfuraceous stipe, cylindric basidiospores 11–13 × 4–5 μm, cystidia without incrustations, and an ixotrichoderm-type pileipellis (Ayala-Vásquez et al. 2023a); *A. venustus*, with type locality in Guangdong of China, has a reddish-orange to reddish-brown pileus, a reddish-orange to grayish-red stipe, cystidia without incrustations, and an ixotrichoderm-type pileipellis (Li et al. 2016).

In addition, *A. pallidorubellus* was previously misidentified as *A. rubellus* Kuan Zhao & G. Wu (Zhang et al. 2019). Although these two phylogenetically closely related taxa share many morphological characteristics, they can be distinguished. *A. rubellus*, with type locality in Jiangxi of China, has a pileus adorned with a thin whitish pruina when young, becoming tomentose with age, context turning pale blue upon injury, and a light yellow stipe (Fang et al. 2019).

***Aureoboletus phaeosquamus*** N.K. Zeng, H.Z. Qin, W.F. Lin & L.G. Hu, sp. nov. Figs 6a–c, 18

MycoBank: MB 860298; Facesoffungi: FoF 19077

Etymology – Latin "*phaeosquamus*" signifies the pileus and stipe adorned with brown-tinged squamules.

Diagnosis – This species can be diagnosed by a pileus adorned with reddish-brown to brown squamules, a hymenophore and context turning pale bluish-green upon injury, a stipe densely adorned with small and pale brown squamules, and relatively larger basidiospores, which distinguish it from the closest *Aureoboletus* species.

Basidiomata ranging from small to large in size. Pileus 4.5–9.8 cm across, convex when young, expanding to applanate with age; surface maize yellow (3A3–4) to light salmon (5A4–5), adorned with reddish-brown (7C6) when young, then dark brown (6E7–8) to brown (6B5–6) squamules, deeper in the center, dry; margin decurved, entire; context at center 0.2–1.3 cm thick, white (1A1) to yellowish-white (2A2), turning pale bluish-green (26A3–4) upon injury. Hymenophore poroid, sinuate; pores angular, white (1A1) to yellowish-white (1A2) when young, and pale yellow (2A2) to fawn (1B4) in age, turning pale bluish-green (26A3) upon injury; tubes 0.1–1.2 cm deep, light yellowish-brown (1B4–5), turning pale bluish-green (26A4) upon injury. Stipe 7.3–11.2 × 1.5–2.1 cm, subcylindric, mid-positioned, consolidated; surface pale yellow (4A3–4) when young, then becoming light reddish-brown (7B5–6) to brown (6C4–5), densely adorned with small and pale brown (5B4) squamules, dry; context white (2A1) to yellowish-white (2A3), turning pale bluish-green (26A3) upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [40/2/1] (13–) 13.5–15.84–18 (–19) × 5–5.79–6 (–6.5) μm, Q = (2.33–) 2.36–3.2 (–3.4), Qm = 2.75 ± 0.26, smooth, fusoid to cylindric, wall thickness 0.5–0.8 μm, yellowish-brown. Basidia 29–45 × 9.5–15 μm, 4-spored, subclavate to subcylindric, wall thickness 0.5–1 μm, yellowish to yellow, with inflated apex and granular contents; sterigmata 2–7 μm. Cheilocystidia 39–71 × 15–26 μm, subfusiform, numerous, wall thickness approximately 1 μm, achromatic, without incrustations. Pleurocystidia 50–70 × 21–29 μm, subfusiform, numerous, wall thickness approximately 1 μm, achromatic, without incrustations. Hymenophoral trama consists of hyphae 4–11 μm wide, wall thickness approximately 1 μm, achromatic. Pileipellis a trichoderm-type, 130–230 μm thick, consists of hyphae 5–15 μm wide, wall thickness 0.5–1 μm, yellowish to yellow, with cylindric apical cells 12–64 × 5–13 μm. Pileal trama consists of hyphae 4–17 μm wide, wall thickness approximately 0.5 μm, yellowish to achromatic. Stipitipellis 96–280 μm thick, consists of hyphae 4–

17 μm wide, wall thickness approximately 1 μm, yellowish to yellow, with subcylindric to cylindric apical cells 26–95 × 6–11 μm. Stipe trama consists of hyphae 4–20 μm wide, wall thickness approximately 1 μm, achromatic. Clamp connections not observed in any tissue.

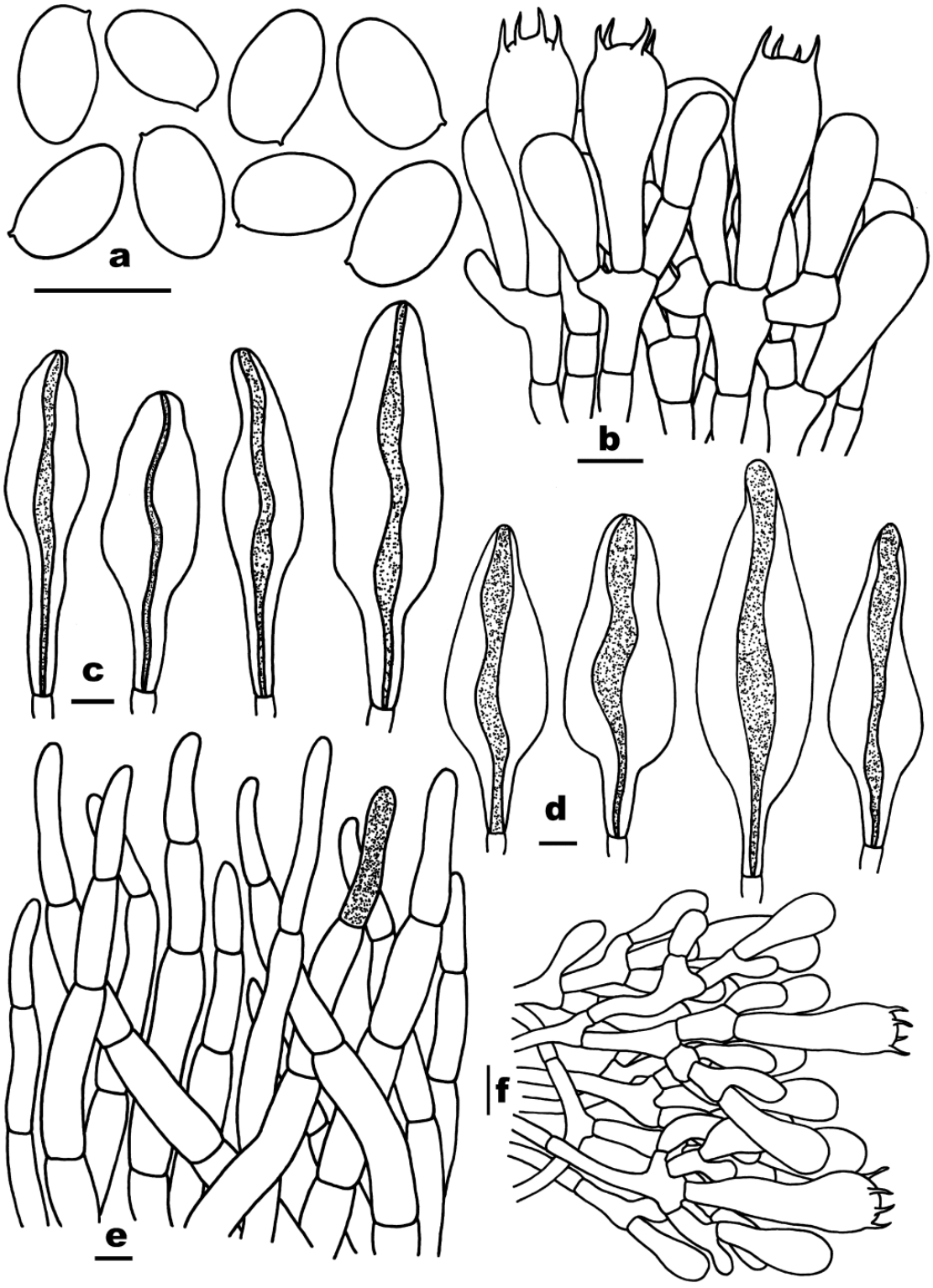


**Figure 17** – Microscopic characters of *Aureoboletus pallidorubellus* (FHMU9222, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Known distribution – Zhejiang Province of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1200 m elev., on soil in Pinaceae and Fagaceae mixed forests, solitary or gregarious, 14 August 2023, N.K. Zeng7915 (FHMU9227); same locality and date, N.K. Zeng7920 (FHMU9228, holotype).

Notes – *Aureoboletus phaeosquamus* shares morphological similarities with *A. ayuukii*, *A. conicus*, and *A. velutipes*. However, *A. ayuukii*, with type locality in Mexico, has a small, sticky, furfuraceous and brownish-orange pileus, a context turning brownish-orange upon injury, a furfuraceous stipe, and relatively smaller basidiospores 9–11 × 4–5 μm (Ayala-Vásquez et al. 2023a); *A. conicus*, with type locality in Hainan, has a small and orangish-brown pileus, a hymenophore and context no color change upon injury, and broadly ellipsoid and relatively smaller basidiospores 7–9 × 4–5.5 μm (Xue et al. 2023); *A. velutipes*, with type locality in Guangdong, has a smaller basidioma, a context slightly changing to pastel red upon injury, a pastel yellow stipe, and relatively smaller basidiospores 10–13 × 5–6 μm (Zhang et al. 2019).

Phylogenetically, *A. phaeosquamus* exhibits close affinity with *A. russellii* and *A. wusangongii* N.K. Zeng et al. (Fig. 2). However, *A. russellii* has a glutinous pileus, a stipe with distinctly coarse-lacerate reticulations, a hymenophore and context with no color change upon injury, relatively smaller basidiospores 7.6–10 × 3–3.4 μm, and an ixotrichoderm-type pileipellis, and it occurs in North America (Frost 1874, Halling 1983, Wu et al. 2016); Chinese *A. wusangongii* has a sticky pileus densely adorned with grayish-white to white fluffs, a stipe with distinctly coarse-lacerate reticulations, a hymenophore and context with no color change upon injury, wider basidiospores 15–17.5 × 7–9 μm, with longitudinal ridges, and a subcutis-type pileipellis (Qin et al. 2024b).

***Aureoboletus sinocyanescens*** G. Wu & Zhu L. Yang, Fungal Diversity 10.1007/s13225-025-00558-x: [90], 2025 Figs 6d–h, 19

MycoBank: MB 858319; Facesoffungi: FoF 19078

Basidiomata ranging from small to medium in size. Pileus 3.3–9 cm across, hemispherical to convex; surface pinkish (11A4–5), rosy (11B6) to pale orange red (7A5–6), smooth, slightly sticky when wet; margin decurved, entire; context at center 0.3–1.6 cm thick, white (1A1) to yellowish-white (3A2), changing blue (25A4–5), then turning reddish-brown (9B4), and finally brown (5C5–6) upon injury; Hymenophore poroid, sinuate; pores angular to subcircular, yellowish-white (1A2) when young, and pale yellow (1A4–5) in age, changing blue (25A5), then turning red (9B4), and finally brown (5C5) upon injury; tubes 0.3–1.8 cm deep, pale yellow (2A3), variation with pores. Stipe 5.5–10 × 1.6–3.4 cm, subcylindric, mid-positioned, consolidated, slightly enlarged at the base; surface reticulate, pinkish (11A5–6) to yellowish (1A2–3) when young, and pale orange red (8A5), pinkish (11B6), rosy (11B7) to rufous (11C7) in age, slightly sticky when wet; context pale yellow (1A4) to yellow (2A5), changing blue (25A4–5), then turning red (9B4) slowly upon injury. Basal mycelium pale yellow (1A2–2A2). Odor unremarkable.

Basidiospores [100/5/2] (5–) 6–7.05–8 × 4–5.02–5.5 (–6) μm, Q = (1.11–) 1.17–1.56 (–1.75), Qm = 1.41 ± 0.11, smooth, ovoid, broadly ellipsoid to ellipsoid, wall thickness 0.5–1 μm, pale yellowish-brown. Basidia 16–29 × 7–9 μm, 4-spored, subclavate to cylindric, wall thickness approximately 0.5 μm, yellowish to yellow; sterigmata 2–6 μm. Cheilocystidia 17–31 × 4–6 μm, subfusiform, not numerous, wall thickness approximately 0.5 μm, yellowish, without incrustations. Pleurocystidia 21–30 × 6–8 μm, subfusiform, not numerous, wall thickness 0.5–1 μm, yellowish to yellow, without incrustations. Hymenophoral trama consists of hyphae 4.5–15 μm wide, wall thickness approximately 0.5 μm, yellowish to achromatic. Pileipellis a trichoderm-type, 120–265 μm thick, consists of hyphae 3.5–9 μm wide, wall thickness approximately 0.5 μm, occasionally bifurcate, yellowish to yellow, with clavate apical cells 18–62 × 4–8 μm, with inflated apex. Pileal trama consists of hyphae 3–14 μm wide, wall thickness approximately 0.5 μm, yellowish. Stipitipellis 120–230 μm thick, consists of hyphae 4–7 μm wide, wall thickness approximately 0.5 μm, yellowish to yellow, with subcylindric to cylindric apical cells 35–66 × 4–6 μm. Stipe trama consists of hyphae 2–10 μm wide, wall thickness approximately 1 μm, yellowish. Clamp connections not observed in any tissue.

Known distribution – Yunnan, Zhejiang and Fujian Provinces of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1200 m elev., on soil in Pinaceae and Fagaceae mixed forests, solitary or gregarious, 13 August 2023, N.K. Zeng7801 (FHMU9223); same locality and date, N.K. Zeng7835 (FHMU9224); same locality, 14 August 2023, N.K. Zeng7919 (FHMU9225). Fujian Province, Jiangle County, Longqi Mountain National Nature Reserve, 600 m elev., on soil in Pinaceae and Fagaceae mixed forests, gregarious, 21 August 2023, N.K. Zeng8208 (FHMU9226).

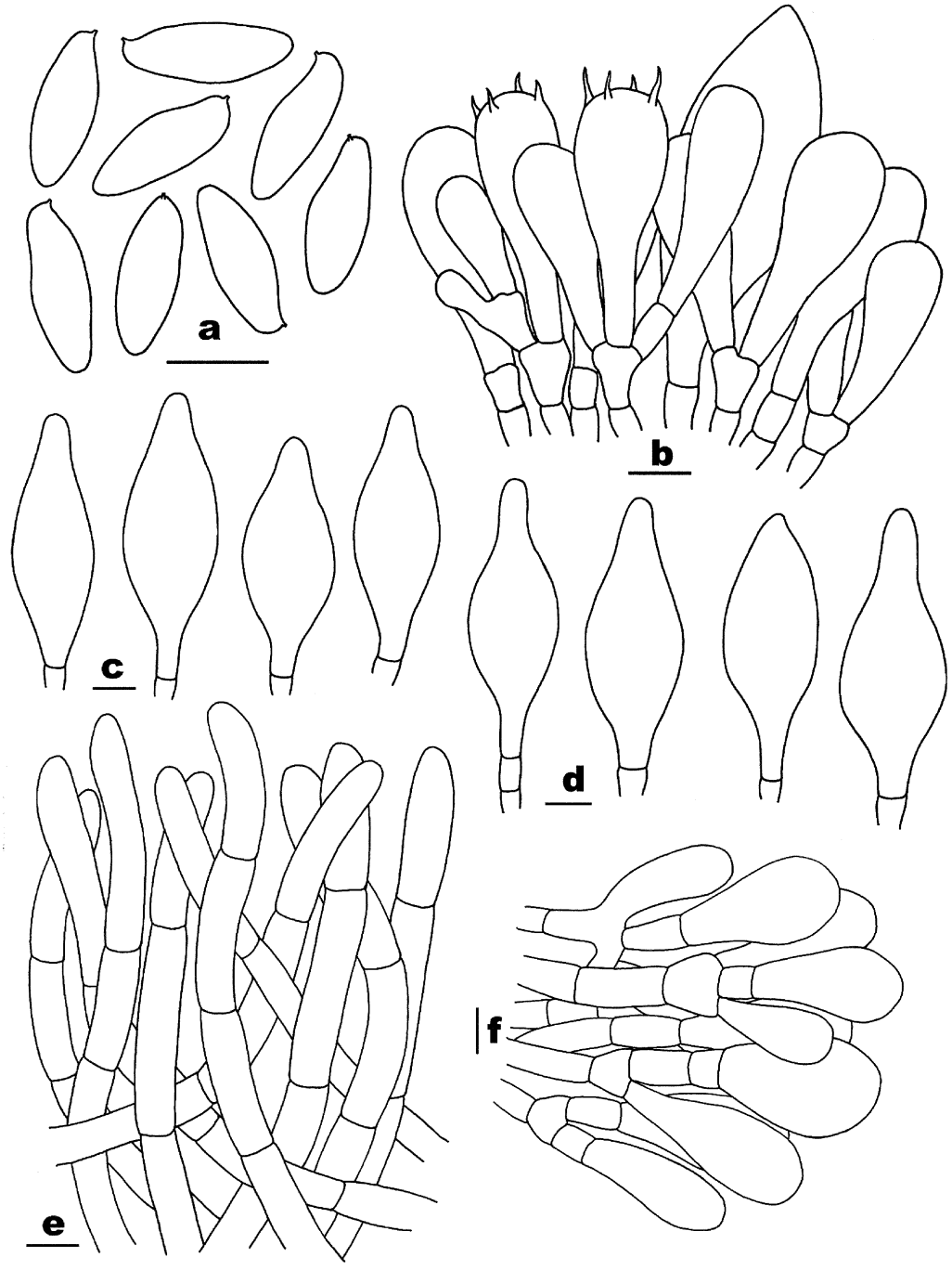


**Figure 18** – Microscopic characters of *Aureoboletus phaeosquamus* (FHMU9228, holotype). a Basidiospores. b Basidia and pleurocystidium. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

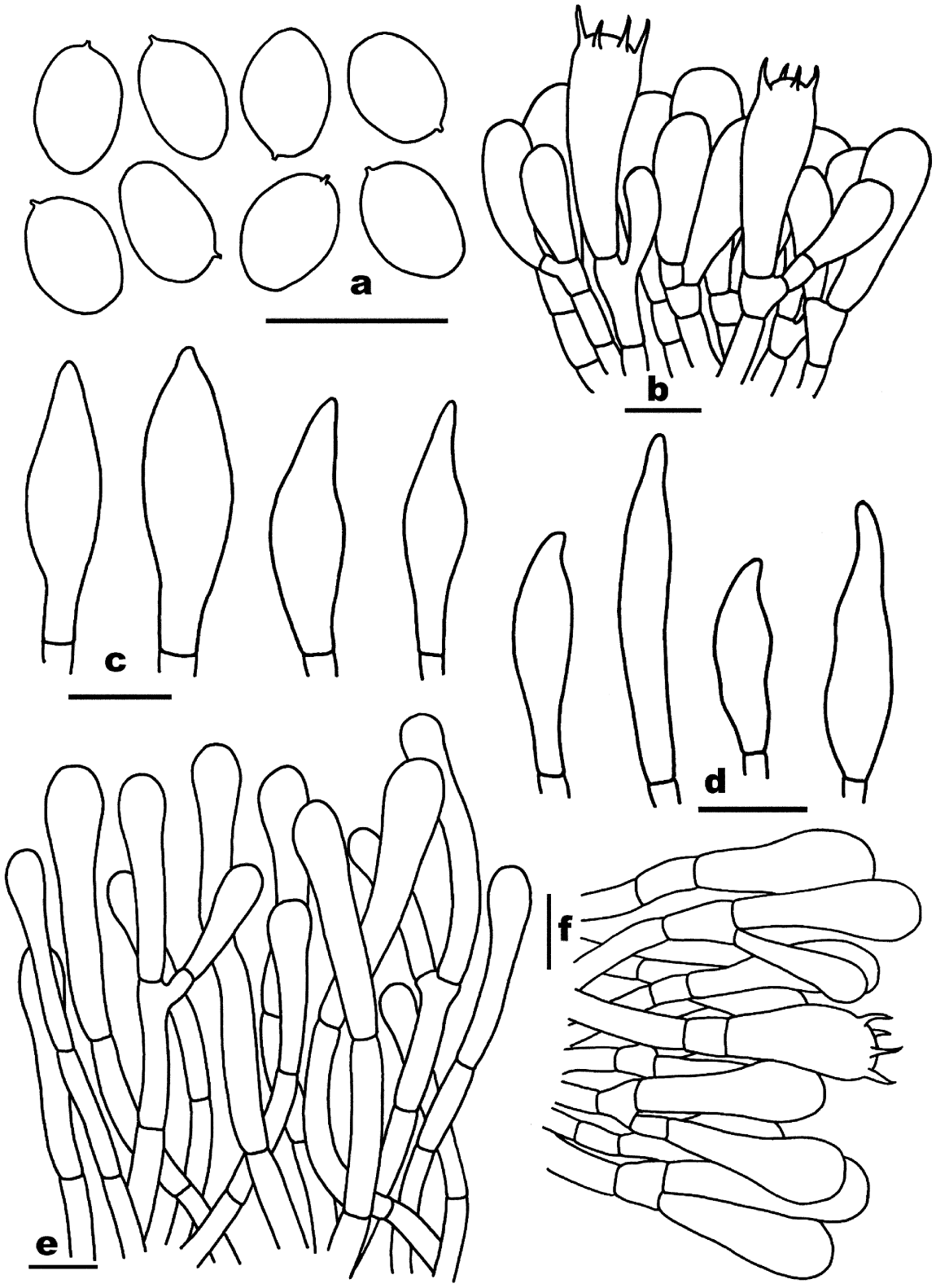


**Figure 19** – Microscopic characters of *Aureoboletus sinocyanescens* (FHMU9225). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Notes – The type locality of *A. sinocyanescens* is situated in Yunnan (Wang et al. 2025). Our study documents its additional occurrence in Zhejiang and Fujian. The species was redescribed using recently collected specimens, featuring a pinkish to pale orange-red basidioma, a blue-red-brown color change of hymenophore and context upon injury, a reticulate stipe, ovoid and small basidiospores, and a trichodermal-type pileipellis with inflated apex of apical cells. Additionally,

certain morphological differences have been documented among specimens identified as *A. sinocyanescens*. Notably, collections reported by Wang et al. (2025) exhibit a hymenophore and context only changing blue upon injury and a pastel yellow stipe.

***Aureoboletus urceopileus*** N.K. Zeng & H.Z. Qin, sp. nov. Figs 6i–j, 20

MycoBank: MB 860299; Facesoffungi: FoF 19079

Etymology – Latin "*urceopileus*" signifies the color and shape of the pileus, which resemble the lid of a Chinese pickle jar.

Diagnosis – This species can be diagnosed by a brown basidioma, a grayish-yellow hymenophore, and narrower cystidia, which distinguish it from the closest *Aureoboletus* species.

Basidiomata ranging from medium to large in size. Pileus 8–9.8 cm across, convex to plano-convex; surface pale brown (6C5) to brown (6C6–6D6), smooth, dry; margin decurved, entire; context at center 1–1.5 cm thick, white (1A1), no color change upon injury. Hymenophore poroid, slightly sinuate; pores angular to subcircular, grayish-yellow (30B4–5) to pale yellowish-green (30B6), no color change upon injury; tubes 0.5–1 cm deep, grayish-yellow (30A5), no color change upon injury. Stipe 7.5–8.6 × 1.5–2.2 cm, subcylindric, mid-positioned, consolidated, slightly enlarged at the base; surface brown (5C5–6), whitish (5A1–2), dry; context yellowish-white (4A2), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [40/2/2] 9–10.41–11.5 (–12) × 4–4.79–5 μm, Q = (1.8–) 1.9–2.4 (–2.75), Qm = 2.18 ± 0.16, smooth, elongate to cylindric, wall thickness 0.5–1 μm, yellowish-brown. Basidia 15–25 × 7.5–10 μm, 4-spored, subclavate, wall thickness approximately 0.5 μm, yellowish to achromatic, with inflated apex; sterigmata 1–4 μm. Cheilocystidia 31–48 × 6.5–8 μm, subfusiform, not numerous, wall thickness approximately 1 μm, yellowish to achromatic, without incrustations. Pleurocystidia 39–63 × 7–9 μm, subfusiform, not numerous, wall thickness approximately 1 μm, yellowish to achromatic, without incrustations. Hymenophoral trama consists of hyphae 4–13 μm wide, wall thickness 0.5–0.8 μm, achromatic. Pileipellis a trichoderm-type, 145–310 μm thick, consists of hyphae 6–14 μm wide, wall thickness approximately 1 μm, yellowish to yellow, with subcylindric apical cells 23–64 × 6–15 μm. Pileal trama consists of wall thickness 0.5–0.8 μm, 5–16 μm wide hyphae, yellowish to achromatic. Stipitipellis 130–220 μm thick, consists of hyphae 3–10 μm wide, wall thickness approximately 0.5 μm, yellowish to yellow, with subcylindric to cylindric apical cells 26–62 × 4–7 μm. Stipe trama consists of hyphae 4–18 μm wide, wall thickness approximately 1 μm, yellowish. Clamp connections not observed in any tissue.

Known distribution – Fujian Province of China.

Materials examined – China, Fujian Province, Wuyishan, 1100 m elev., on soil in Fagaceae-dominated forests, solitary, 16 August 2023, N.K. Zeng7961 (FHMU9252, holotype); same locality and date, N.K. Zeng7961-1 (FHMU9253).

Notes – *Aureoboletus urceopileus* shares morphological similarities with *A. duplicatoporus*, *A. nanlingensis*, and *A. ornatipes*. However, *A. duplicatoporus*, with type locality in Yunnan, has a nearly glabrous and sticky pileus, a maize yellow hymenophore, a reddish-orange and sticky stipe, and an ixotrichoderm-type pileipellis (Zang 1992, Wu et al. 2016); *A. nanlingensis*, with type locality in Guangdong, has a small, subtomentose pileus, a light yellow hymenophore, a yellowish-white stipe, and ellipsoidal and relatively smaller basidiospores 7–8.5 × 4.5–5 μm (Liu et al. 2024); *A. ornatipes*, with type locality in Hainan, has a reddish-brown and reticulate stipe (Xue et al. 2023).

***Aureoboletus velutipes*** Ming Zhang & T.H. Li, MycoKeys 61: 121, 2019 Figs 6k–l, 21

MycoBank: MB 827108; Facesoffungi: FoF 19080

Basidiomata very small in size. Pileus 0.6–1.6 cm across, subhemispherical, convex to plano-convex; surface pale brown (5B3–6), adorned with brown (6C7–8) and tomentose squamules, dry; margin decurved, entire; context at center 0.15–0.4 cm thick, yellowish-white (1A2), no color change upon injury. Hymenophore poroid, sinuate; pores angular to subcircular, white (1A1) when young, becoming yellowish-white (1A2–3) with age, no color change upon injury; tubes 0.05–0.25 cm deep, yellowish-white (1A3), no color change upon injury. Stipe 2.1–2.5 × 0.2–0.7 cm, subcylindric, mid-

positioned, consolidated, becoming hollow when old; surface pale brown (5C5–6), adorned with scattered and tomentose squamules, white (1A1), dry; context yellowish-white (3A2), no color change upon injury. Basal mycelium whitish (3A1). Odor unremarkable.

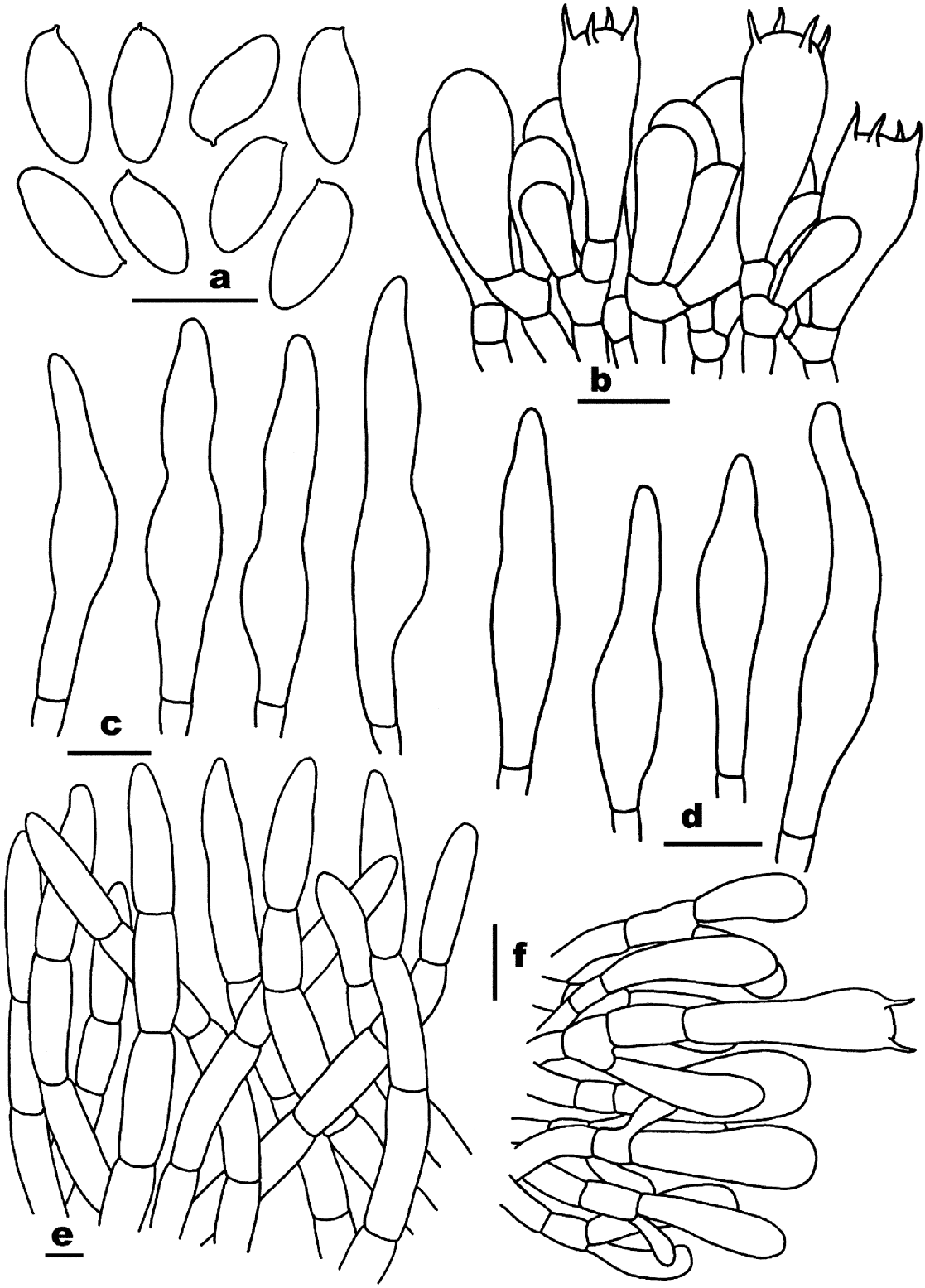


**Figure 20** – Microscopic characters of *Aureoboletus urceopileus* (FHMU9252, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Basidiospores [80/4/1] 8–9.83–11 (–12) × 4–4.94–5.5 (–6) μm, Q = (1.6–) 1.78–2.25 (–2.38), Qm = 1.99 ± 0.15, smooth, elongate to cylindric, wall thickness approximately 0.5 μm, pale

yellowish-brown. Basidia 22–32 × 8–11 μm, 4-spored, subclavate to subcylindric, wall thickness approximately 0.5 μm, yellowish, with granular contents; sterigmata 2–5 μm. Hymenophoral trama consists of hyphae 3–15 μm wide, wall thickness 0.5–1 μm, achromatic. Cheilocystidia 30–59 × 8–17 μm, subfusiform, numerous, wall thickness approximately 0.5 μm, yellowish to achromatic, without incrustations. Pleurocystidia 35–56 × 9–14 μm, subfusiform, numerous, wall thickness approximately 0.5 μm, yellowish to achromatic, without incrustations. Pileipellis a trichoderm-type, 170–350 μm thick, consists of hyphae 5–15 μm wide, wall thickness approximately 1 μm, achromatic, with subclavate to cylindric apical cells 28–100 × 6–11 μm. Pileal trama consists of hyphae 3–15 μm wide, wall thickness 0.5–1 μm, achromatic. Stipitipellis 240–490 μm thick, consists of parallel, hyphae 3–14 μm wide, wall thickness approximately 0.5 μm, yellowish, with subcylindric to cylindric apical cells 30–125 × 5–13 μm. Stipe trama consists of hyphae 3–21 μm wide, wall thickness approximately 1 μm, yellowish. Clamp connections not observed in any tissue.

Known distribution – Guangdong, Guangxi, Jiangxi and Fujian Provinces of China.

Material examined – China, Fujian Province, Jiangle County, Longqi Mountain National Nature Reserve, 1100 m elev., on soil in Fagaceae-dominated forests, gregarious, 21 August 2023, N.K. Zeng8182 (FHMU9254).

Notes – The type locality of *A. velutipes* is situated in Guangdong, then it was reported in Guangxi and Jiangxi (Zhang et al. 2019). Our study documents its additional occurrence in Fujian. The species was redescribed using recently collected specimens, featuring a smaller basidioma, a pale brown pileus adorned with brown and tomentose squamules, a pale brown stipe adorned with white, scattered and tomentose squamules, elongate to cylindric basidiospores, and a trichodermal pileipellis. Additionally, certain morphological differences have been documented among specimens identified as *A. velutipe*s. Notably, collections reported by Zhang et al. (2019) exhibit a larger pileus (up to 4 cm across) and a context turning slightly pastel red upon injury.

***Aureoboletus wusangongii*** N.K. Zeng, H.Z. Qin, W.F. Lin & L.G. Hu, Phytotaxa 674(2): 210, 2024

MycoBank: MB 855601

**Synonym** – *Aureoboletus pseudorussellii* D.F. Sun, R. Hua, Fan Zhou & Jun B. Zhang, Mycobiology 53(3): 308, 2025Known distribution – Zhejiang Province of China.

Notes – The type locality of *A. wusangongii* is situated in Zhejiang (Qin et al. 2024b). Subsequently, *A. pseudorussellii* was published based on collections also from Zhejiang Province (Qin et al. 2024b). Our molecular data confirm that *A. pseudorussellii* is a synonym of *A. wusangongii* (Fig. 2). Furthermore, no fundamental morphological distinctions exist between the two (Qin et al. 2024b; Zhou et al. 2025).

***Aureoboletus yunnanensis*** G. Wu & Zhu L. Yang, Fungal Diversity 81: 55, 2016 Figs 6m–n, 22

MycoBank: MB 818391; Facesoffungi: FoF 19081

Basidiomata ranging from small to large in size. Pileus 3.5–11.5 cm across, subhemispherical, convex to plano-convex; surface grayish-blue (25B3–5), sticky when wet; margin decurved, entire; context at center 0.5–1.2 cm thick, white (1A1) to reddish (8A2), no color change upon injury. Hymenophore poroid, adnate; pores angular to subcircular, vivid yellow (1A7–2A8), no color change upon injury; tubes 0.2–0.6 cm deep, pale yellow (1A4–5) to yellow (1A7–8), no color change upon injury. Stipe 4.5–10.5 × 1.2–2.2 cm, subcylindric, mid-positioned, consolidated; surface yellowish- white (2A2) to reddish (7A2–3), smooth, white (1A1), dry; context white (2A1), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [80/4/3] 7–9.38–10.5 (–11) × 4–4.72–5 (–5.5) μm, Q = (1.6–) 1.75–2.25, Qm = 1.99 ± 0.16, smooth, elongate to cylindric, wall thickness 0.5–0.8 μm, pale yellowish-brown. Basidia 22–30 × 7–10 μm, 4-spored, subclavate to subcylindric, wall thickness approximately 0.5 μm, yellowish to achromatic; sterigmata 2–4 μm. Cheilocystidia 21–36 × 6–12 μm, subfusiform, numerous, wall thickness approximately 1 μm, achromatic, without incrustations. Pleurocystidia 22–56 × 7–13 μm, subfusiform, numerous, wall thickness 0.5–1 μm, achromatic, without incrustations. Hymenophoral trama consists of hyphae 3–8 μm wide, wall thickness approximately 1 μm, yellowish

to achromatic. Pileipellis an ixocutis-type, 130–240 μm thick, consists of hyphae 3–10 μm wide, wall thickness approximately 0.5 μm, yellowish to achromatic, with subclavate to cylindric apical cells 41–75 × 3–9 μm. Pileal trama consists of hyphae 3–14 μm wide, wall thickness approximately 1 μm, yellowish to achromatic. Stipitipellis 240–440 μm thick, buried in the gelatinous substance, consists of hyphae 4–15 μm wide, wall thickness 0.5–0.8 μm, yellowish to achromatic, with subcylindric to cylindric apical cells 22–70 × 6–15 μm. Stipe trama consists of hyphae 3–13 μm wide, wall thickness approximately 1 μm, achromatic. Clamp connections not observed in any tissue.

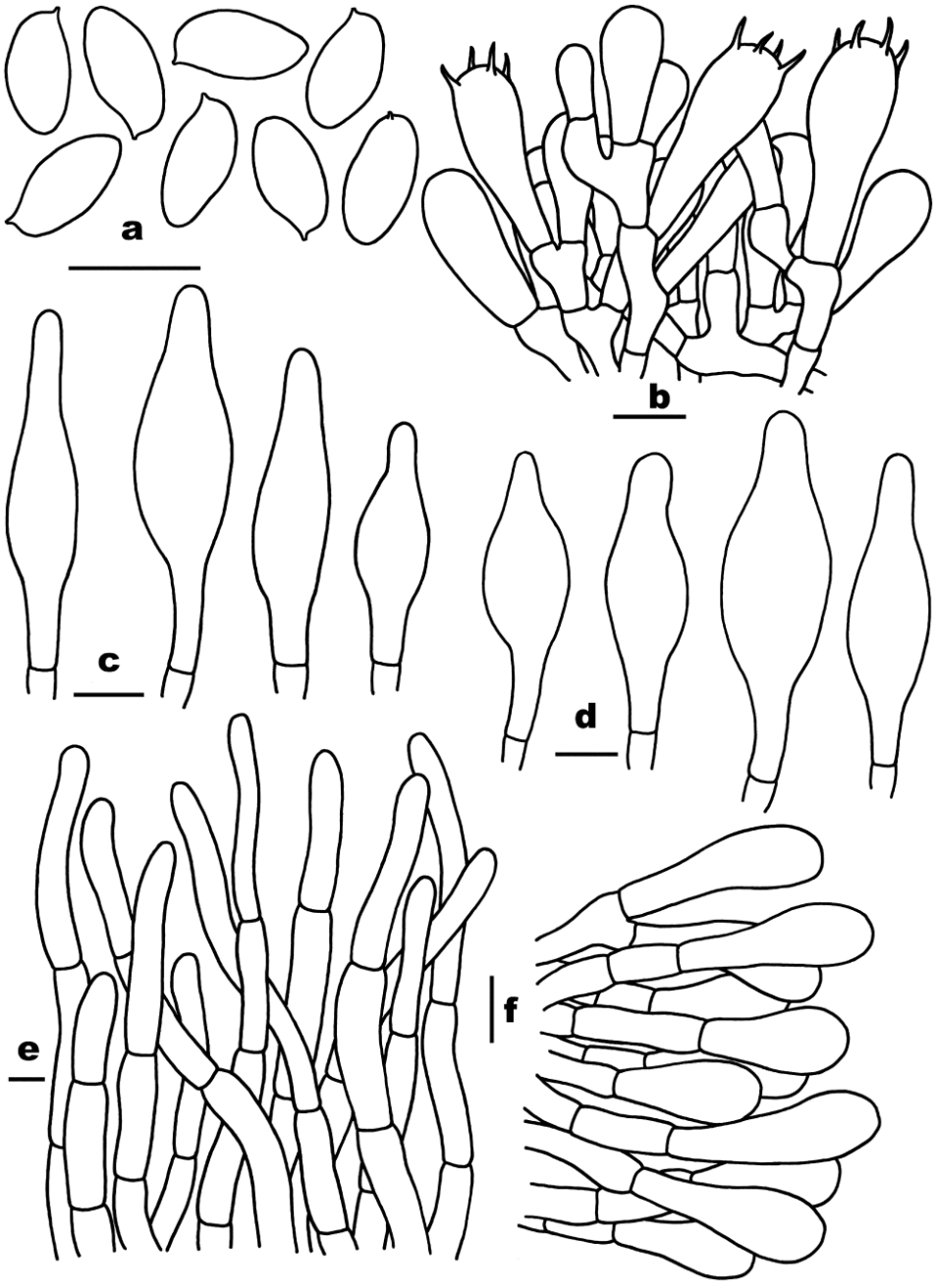


**Figure 21** – Microscopic characters of *Aureoboletus velutipes* (FHMU9254). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

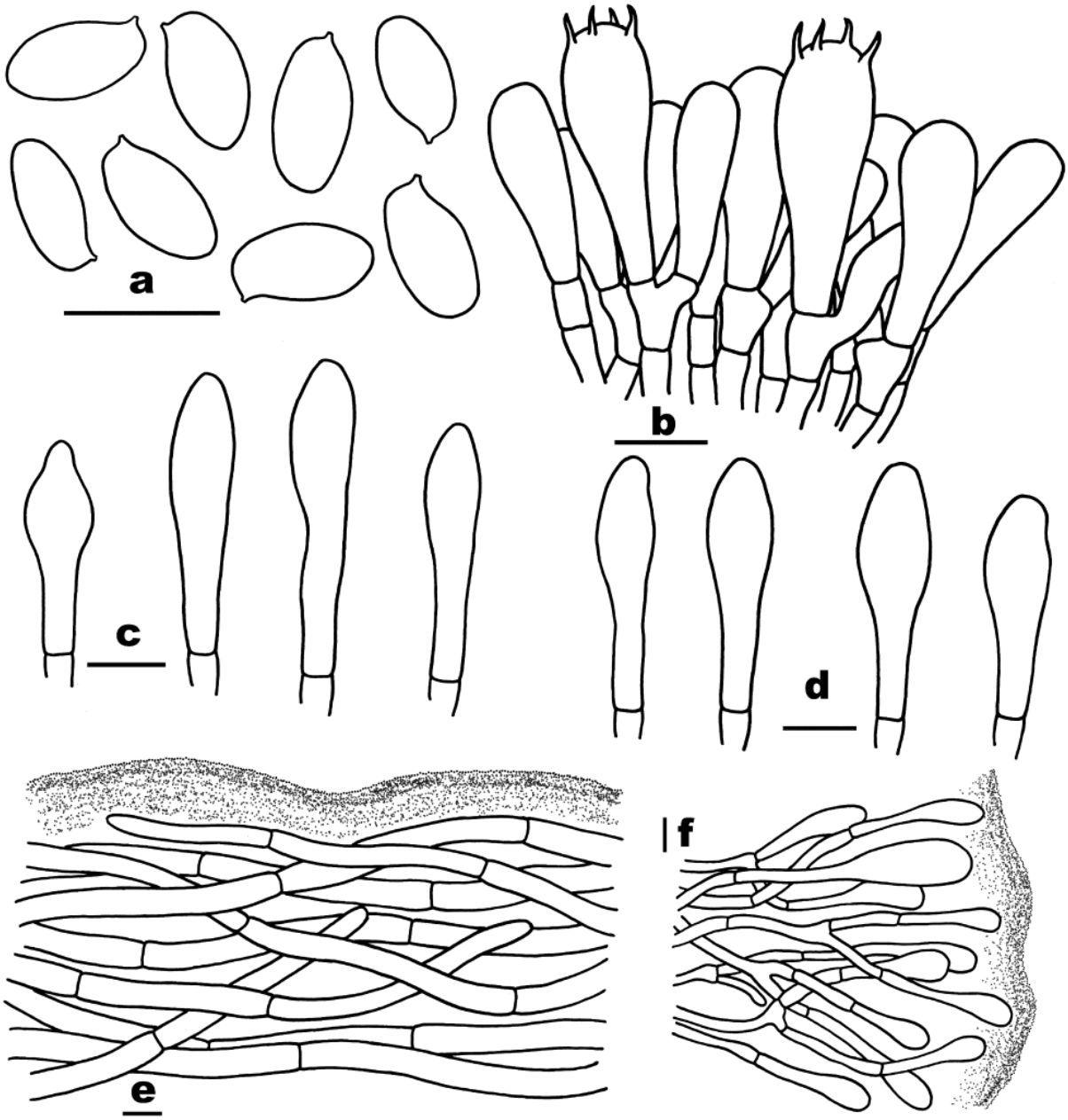


**Figure 22** – Microscopic characters of *Aureoboletus yunnanensis* (FHMU9255). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Known distribution – Yunnan, Fujian and Zhejiang Provinces of China.

Materials examined – China, Fujian Province, Tiantai National Forest Park, 370 m elev., 28 August 2009, N.K. Zeng623 (FHMU392); Wuyishan, 1100 m elev., on soil in Fagaceae-dominated forests, solitary, 16 August 2023, N.K. Zeng7939 (FHMU9256). Zhejiang Province, Qingyuan County, Zuoxi Town, Yinjiang Village, 800 m elev., on soil in Fagaceae-dominated forests, gregarious, 14 August 2023, gui0001 (FHMU9255).

Notes – The type locality of *A. yunnanensis* is situated in Yunnan (Wu et al. 2016), then it was reported in Fujian (Xue et al. 2023). Our study documents its additional occurrence in Zhejiang. The species was redescribed using recently collected specimens, featuring a larger basidioma, a sticky and grayish-blue pileus, a vivid yellow hymenophore, a whitish stipe, and an ixocutis-type pileipellis. Additionally, certain morphological differences have been documented among specimens identified as *A. yunnanensis*. Notably, collections reported by Wu et al. (2016) exhibit a grayish-orange to brownish-orange pileus, a grayish-yellow stipe, and an ixotrichoderm-type pileipellis.

**Key to accepted species of *Aureoboletus* in China**

1. Stipe surface adorned with reticulation ..... 2
1. Stipe surface without reticulation ..... 4
2. Basidiospores larger 15–17.5 × 7–9 μm, with longitudinal ridges, pileipellis a subcutis, stipe with distinctly coarse-lacerate reticulations ..... *A. wusangongii*
2. Basidiospores smaller up to 12.5 μm long and 5 μm wide, smooth, pileipellis a trichoderm, stipe with short and shallow reticulations ..... 3
3. Pileal surface old rose to greyish-red, a hymenophore and context turning blue upon injury, basidiospores 7–9 × 4–5 μm ..... *A. sinocyanescens*
3. Pileal surface reddish-brown, context and hymenophore no color change upon injury, basidiospores 10–12.5 × 4–5 μm ..... *A. ornatipes*
4. Pileal surface dry or slightly sticky when wet ..... 5
4. Pileal surface sticky ..... 29
5. Basidiomata medium to larger (pileus ≥ 6 cm across) ..... 6
5. Basidiomata smaller (pileus < 6 cm across) ..... 11
6. Stipe surface white to yellowish-white ..... 7
6. Stipe surface yellowish-brown, reddish-brown to brown ..... 8
7. Pileus reddish-brown to brown, an intricate trichoderm pileipellis ..... *A. albipes*
7. Pileus grayish-orange to brownish-orange, or grayish-blue, an ixotrichodermal to ixocutis pileipellis ..... *A. yunnanensis*
8. Pileal surface smooth, without squamules ..... 9
8. Pileal surface adorned with brown to reddish-brown squamules ..... 10
9. Hymenophore turning pale red to red slowly upon injury, pleuro- and cheilocystidia up to 15 μm wide, pileipellis consists of narrow and clavate hyphae (up to 6 μm wide) ..... *A. macrocarpus*
9. Hymenophore no color change upon injury, pleuro- and cheilocystidia up to 9 μm wide, pileipellis consists of thick and subcylindric hyphae (up to 15 μm wide) ..... *A. urceopileus*
10. Hymenophore no color change upon injury, context turning to yellowish-olive upon injury, stipe surface without squamules, basidiospores subglobose, 7–8 × 5.5–6 μm, a slightly interwoven trichoderm pileipellis consists of clavate hyphae ..... *A. clavatus*
10. Hymenophore changing pale bluish-green upon injury, context changing pale bluish-green upon injury, stipe surface densely adorned with small and pale brown squamules, basidiospores fusoid to cylindric, 13.5–18 × 5–6 μm, a trichoderm pileipellis consists of cylindric hyphae ..... *A. phaeosquamus*
11. Basidiospores with nodulose to verrucose ornamentations ..... *A. shichianus*
11. Basidiospores smooth ..... 12
12. Hymenophore vivid yellow to bright yellow ..... 13
12. Hymenophore pale yellow, yellowish-white, grayish-yellow, greenish-yellow to olive brown ..... 16
13. Context turning to greyish-red to greyish-rose upon injury, pleuro- and cheilocystidia without incrustations ..... *A. griseorufescens*
13. Context no color change upon injury, pleuro- and cheilocystidia surface coated with a layer of material ..... 14
14. Pileal surface adorned with furfuraceous and yellowish-brown to pale pink scales, basidiospores 7.5–9 × 5–5.5 μm ..... *A. hainanensis*
14. Pileal surface glabrous to slightly subtomentose, basidiospores maximum length 11 μm, width 7 μm ..... 15
15. Pileus brownish-red to greyish-rose, stipe orange to yellowish-ochre, with furfuraceous squamules and distinct longitudinal bands, pleuro- and cheilocystidia up to 7.5 μm ..... *A. nephrosporus*
15. Pileus light brownish-red, stipe yellowish-green, without squamules, pleuro- and cheilocystidia up to 34 μm ..... *A. pallidorubellus*
16. Pileal surface adorned with a thin layer of white pruina when young ..... *A. rubellus*

16. Pileal surface without white pruina ..... 17
17. Pileus pinkish-white to yellowish-white ..... *A. raphanaceus*
17. Pileus orangish-brown, reddish-yellow, reddish-brown, reddish-violet, reddish-orange, orange, orangish-yellow, yellowish-brown to pinkish-purple ..... 18
18. Pileus yellowish-orange to orange ..... *A. miniatoaurantiacus*
18. Pileus yellowish-brown, reddish-brown, brown, reddish-violet to pinkish-purple ..... 19
19. Pileal surface adorned with conical squamules ..... *A. conicus*
19. Pileal surface subtomentose, or adorned with tomentose to fibrillose scales ..... 20
20. Pileus context staining pastel red, greyish-rose or greyish-red upon injury ..... *A. velutipes*
20. Pileus context no color change upon injury ..... 21
21. Hymenophore discolors upon injury ..... 22
21. Hymenophore no color change upon injury ..... 23
22. Pileus pinkish-purple to flesh pink, densely adorned with black and floccose to tomentose squamules, the hymenophore changing pale reddish-brown upon injury, stipe without squamules, cystidia coated with a layer of achromatic material, a cutis pileipellis ..... *A. atrotomentosus*
22. Pileus yellowish-brown to pale brown, without floccose squamules, the hymenophore sometimes turning pale blue upon injury, stipe adorned with pale brown and small squamules, cystidia without incrustations, an intricate trichoderm to subcutis pileipellis ..... *A. exiguisquamatus*
23. Pileipellis an epithelium type ..... *A. catenarius*
23. Pileipellis a trichoderm or cutis type ..... 24
24. Pileipellis a cutis type ..... 25
24. Pileipellis a trichoderm type ..... 27
25. Hymenophore grayish-yellow with relatively larger and sparser pores ..... *A. magniporus*
25. Hymenophore yellowish-white to pale yellow with relatively smaller and denser pores ..... 26
26. Pileus yellowish-brown, stipe pale brown andup to 2.8 cm, pleuro- and cheilocystidia without slender tip, basidiospores 9–11 × 4–5.5 μm ..... *A. applanatus*
26. Pileus pale brown to reddish-brown, stipe greyish-yellow and up to 6.5 cm, pleuro- and cheilocystidia with enlarged middle and slender tip, basidiospores 9–12.5 × 4–6 μm……. ..... *A. canceriformis*
27. Basidiospores maximum 9 μm ..... *A. nanlingensis*
27. Basidiospores maximum 11 μm ..... 28
28. Pileus2–4.5 cm, reddish-brown to reddish violet, pleuro- and cheilocystidia 29–40 × 8–10 μm, pileipellis consists of slightly inflated to moniliform hyphae ..... *A. guangdongensis*
28. Pileus 1.5–2.5 cm, brownish-yellow, brownish-orange to greyish-red, pleuro- and cheilocystidia 38–66 × 11–15 μm, pileipellis consists of cylindric hyphae ..... *A. solus*
29. Pileal margin with a gelatinised membranous veil ..... 30
29. Pileal margin pileus without membranous veil ..... 36
30. Basidiospores with longitudinal ridges, stipe with annulus ..... *A. longicollis*
30. Basidiospores smooth, stipe without annulus ..... 31
31. Pileus coarsely rugose or distinctly reticulate ..... *A. thibetanus*
31. Pileus slightly rugose or glabrous ..... 32
32. Pileus relatively large (maximum 3.5 cm) ..... 33
32. Pileus relatively small (maximum 2.5 cm) ..... 34
33. Basidiospores 10–14.5 × 4–6 μm, pileipellis an intricate ixotrichoderm-type ..... *A. rugosus*
33. Basidiospores 10–12 × 4–5 μm, pileipellis an ixotrichoderm-type ..... *A. tenuis*
34. Pileus ruby to reddish-brown ..... *A. glutinosus*
34. Pileus brown, brownish to blackish-brown ..... 35
35. Basidiospores 12–15.5 × 4–5.5 μm, cystidia apical surface coated with a layer of pale yellow material ..... *A. stickyipes*
35. Basidiospores 8.5–12.5 × 4–5.5 μm, cystidia apical surface without incrustations…….. ..... *A. microcarpus*
36. Basidiospores possessing Qm > 3.0 ..... 37

36. Basidiospores possessing Qm < 3.0.....38
37. Pileus pink, brownish-red to greyish-ruby, basidiospores 15–16.5 × 4.5–5 μm, occurs in subtropical zones of China.....*A. formosus*
37. Pileus pale yellow, light orange, brownish-orange, brownish-red, greyish-yellow to greyish-orange, basidiospores 15–21 × 5–6.5 μm, occurs in temperate zones of China……..... ..... *A. quercus-spinosae*
38. Basidiospores ellipsoid, broadly ellipsoid, elongate (Qm < 2.0).....*A. venustus*
38. Basidiospores subfusoid, cylindric (2.0 ≤ Qm < 3.0) .....39
39. Pileus relatively small (maximum 6 cm across) .....*A. zangii*
39. Pileus relatively large (maximum 11 cm across).....40
40. Pileus tinged with violet .....*A. sinobadius*
40. Pileus brown, reddish-brown to dark red.....41
41. Pileipellis an ixotrichodermium-type consists of hyphae up to 17 μm diameter…….. .....*A. duplicatoporus*
41. Pileipellis an interwoven trichoderm-type consists of hyphae up to 9 μm diameter…… .....*A. erythraeus*

***Boletellopsis*** N.K. Zeng, T. Jiang, W.F. Lin & L.G. Hu, gen. nov.

MycoBank: MB 860307; Facesoffungi: FoF 19064

Type species – *Boletellopsis elata* (Nagas.) N.K. Zeng, T. Jiang, W.F. Lin & L.G. Hu

Etymology – Latin "*Boletellopsis*" signifies both the phenotypic resemblances to *Boletellus* and its former taxonomic placement within this genus.

Diagnosis – Differentiated from all previously known genera of Xerocomoideae via a suite of morphological traits: a stipe with longitudinally streaked, context and hymenophore no color change upon injury, basidiospores ornamented with shallow longitudinal ridges, united apically to form a shallow circular depression, and thick-walled pleuro- and cheilocystidia.

Basidiomata pileate-stipitate, hymenophore tubular. Pileus convex to plano-convex; surface yellowish-brown to brown, nearly smooth, dry; context yellowish-white, no color change upon injury. Hymenophoral surface and tubes concolorous, yellow, no color change upon injury. Stipe subcylindric, mid-positioned, consolidated; surface with longitudinally streaked, dry; context yellowish-white, no color change upon injury; Basal mycelium whitish. Basidiospores ornamented with shallow longitudinal ridges, united apically to form a shallow circular depression, elongate; pleuro- and cheilocystidia thick-walled; pileipellis a cutis-type. Clamp connections not observed in any tissue.

***Boletellopsis elata*** (Nagas.) N.K. Zeng, T. Jiang, W.F. Lin & L.G. Hu, comb. nov. Figs 23–25

MycoBank: MB 860308; Facesoffungi: FoF 19082

Basionym – *Boletellus elatus* Nagas., Transactions of the Mycological Society of Japan 25: 361, 1984

Diagnosis – *Boletellopsis elata* is characterized by a tall basidioma, with no discoloration in all parts upon injury, a long stipe with longitudinally streaked, large basidiospores with shallowly longitudinal ridges, united at the apex around a shallow circular depression, and thick-walled pleuro- and cheilocystidia.

Basidiomata ranging from small to medium in size. Pileus 4.5–7.2 cm across, initially subhemispherical, expanding to convex to plano-convex with age; surface yellowish-brown (5D7) to brown (5C6), nearly smooth, dry; margin decurved when young, becoming straight in age, entire; context at center 0.5–0.7 cm thick, yellowish-white (3A2–4), no color change upon injury. Hymenophore poroid, sinuate to slightly decurrent; pores angular to subcircular, yellow (1A6), no color change upon injury; tubes 1–3 cm deep, yellow (1A6), no color change upon injury. Stipe 14–18 × 0.8–1.2 cm, subcylindric, mid-positioned, consolidated; surface concolorous with pileus or darker, with longitudinally streaked, dry; context yellowish-white (3A2–4), no color change upon injury; Basal mycelium whitish (1A1). Odor unremarkable.

**Figure 23** – Fresh basidioma of *B. elata* (FHMU10550). Scale bars represent 1 cm.

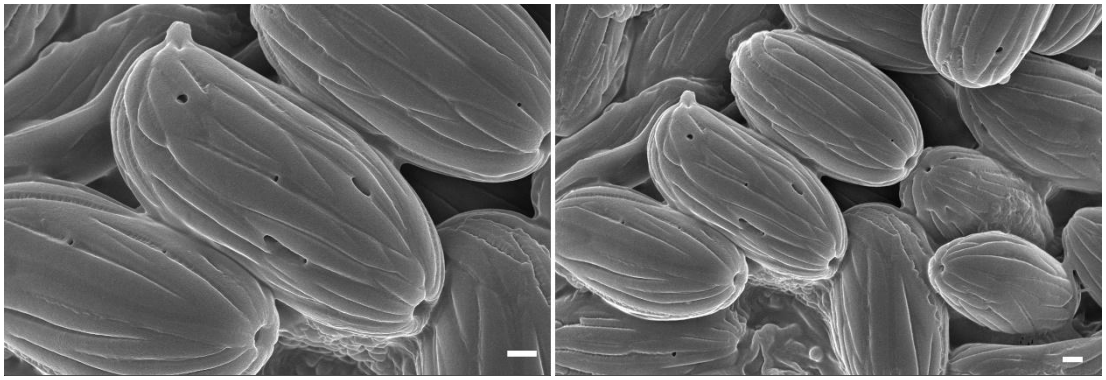

**Figure 24** – Basidiospores of *B. elata* by SEM (FHMU10550). Scale bars represent 1 μm.

Basidiospores [60/3/3] 17.5–18.73–19.5 × 9.5–10.55–11 μm, Q = 1.67–1.95 (–2.05), Qm = 1.78 ± 0.09, with shallowly longitudinal ridges, 8–10 ridges visible in lateral view, projecting 1–1.5 μm wide, elongate, pale yellowish-brown to yellowish-brown; ridges frequently foreshortened and attenuated, occasionally continuous from pole to pole, united at the apex around a shallow circular depression, ridges devoid of cross-striations as observed by light microscopy. Basidia 33–40 × 13–16 μm, 4-spored, subclavate or subcylindric, wall thickness approximately 0.5 μm, pale yellow; sterigmata 4–5.5 μm long. Cheilocystidia 65–80 × 8–10.5 μm, fusiform, numerous, thick-walled (1–1.5 μm), pale yellow or achromatic, without incrustations. Pleurocystidia 62–70 × 7–9 μm, fusiform, numerous, thick-walled (1–1.5 μm), pale yellow or achromatic, without incrustations. Hymenophoral trama consists of hyphae 8–13 μm wide, wall thickness approximately 1 μm, yellowish to achromatic. Pileipellis a cutis-type, 200–400 μm thick, consists of hyphae 4–13 μm wide, wall thickness approximately 1 μm, achromatic, with clavate or subcylindric apical cells 30–70 × 6–13 μm. Pileus trama consists of interlaced, hyphae 4–12 μm wide, wall thickness approximately 0.5 μm, pale yellow or achromatic. Stipitipellis 150–180 μm thick, consists of hyphae 3–10 μm wide, wall thickness approximately 0.5 μm, achromatic, with clavate to subcylindric apical cells 25–72 × 4–11 μm. Stipe trama consists of hyphae 4–12 μm wide, wall thickness 0.5–1 μm, pale yellow. Clamp connections not observed in any tissue.

Known distribution – Zhejiang and Hunan Provinces of China; Japan.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1300 m elev., on soil in Pinaceae and Fagaceae mixed forests, solitary, 14 August 2024, Huligui1 (FHMU10550); same locality and date, Huligui2 (FHMU10551); same locality and date, Huligui3 (FHMU10552).

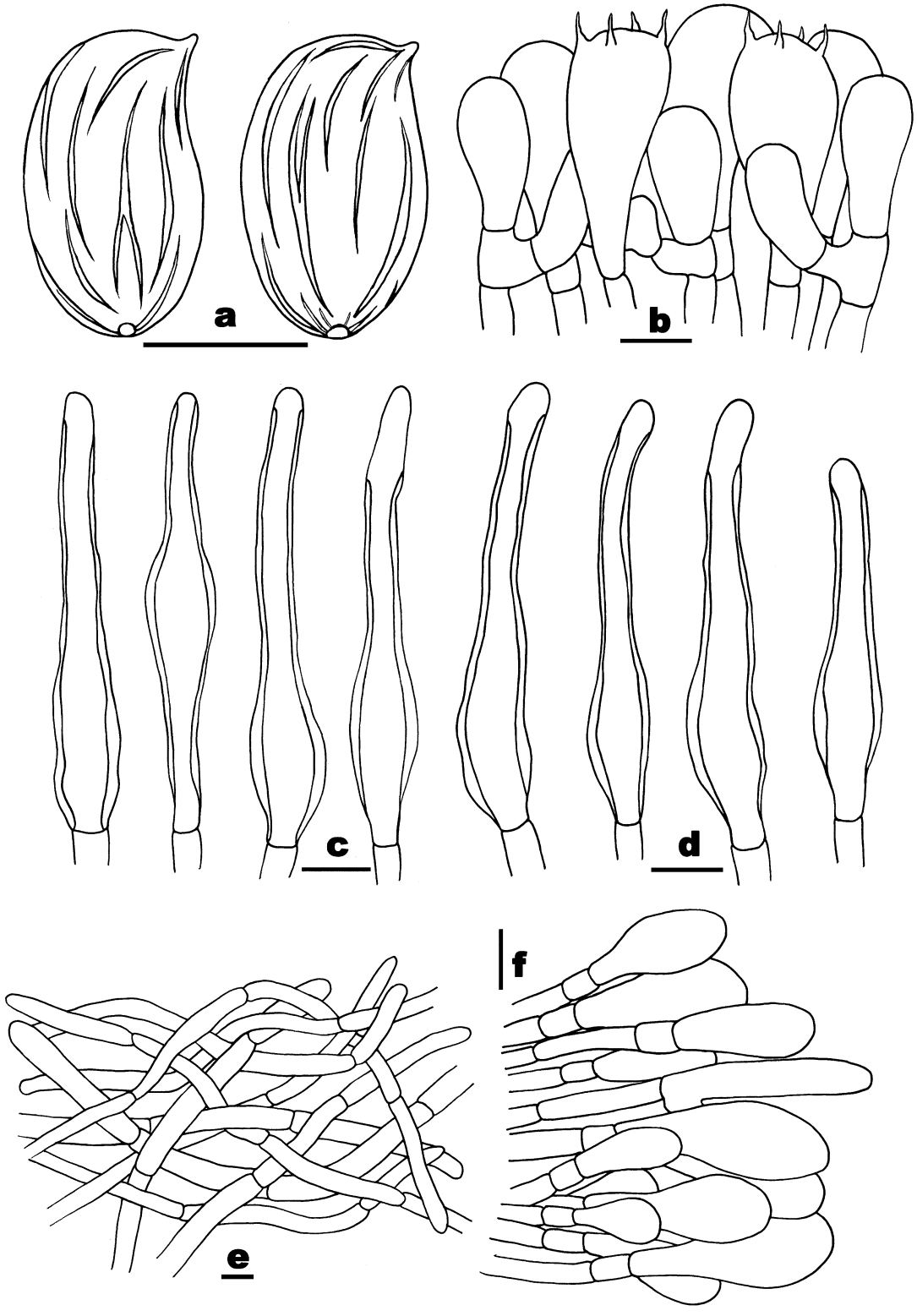


**Figure 25** – Microscopic characters of *Boletellopsis elata* (FHMU8446). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Notes – *Boletellopsis elata* was originally described as *Bol. elatus*, with its conspecificity later confirmed by phylogenetic analysis and morphological comparisons. Molecular data further reveal that this species forms an independent genus-level clade within the subfamily Xerocomoideae, consistent with findings from prior molecular phylogenetic studies (Halling et al. 2015).

Morphologically, *B. elata* resembles *Bol. sinapipes* N.A. Fechner et al., *A. longicollis* (Ces.) N.K. Zeng & Ming Zhang, and *A. singeri* (Gonz.-Velázq. & R. Valenz.) Har. Takah. & Taneyama. However, *Bol. sinapipes* has a dull brownish-red to dull red stipe, relatively smaller basidiospores 11.9–15.4 × 5.6–7 μm, and basidiospores with a continuous fissure or fissures at the apex (Wu et al. 2016); *A. longicollis* has a veil, shorter basidiospores 12–16 × 7.5–12 μm, and basidiospores with a continuous fissure or fissures at the apex (Halling & Ortiz-Santana 2009, Zeng et al. 2015); *A. singeri* has a veil and basidiospores with a continuous fissure or fissures at the apex (Terashima et al. 2016).

***Chenrenyua*** N.K. Zeng, T. Jiang, W.F. Lin & L.G. Hu, gen. nov.

MycoBank: MB 860309; Facesoffungi: FoF 19065

Type species – *Chenrenyua longispora* N.K. Zeng, T. Jiang, W.F. Lin & L.G. Hu

Etymology – "*Chenrenyua"* is in honor of Renyu Chen (1212‑1279), a Southern Song dynasty scholar and author of Jun Pu, the world's earliest known mycology monograph documenting fungal taxonomy and utilization in ancient China.

Diagnosis – Differentiated from all previously known genera of Suillelloideae via a suite of morphological traits: tubes yellow, pores yellowish-brown to reddish, a stipe punctuated with transversely scissurate scales, hymenophore and context staining blue upon injury, smooth and fusiform basidiospores, and a pileipellis that ranges from trichoderm to intricate trichoderm.

Basidiomata pileate-stipitate, hymenophore tubular. Pileus convex to plano-convex; surface brownish-red, brownish-yellow to brown, nearly smooth, dry; context whitish to yellow, staining blue upon injury. Hymenophore poroid, concave near stipe apex, turning blue upon injury. Stipe subcylindric, mid-positioned, consolidated; surface tawny to pale brown, densely adorned with scabers, dry; context pale yellow, turning blue upon injury; basal mycelium yellowish or white. Basidiospores, smooth fusoid; pleuro- and cheilocystidia present; pileipellis ranges from trichoderm to intricate trichoderm. Clamp connections not observed in any tissue.


**Figure 26** – Fresh basidiomata of *Chenrenyua* species. a–d *C. longispora* (a–b from FHMU7986; c–d from FHMU8446, holotype). e–f *C. verrucosa* (FHMU8452, holotype). Scale bars represent 1 cm.

***Chenrenyua longispora*** N.K. Zeng, T. Jiang, W.F. Lin & L.G. Hu, sp. nov. Figs 26a–d, 27a–b, 28

MycoBank: MB 860310; Facesoffungi: FoF 19083

Etymology – Latin "*longispora*" signifies the long basidiospores of the new species.

Diagnosis – *Chenrenyua longispora* is characterized by a blood red hymenophore, a stipe densely adorned with red to ochre scabers, hymenophore and context quickly turning blue upon injury, slender and fusoid basidiospores, and a trichoderm-type pileipellis.

Basidiomata ranging from small to medium in size. Pileus 4.5–5.5 cm across, initially subhemispherical, expanding to convex to plano-convex with age; surface dark brownish-red (7C8) when young, then earthy yellow (3B8), smooth, dry; margin decurved when young, becoming straight in age, entire; context at center 1–1.4 cm thick, off-white (1A1), turning blue (24B6) quickly upon injury. Hymenophore poroid, adnate to sinuate; pores angular to subcircular, blood red (9B8), turning dark blue (24F8) quickly upon injury; tubes 0.2–0.5 cm deep, pale yellow (2A3), turning blue (24B6) quickly upon injury. Stipe 6–6.3 × 1.7–2.5 cm, subcylindric, mid-positioned, consolidated; surface ochre (6C4), densely adorned with scales, red (7B8) when young, reddish-brown (7C5–6) in age, dry; context off-white (1A1), turning blue (24B6) quickly upon injury; Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [40/2/2] 16–17.34–18 (–18.5) × 3.5–4.07–4.5 μm, Q = 3.78–4.57 (–4.63), Qm = 4.27 ± 0.23, smooth, fusoid, wall thickness approximately 1 μm, pale yellowish-brown. Basidia 25–30 × 9–10 μm, 4-spored, subclavate or subcylindric, slightly thick-walled (0.5–0.8 μm), yellowish; sterigmata 3–6 μm long. Cheilocystidia 40–52 × 8–13 μm, subfusiform, not numerous, wall thickness approximately 0.5 μm, pale yellow or achromatic, without incrustations. Pleurocystidia 35–60 × 8.5–13 μm, subfusiform, not numerous, wall thickness approximately 0.5 μm, pale yellow or achromatic, without incrustations. Hymenophoral trama consists of hyphae 5–9 μm wide, wall thickness approximately 0.5 μm, yellowish to achromatic. Pileipellis a trichoderm-type, 100–350 μm thick, consists of hyphae 4–11 μm wide, wall thickness approximately 0.8 μm, achromatic, with clavate or subcylindric apical cells 32–80 × 4–12 μm. Pileus trama consists of interlaced, hyphae 6–11 μm wide, wall thickness approximately 0.5 μm, pale yellow or achromatic. Stipitipellis 125–225 μm thick, consists of hyphae 4–10 μm wide, wall thickness approximately 0.8 μm, achromatic, with clavate to subcylindric apical cells 50–80 × 4–12 μm. Stipe trama consists of hyphae 5–12 μm wide, wall thickness 0.5–1 μm, achromatic. Clamp connections not observed in any tissue.

Known distribution – Zhejiang Province of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1300 m elev., on soil in Fagaceae-dominated forests, solitary, 15 August 2024, Huligui0029 (FHMU8446, holotype); same locality, 21 August 2024, Zeng10314 (FHMU7986).

Notes – *Neoboletus brunneorubrocarpus* G. Wu et al. and *Rubroboletus sinicus* (W.F. Chiu) Kuan Zhao & Zhu L. Yang share morphological similarities with *C. longispora*. However, *N. brunneorubrocarpus* has a larger pileus, a reddish-brown to reddish-orange hymenophore quickly turning dark blue upon injury, light brown to brownish-yellow basal mycelium, and relatively smaller basidiospores 11.5–14.5 × 4.5–6 μm (Wu et al. 2023); *R. sinicus* has a stipe adorned with red to dark red reticulations and relatively smaller basidiospores 7.5–11 × 4.5–5.5 μm (Zhao et al. 2014a). Phylogenetically, *C. longispora* exhibits close affinity with *C. verrucosa*. However, *C. verrucosa* has a yellowish-brown hymenophore, shorter basidiospores 13–15 × 4–5 μm, and an intricate trichoderm-type pileipellis (see below).

***Chenrenyua verrucosa*** N.K. Zeng, T. Jiang, W.F. Lin & L.G. Hu, sp. nov. Figs 26e–f, 27c–d, 29

MycoBank: MB 860311; Facesoffungi: FoF 19084

Diagnosis – *Chenrenyua verrucosa* is characterized by a caramel basidioma, a stipe punctuated with scabers, a hymenophore and context turning blue upon injury, and an intricate trichoderm-type pileipellis.

Basidiomata medium in size. Pileus 7.3–8.2 cm across, convex to plano-convex; surface smooth, caramel (4B7), dry; margin straight to uplift, entire; context at center 0.8–1.3 cm thick, yellowish-white (3A2–4), turning blue (24B6) upon injury. Hymenophore poroid, adnate to sinuate; pores angular to subcircular, yellowish-brown (4B8), turning blue (24F8) upon injury; tubes 0.6–0.7 cm deep, yellow (2A6), turning blue (24F8) upon injury. Stipe 6.8–7.1 × 1.4–2.2 cm, subcylindric, mid-positioned, consolidated; surface sand brown (3B3), punctuated with brown (6E7–8) scabers,

dry; context yellowish-white (3A2–4), turning blue (24F8) upon injury; basal mycelium yellowish-white (3A2–4). Odor unremarkable.

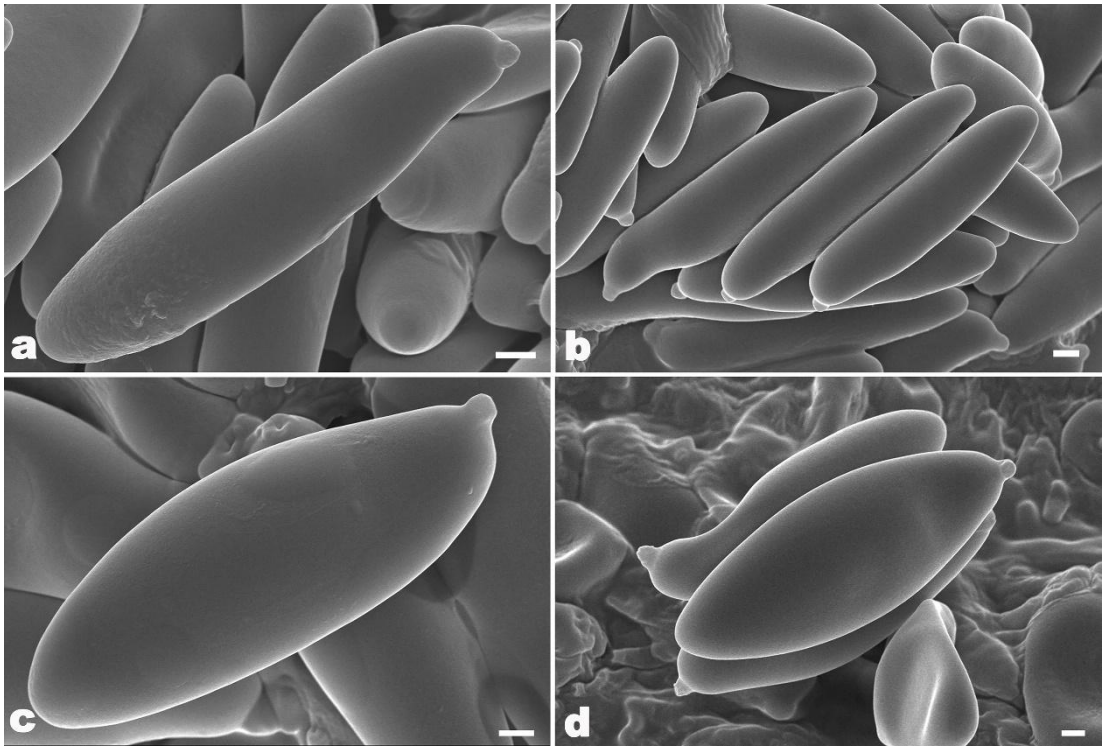


**Figure 27** – Basidiospores of *Chenrenyua* species by SEM. a–b *C. longispora* (FHMU8446, holotype). c–d *C. verrucosa* (FHMU8452, holotype). Scale bars represent 1 μm.

Etymology – Latin "*verrucosa*" signifies the stipe is adorned with verrucae.

Basidiospores [80/4/4] 13–13.95–14.5 (–15) × 4–4.35–4.5 (–5) μm, Q = 2.6–3.63 (–3.75), Qm = 3.2 ± 0.28, smooth, subfusoid, wall thickness approximately 0.5 μm, pale yellowish-brown. Basidia 22–32× 8–12 μm, 4-spored, subclavate or subcylindric, wall thickness approximately 0.8 μm, yellowish; sterigmata 2–4 μm long. Cheilocystidia 30–55 × 9–10 μm, subfusiform, numerous, wall thickness approximately 0.5 μm, yellow, without incrustations. Pleurocystidia 45–60 × 8–15 μm, subfusiform, numerous, wall thickness approximately 0.5 μm, yellow, without incrustations. Hymenophoral trama consists of hyphae 3.5–8 μm wide, wall thickness approximately 0.8 μm, yellowish to achromatic. Pileipellis an intricate trichoderm-type, 250–400 μm thick, consists of hyphae 3.5–7 μm wide, yellowish-brown pigmented, wall thickness approximately 0.5 μm, with clavate or subcylindric apical cells 30–80 × 3.5–6 μm. Pileus trama consists of interlaced, hyphae 4–8 μm wide, wall thickness approximately 0.5 μm, yellowish. Stipitipellis 100–200 μm thick, consists of hyphae 5–8μm wide, wall thickness approximately 0.5 μm, yellowish-brown, with clavate to subcylindric apical cells 30–65 × 4–8 μm. Stipe trama consists of hyphae 5–8 μm wide, wall thickness 0.5–1 μm, yellowish-brown. Clamp connections not observed in any tissue.

Known distribution – Zhejiang Province of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1300 m elev., on soil in Fagaceae-dominated forests, solitary, 23 August 2024, N.K. Zeng10144 (FHMU8452, holotype); same locality and date, N.K. Zeng10144-1 (FHMU10545); same locality and date, N.K. Zeng10144-2 (FHMU10546); same locality and date, N.K. Zeng10144-3 (FHMU10547).

Notes – *Leccinum scabrum* (Bull.) Gray and *Suillellus pinophilus* G. Wu et al. share morphological similarities with *C. verrucosa* on brownish orange to caramel brown pileus. However, *L. scabrum* has tissue with no color change upon injury, a whitish to grayish-white hymenophore, and longer basidiospores 16–21 × 6–7.5 μm (den Bakker & Noordeloos 2005, Wu et al. 2016); *S. pinophilus* differs in a brownish violet stipe fully adorned with concolorous reticulations, shorter

basidiospores 9–12 × 5–6 μm, and a trichodermal pileipellis (Wu et al. 2023). In addition, *C. verrucosa* is phylogenetically close to *C. longispora*; to aid in morphological differentiation between them, see the discussion in the section on *C. longispora*.

***Hemileccinum*** Šutara, Czech Mycol. 60: 52, 2008.

MycoBank: MB 511891; Facesoffungi: FoF 14989

***Hemileccinum brevisporum*** M. Xiang Li, Zhu L. Yang & G. Wu, J. Fungi 7: 11, 2021

Figs 30a–d, 31a–d, 32

MycoBank: MB 840701; Facesoffungi: FoF 19085

Basidiomata small in size. Pileus 2–3 cm across, initially hemispherical, expanding to convex to applanate with age; surface orangish-red (6B8) when young, becoming pale brown (5A5) in age, darker in the center (5B8) and gradually lightening towards the edges, dry; margin decurved, entire; context at center 0.2–0.3 cm thick, white (1A2), no color change upon injury. Hymenophore poroid, sinuate; pores angular to subcircular, yellowish (1A4), no color change upon injury; tubes 1–1.2 cm deep, yellowish (1A4), no color change upon injury. Stipe 4–6 × 1–1.5 cm, subcylindric, mid-positioned, consolidated; surface initially whitish (1A2) to pale brown (5A4), becoming light brown (5A2) to brown (5B5) when mature, the upper part slightly paler (1A4) and adorned with concolorous scales, dry; context yellowish (1A2), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [20/1/1] 8‑9.48–11 (–12) × 4‑4.32–5 μm, Q = (1.9–) 2–2.38 (–2.44), Qm = 2.19 ± 0.14, appearing smooth under light microscopy, while displaying bacilliform decorations or microscopic warts in SEM, subcylindric to cylindric, wall thickness 0.5–1 μm, pale yellowish-brown. Basidia 9–42 × 2–10 μm, 4-spored, clavate, wall thickness approximately 0.5 μm, achromatic; sterigmata 2–5 μm. Cheilocystidia 31–40 × 8–10 μm, fusiform to ventricose-fusiform, not numerous, wall thickness approximately 0.5 μm, achromatic, without incrustations. Pleurocystidia 25–34 × 8–12 μm, subfusiform, not numerous, wall thickness approximately 1 μm, achromatic, without incrustations. Hymenophoral trama consists of hyphae 5–10 μm wide, wall thickness 0.5–1 μm, achromatic. Pileipellis a hyphoepithelioid, 85–107 μm thick, consists of chains of subglobose to pyriform, hyphae 10–14 μm wide, wall thickness approximately 0.5 μm, yellowish to achromatic, with clavate or subcylindric apical cells 9–43 × 4–10 μm. Pileal trama consists of hyphae 6–11 μm wide, wall thickness approximately 1 μm, achromatic. Stipitipellis 54–90 μm thick, consists of emergent hyphae with clavate apical cells 11–22 × 4–6 μm, wall thickness approximately 0.5 μm, achromatic. Stipe trama consists of hyphae 7–13 μm wide, wall thickness 0.5–1 μm, achromatic. Clamp connections not observed in any tissue.

Known distribution – Yunnan and Zhejiang Provinces of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1200 m elev., on soil in Fagaceae-dominated forests, solitary, 22 May 2024, N.K. Zeng10350 (FHMU8601); same locality and date, N.K. Zeng10353 (FHMU8395).

Notes – The type locality of *H. brevisporum* is situated in Yunnan (Li et al. 2021). Our study documents its additional occurrence in Zhejiang. The species was redescribed using recently collected specimens featuring a smaller, orangish-red to pale brown pileus, and a light brown to brown stipe, surface adorned with concolorous scales. Additionally, certain morphological differences have been documented among specimens identified as *H. brevisporum*. Notably, collections reported by Li et al. (2021) exhibit a larger pileus and a yellowish-brown to cream stipe, surface adorned with small, yellowish-brown dotted scales.

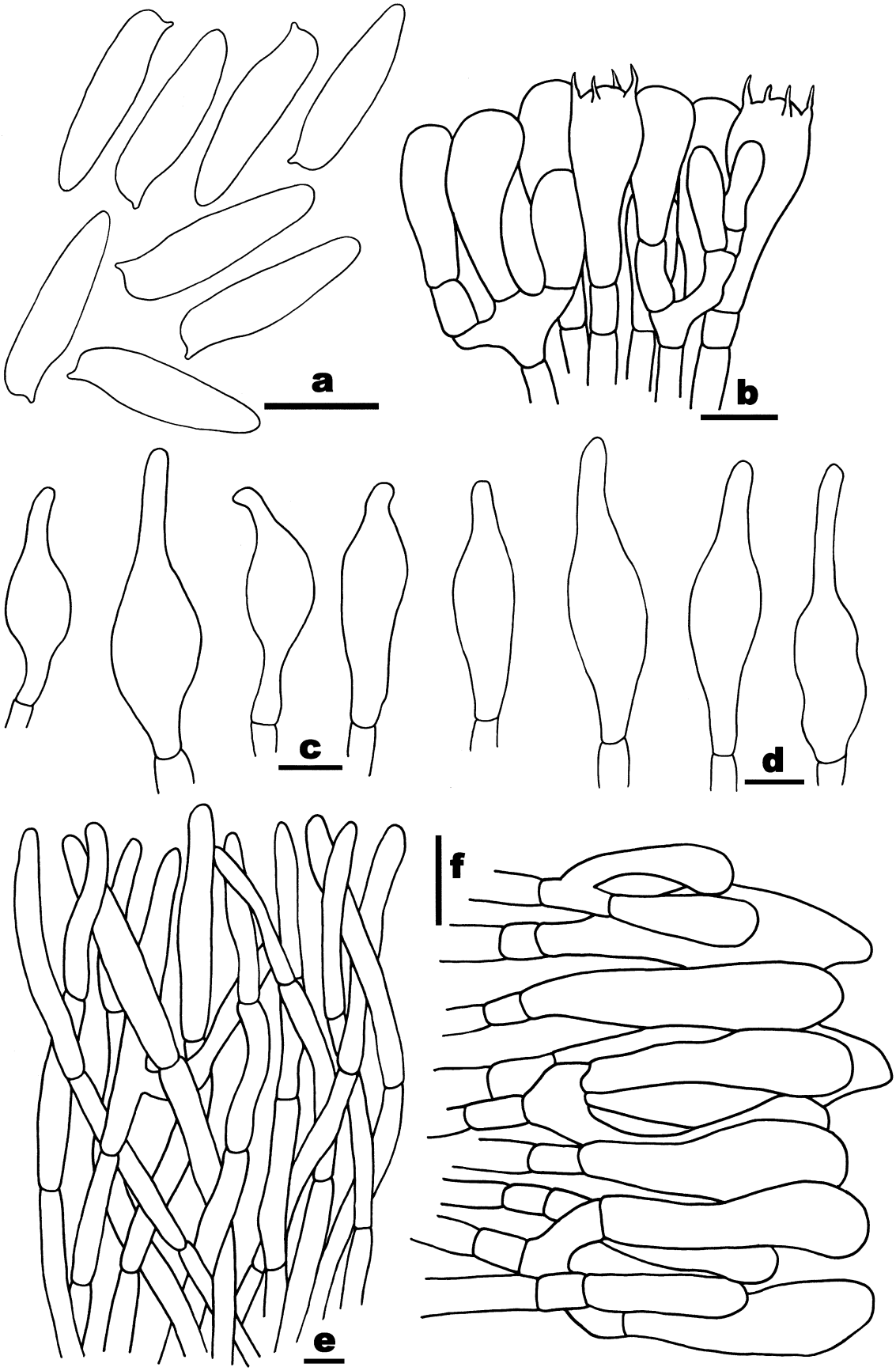


**Figure 28** – Microscopic characters of *Chenrenyua longispora* (FHMU8446, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

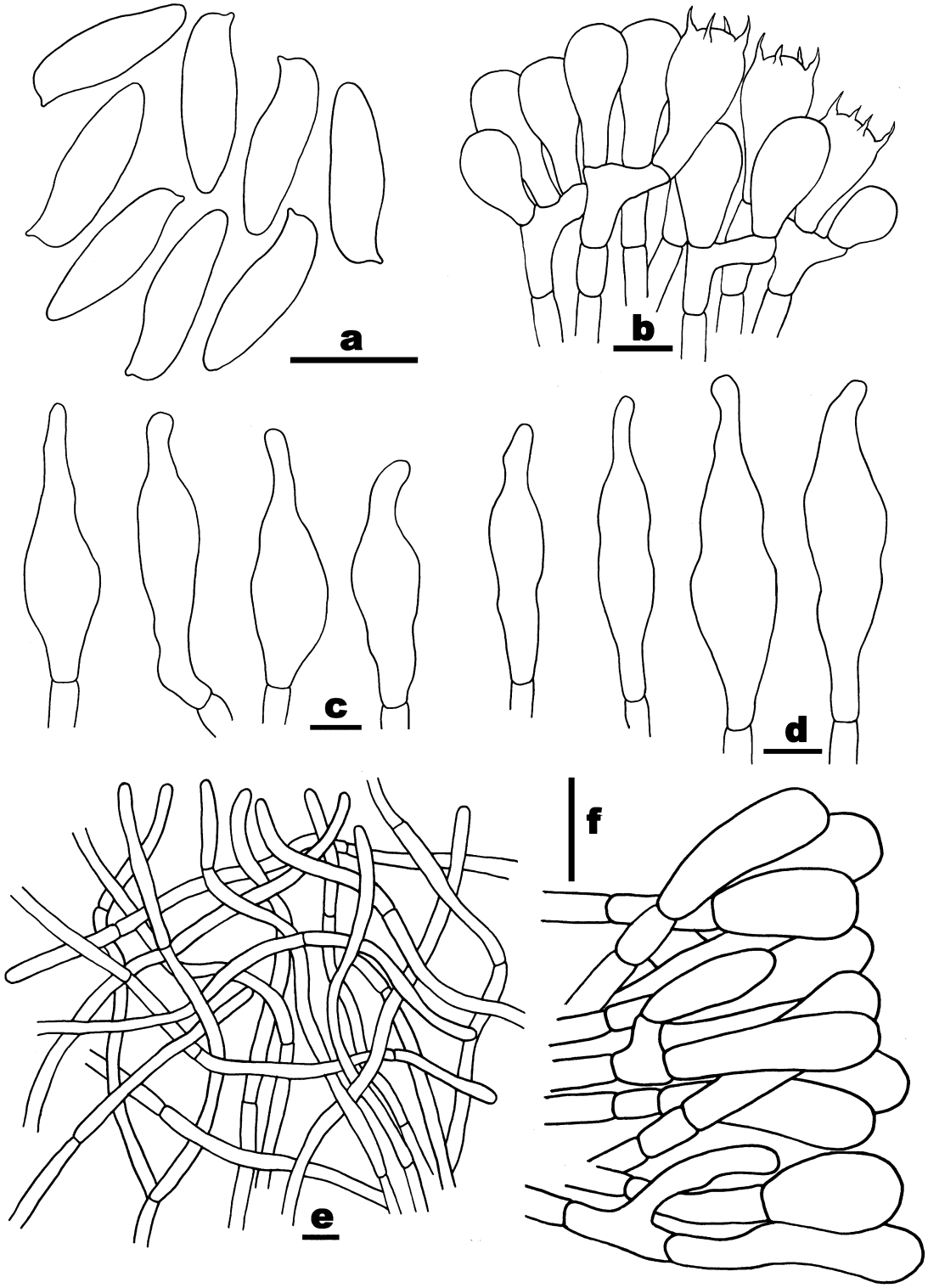


**Figure 29** – Microscopic characters of *Chenrenyua verrucosa* (FHMU8452, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

***Hemileccinum brunneoalbum*** N.K. Zeng, R.X. Zhao, T. Jiang & Zhi Q. Liang, sp. nov.
Figs 30e–f, 31e–g, 33

MycoBank: MB 860302; Facesoffungi: FoF 19086
Etymology – Latin "*brunneoalbum*" signifies the brownish-white pileus.

Diagnosis – This species can be diagnosed by an applanate, brownish-white pileus, a white, pale yellow to pinkish stipe, surface densely adorned with concolorous squamules, smaller cystidia, and its distribution in tropical China, which distinguish it from the closest *Hemileccinum* species.


**Figure 30** – Fresh basidiomata of *Hemileccinum* species. a–d *H. brevisporum* (a–b from FHMU8601; c–d from FHMU8395). e–f *H. brunneoalbum* (FHMU8319, holotype). g–h *H. dilutibrunneum* (FHMU8853, holotype). i–j *H. ferrugineipes* (FHMU9184). k–l *H. lutosum* (FHMU8142, holotype). m–n *H. verrucatum* (FHMU10025, holotype). Scale bars represent 1 cm.

Basidiomata small in size. Pileus 4.5–5 cm across, subapplanate, sometimes slightly depress in the center; surface pale brownish-white (5A2), smooth, dry; margin straight, entire; context at center 0.7–0.8 cm thick, white (1A1), no color change upon injury. Hymenophore poroid, sinuate; pores angular to subcircular, light yellowish-green (29A3), no color change upon injury; tubes 0.5–0.6 cm deep, yellowish-green (29A4), no color change upon injury. Stipe 6.1–7 × 1–1.2 cm, subcylindric, mid-positioned, consolidated; surface pale yellow (29A2) at the apex, pinkish (15B2) in the middle,

white (1A1) at the base, densely adorned with concolorous squamules, dry; context white (1A1), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [40/2/1] 10–10.76–12 × 4–4.05–5 μm, Q = (2.2–) 2.5–2.88, Qm = 2.66 ± 0.15, appearing smooth under light microscopy, while displaying bacilliform decorations or microscopic warts in SEM, subcylindric to cylindric, wall thickness 0.5–1 μm, yellowish-brown. Basidia 18–25 × 8–12 μm, 4-spored, clavate, wall thickness approximately 0.5 μm, achromatic; sterigmata 3–4 μm. Cheilocystidia 35–38 × 12–14 μm, fusiform to subfusiform, not numerous, wall thickness approximately 0.5 μm, achromatic, without incrustations. Pleurocystidia 35–38 × 11–13 μm, subfusiform, not numerous, wall thickness approximately 0.5 μm, achromatic, without incrustations. Hymenophoral trama consists of hyphae 9–15 μm wide, wall thickness 0.5–1 μm, achromatic. Pileipellis a hyphoepithelioid, 92–108 μm thick, consists of chains of subglobose to pyriform, hyphae 12–18 μm wide, wall thickness approximately 0.5 μm, yellowish to achromatic, with clavate to cylindric apical cells 12–26 × 3–6 μm. Pileal trama consists of hyphae 8–13 μm wide, wall thickness 0.5–1, achromatic. Stipitipellis 70–105 μm thick, consists of emergent hyphae with clavate apical cells 19–25 × 8–10 μm, wall thickness approximately 1 μm, achromatic. Stipe trama consists of hyphae 9–13 μm wide, wall thickness approximately 0.5 μm, achromatic. Clamp connections not observed in any tissue.

Known distribution – Hainan Province of China.

Materials examined – China, Hainan Province, Qiongzhong Li and Miao Autonomous County, Limushan of Hainan Tropical Rainforest National Park, 650 m elev., on soil in Fagaceae-dominated forests, gregarious, 21 May 2024, JT-48 (FHMU8319, holotype); same locality and date, JT-48-3 (FHMU10540).

Notes – *Hemileccinum brunneoalbum* shares morphological similarities with Chinese *H. albidum* Mei Xiang Li et al., *H. rugosum* G. Wu & Zhu L. Yang, and *H. parvum* Mei Xiang Li et al. However, *H. albidum* has a larger, finely wrinkled and pompeian yellow to ochraceous pileus and larger cystidia (Li et al. 2021); *H. rugosum* has a larger, light orange and rugose pileus, and larger cystidia (Wu et al. 2016); *H. parvum* has a rugose and brownish pileus, a context turning bluish slowly upon injury at some spots, and longer basidiospores 12–14 × 4–5 μm (Li et al. 2021). Moreover, Singaporean *Xerocomus calvus* (Corner) E. Horak, a species whose systematic position needs further verification, shows some similarity to *H. brunneoalbum*. However, *X. calvus* has a smaller, innately pruinose, rugulose, and fuscous-olivaceous to grey-olivaceous pileus with minutely appressed sericeous-fibrillose, a pruinose stipe, relatively smaller basidiospores 8.5–10 × 3–4 μm, and it is found in forests dominated by dipterocarps (Horak 2011). In the phylogenetic tree (Fig. 3), the sister group of *H. brunneoalbum*, remains unresolved, and its resolution requires expanded sampling across the genus in future studies.

***Hemileccinum dilutibrunneum*** N.K. Zeng, R.X. Zhao, T. Jiang & Zhi Q. Liang, sp. nov.

Figs 30g–h, 31h–k, 34

MycoBank: MB 860304; Facesoffungi: FoF 19087

Etymology – Latin "*dilutibrunneum*" signifies the pale brown pileus.

Diagnosis – This species can be diagnosed by a pale brown to pale reddish-brown, subtomentose pileus, a pale brown stipe, surface densely adorned with brown scales, and its distribution in tropical China, which distinguish it from the closest *Hemileccinum* species.

Basidiomata medium in size. Pileus 7.1–7.5 cm across, subhemispherical; surface pale brown (6B3) to pale reddish-brown (6B4), subtomentose, dry; margin decurved, entire, brownish (5B2); context at center 0.85–1 cm thick, white, sometimes tinged with greenish (28A4), no color change upon injury. Hymenophore poroid, slightly sinuate; pores angular to subcircular, yellowish (2A2), no color change upon injury; tubes 0.5–0.7 cm deep, yellowish (2A2), no color change upon injury. Stipe 6.1–6.5 × 0.6–2.1 cm, subcylindric, mid-positioned, consolidated, with inflated base; surface yellowish (1A2), densely adorned with brown (5A2) scales, dry; context whitish (1A1), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

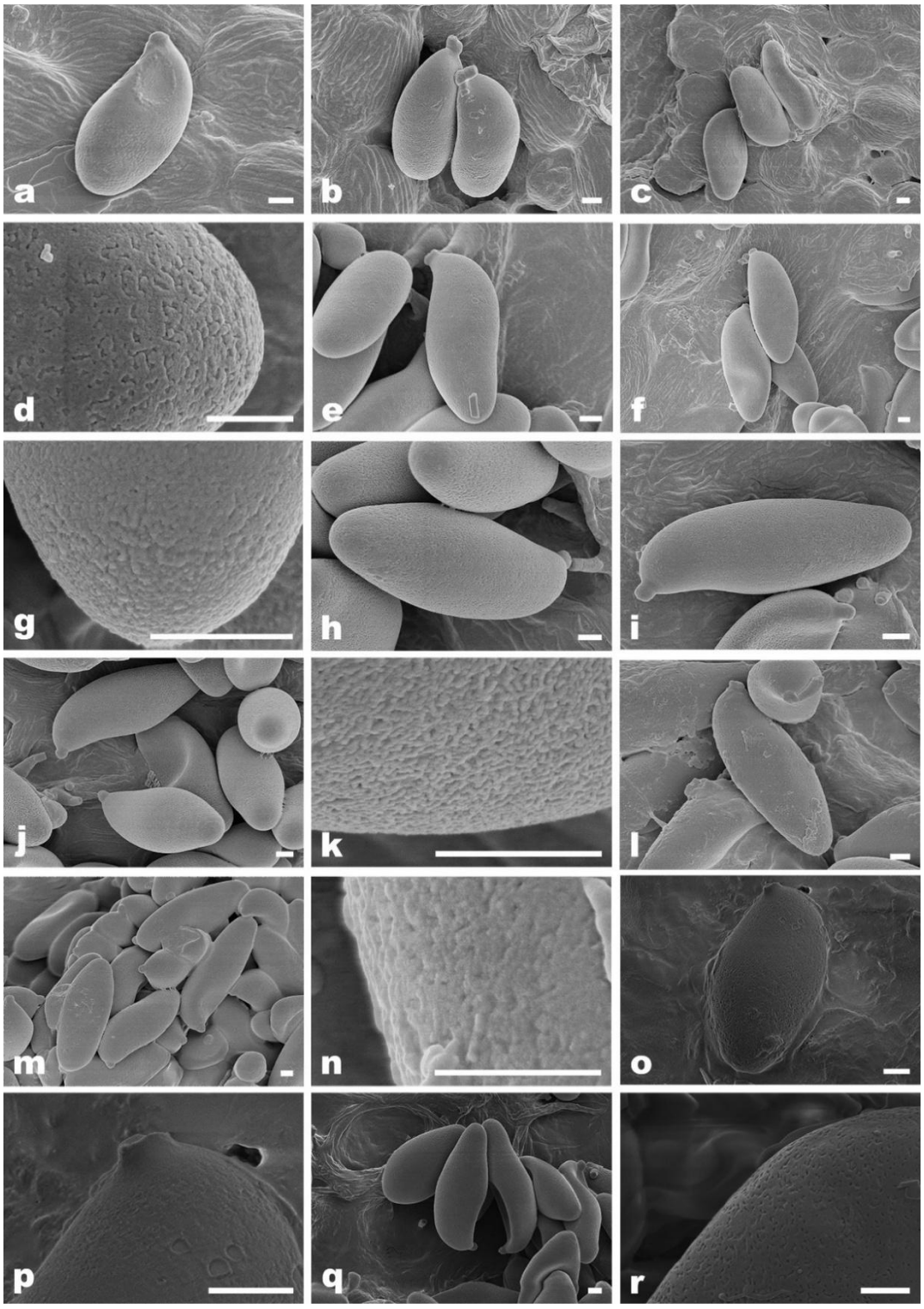


**Figure 31** – Basidiospores of *Hemileccinum* species by SEM. a–d *H. brevisporum* (FHMU8601). e–g *H. brunneoalbum* (FHMU8319, holotype). h–k *H. dilutibrunneum* (FHMU8853, holotype). l–n *H. ferrugineipes* (FHMU9184). o–p *H. lutosum* (FHMU8142, holotype). q–r *H. verrucatum* (FHMU10025, holotype). Scale bars represent 1 µm.

Basidiospores [80/4/4] 10–10.6–11 × 4–4.52–5 µm, Q = (2–) 2.2–2.75, Qm = 2.36 ± 0.2, appearing smooth under light microscopy, while displaying bacilliform decorations or microscopic warts in SEM, subcylindric to cylindric, wall thickness approximately 1 µm, pale yellowish-brown. Basidia 20–29 × 9–11 µm, 4-spored, clavate, wall thickness approximately 0.5 µm, achromatic; sterigmata 2–3 µm. Cheilocystidia 41–45 × 10–12 µm, subfusiform, not numerous, wall thickness

approximately 0.5 μm, achromatic, without incrustations. Pleurocystidia 48–56 × 16–18 μm, subfusiform, not numerous, wall thickness approximately 0.5 μm, achromatic, without incrustations. Hymenophoral trama consists of hyphae 8–13 μm wide, wall thickness approximately 0.5 μm, achromatic. Pileipellis a hyphoepithelioid, 95–112 μm thick, consists of chains of subglobose to pyriform, hyphae 12–21 μm wide, wall thickness 0.5–1 μm, yellowish to achromatic, with subcylindric to cylindric apical cells 14–26 × 5–9 μm. Pileal trama consists of hyphae 8–14 μm wide, wall thickness approximately 1 μm, achromatic. Stipitipellis 55–62 μm thick, consists of slightly emergent hyphae with clavate apical cells 14–22 × 8–11 μm, wall thickness approximately 0.5 μm, yellowish to achromatic. Stipe trama consists of hyphae 9–13 μm wide, wall thickness 0.5–1 μm, achromatic. Clamp connections not observed in any tissue.

Known distribution – Hainan Province of China.

Materials examined – China, Hainan Province, Qiongzhong Li and Miao Autonomous County, Limushan of Hainan Tropical Rainforest National Park, 650 m elev., on soil in Fagaceae-dominated forests, solitary, 22 May 2024, JT-43 (FHMU8853, holotype); same locality and date, JT-43-1 (FHMU10541); same locality and date, JT-43-2 (FHMU10542); same locality and date, JT-43-3 (FHMU10543).

Notes – *Hemileccinum dilutibrunneum* shares morphological similarities with Chinese *H. ferrugineipes* Mei Xiang Li et al., *H. parvum*, and *H. verrucatum*. However, *H. ferrugineipes* has a larger and rugose pileus, a stipe tinged with reddish at lower part, and relatively larger basidiospores 11‑12.5 × 4–5 μm (Li et al. 2021); *H. parvum* has a smaller pileus, a yellow stipe, and longer basidiospores 12–14 × 4.5–5 μm (Li et al. 2021); *H. verrucatum* has a coffee-brown pileus, longer basidiospores 11–13 × 4–5 μm, and a pileipellis consists of chains of cylindric cells (see below). Moreover, *X. raphanolens* (Corner) E. Horak, a species whose systematic position needs further verification, shows some similarity to *H. dilutibrunneum*. However, *X. raphanolens* has a reddish-fuscous and innately pruinose pileus, a reddish-fuscous stipe with fuliginous furfuraceous or pruinose, and relatively larger basidiospores 18–20 × 5–6 μm (Horak 2011). In the phylogenetic tree (Fig. 3), the sister group of *H. dilutibrunneum*, remains unresolved, and its resolution requires expanded sampling across the genus in future studies.

***Hemileccinum ferrugineipes*** M. Xiang Li, Zhu L. Yang & G. Wu, J. Fungi 7: 11, 2021

Figs 30i–j, 31l–m, 35

MycoBank: MB 840700; Facesoffungi: FoF 19088

Basidiomata medium in size. Pileus 2–5.2 cm across, initially hemispherical, expanding to convex to applanate with age; surface orangish (4A2) to orange (4A3), slightly subtomentose and rugose, dry; margin decurved, entire; context at center 0.5–1 cm thick, white (1A1), no color change upon injury. Hymenophore poroid, sinuate; pores angular to subcircular, bright yellow (1A5) when young, then yellowish-green (28A3) in age, no color change upon injury; tubes 1–1.5 cm deep, yellowish-green (28A2–3), no color change upon injury. Stipe 8.4–9 × 1.2–1.8 cm, subcylindric, mid-positioned, consolidated; surface pale yellow (30A5) to light brown (5B5), adorned with pink (15A3) to pinkish-purple (16B3) squamules, and coated white (1A1) pruina, dry; context yellowish (1A3), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [20/1/1] 10‑10.98–11 (–12) × 4‑4.1–5 μm, Q = (2.2–) 2.4–2.75, Qm = 2.69 ± 0.15, appearing smooth under light microscopy, while displaying bacilliform decorations or microscopic warts in SEM, subcylindric to cylindrica, wall thickness approximately 0.5 μm, yellowish-brown. Basidia 17–37 × 6–10 μm, 4-spored, clavate, wall thickness approximately 0.5 μm, achromatic; sterigmata 2–3 μm. Cheilocystidia 36–43 × 8–12 μm, fusiform to subfusiform, not numerous,wall thickness approximately 0.5 μm, achromatic, without incrustations. Pleurocystidia 40–47 × 10–12 μm, subfusiform, not numerous, wall thickness approximately 0.5 μm, achromatic, without incrustations. Hymenophoral trama consists of hyphae 8–12 μm wide, wall thickness 0.5–1 μm, achromatic. Pileipellis a hyphoepithelioid, 101–130 μm thick, consists of chains of subglobose to pyriform, hyphae 12–20 μm wide, wall thickness approximately 1 μm, yellowish to achromatic, with clavate to subcylindric apical cells 14–26 × 4–7 μm. Pileal trama consists of hyphae 7–15 μm

wide, wall thickness approximately 1 μm, achromatic. Stipitipellis 125–151 μm thick, consists of emergent hyphae with clavate apical cells 18–30 × 7–10 μm, wall thickness 0.5–1 μm, yellowish to achromatic. Stipe trama consists of hyphae 9–13 μm wide, wall thickness 0.5–1 μm, achromatic. Clamp connections not observed in any tissue.

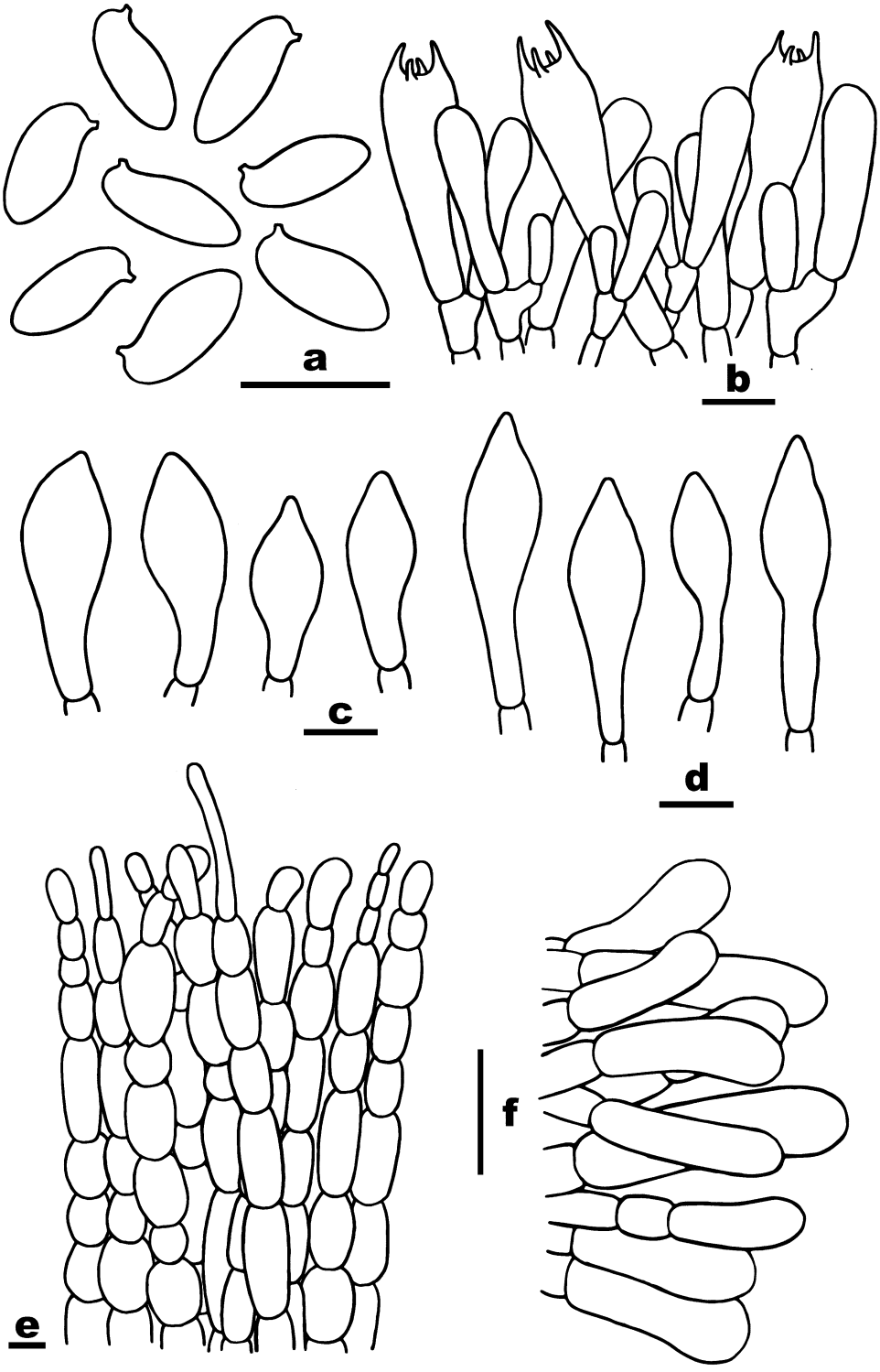


**Figure 32** – Microscopic characters of *Hemileccinum brevisporum* (FHMU8601). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

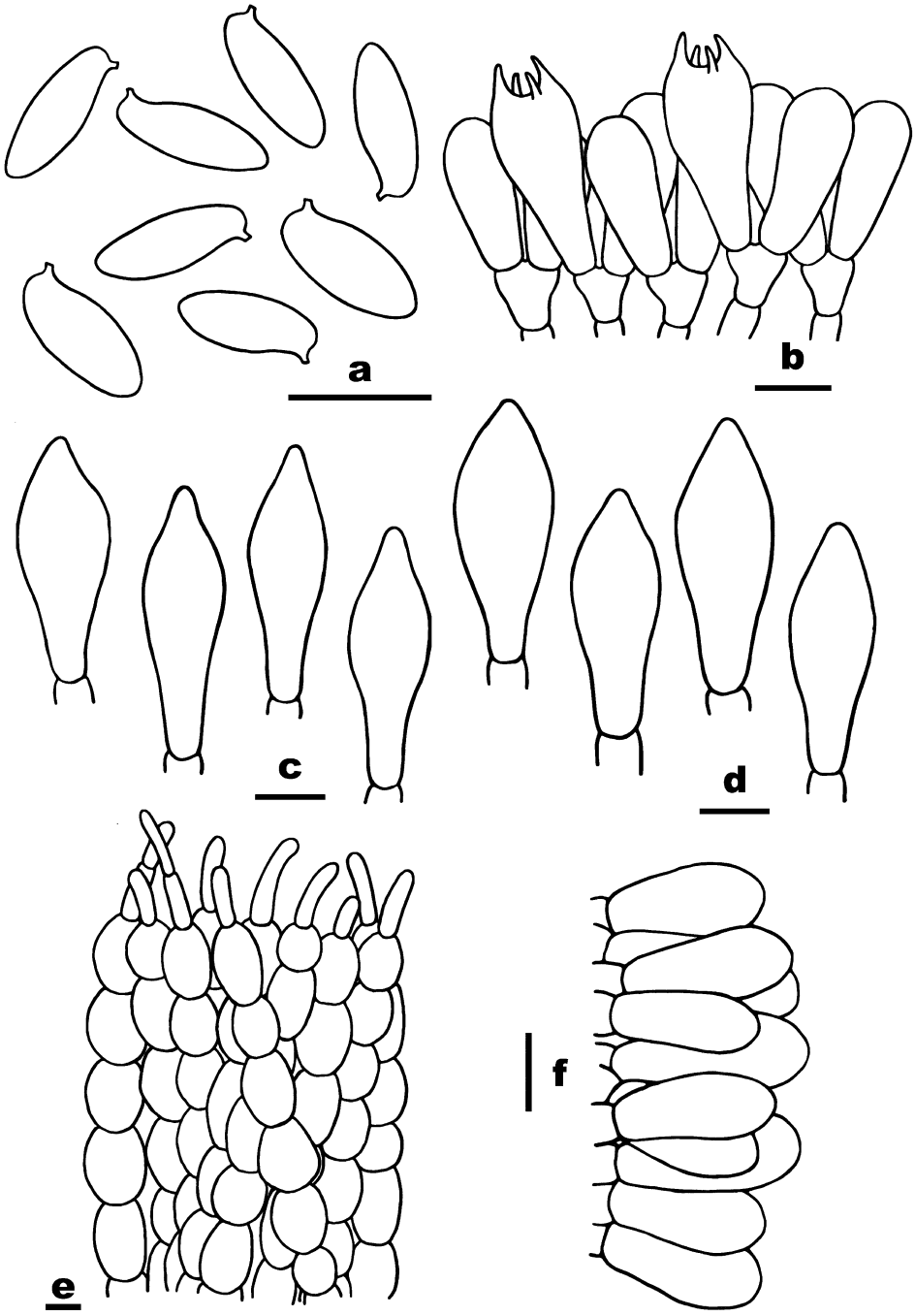


**Figure 33** – Microscopic characters of *Hemileccinum brunneoalbum* (FHMU8319, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Known distribution – Yunnan and Zhejiang Provinces of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1200 m elev., on soil in Fagaceae-dominated forests, gregarious, 22 May 2024, Huligui0053-1 (FHMU9184); same locality and date, Huligui0053-2 (FHMU10544).

Notes – The type locality of *H. ferrugineipes* is situated in Yunnan (Li et al. 2021). Our study documents its additional occurrence in Zhejiang. The species was redescribed using recently collected specimens, featuring a pale orange pileus, a light yellow to pale brown stipe adorned with pink to purplish-pink scales and coated with white pruina. Additionally, certain morphological

differences have been documented among specimens identified as *H. ferrugineipes*. Notably, collections reported by Li et al. (2021) exhibit a larger, dull brown to olive brown pileus, and a reddish-brown stipe.

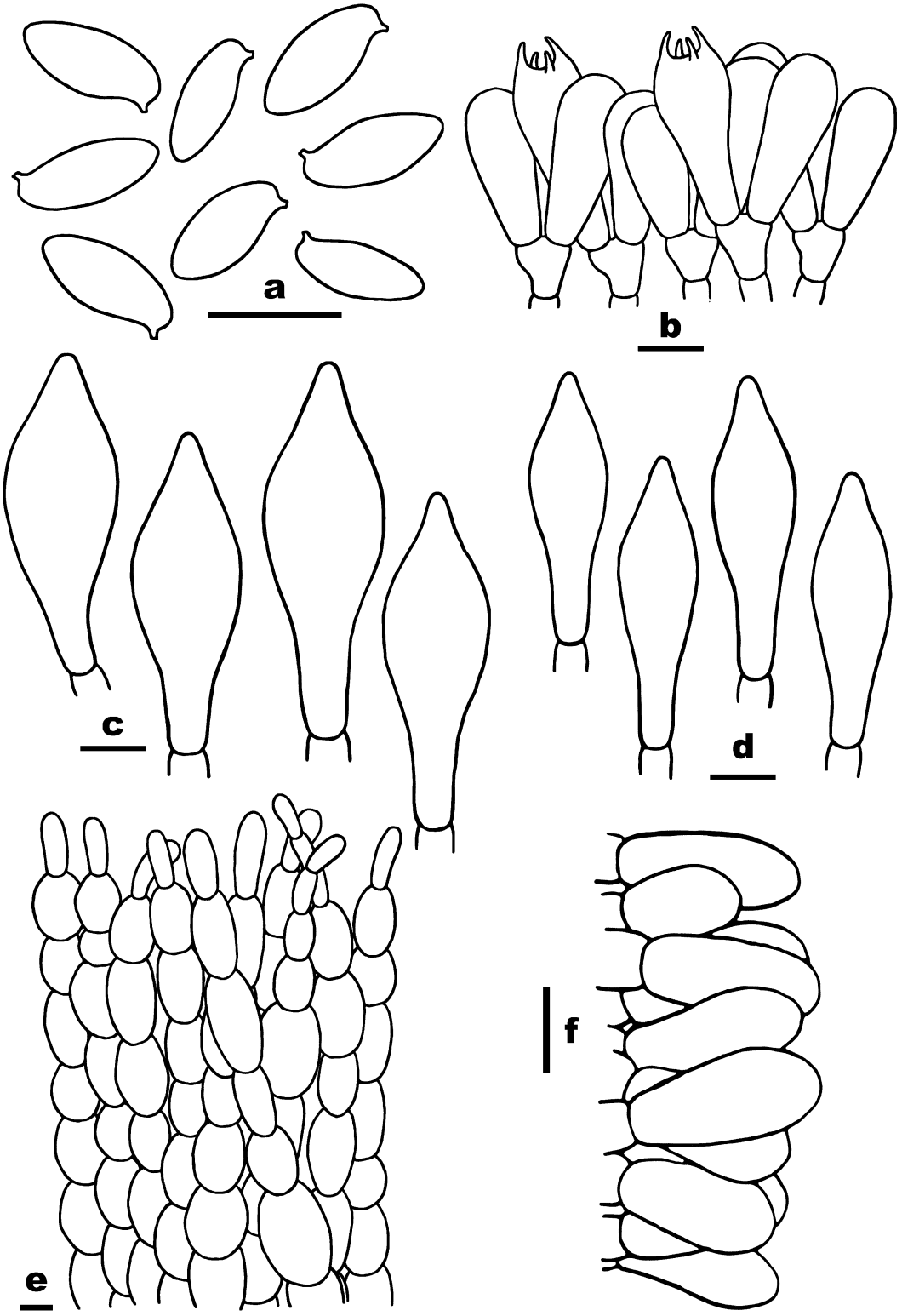


**Figure 34** – Microscopic characters of *Hemileccinum dilutibrunneum* (FHMU8853, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

***Hemileccinum lutosum*** N.K. Zeng, R.X. Zhao & Zhi Q. Liang, sp. nov. Figs 30k–l, 31o–p, 36

MycoBank: MB 860305; Facesoffungi: FoF 19089

Etymology – Latin "*lutosum*" signifies its earth yellow pileal surface.

Diagnosis – This species can be diagnosed by an earth yellow to brown pileus, a yellowish-white to pale brown stipe, surface densely adorned with greenish-white scales and brown spots, and its distribution in tropical China, which distinguish it from the closest *Hemileccinum* species.

Basidiomata medium in size. Pileus 5.3–6 cm across, subhemispherical, rugose, depressed in the center; surface earth yellow (4B5) to brown (6D5), darker in the center, smooth, slightly sticky when wet; margin decurved, entire; context at center 0.4–1 cm thick, white (1A1), no color change upon injury. Hymenophore poroid, sinuate; pores angular to subcircular, greenish-yellow (30A7), no color change upon injury; tubes 0.3–0.5 cm deep, yellowish (1A4), no color change upon injury. Stipe 4–6 × 1.2–1.6 cm, subcylindric, mid-positioned, consolidated, becoming hollow when old; surface yellowish-white (1A2–3), pale brown (4B4) at the base, densely adorned with greenish-white (29A3) scales and brown (4E7) spots, dry; context white (1A1), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [20/1/1] 8–9.1–10 × 4–4.5–5 μm, Q= 1.8–2.25 (–2.5), Qm = 2.04 ± 0.22, appearing smooth under light microscopy, while displaying bacilliform decorations or microscopic warts in SEM, elongate to subcylindric, wall thickness 0.5–1 μm, yellowish-brown. Basidia 16–29 × 8–10 μm, 4-spored, clavate, wall thickness approximately 0.5 μm, achromatic; sterigmata 2–3 μm. Cheilocystidia 30–43 × 11–13 μm, fusiform or subfusiform, not numerous, wall thickness approximately 0.5 μm, achromatic, without incrustations. Pleurocystidia 40–58 × 14–16 μm, fusiform or subfusiform, not numerous, wall thickness approximately 0.5 μm, achromatic, without incrustations. Hymenophoral trama consists of hyphae 9–12 μm wide, wall thickness approximately 0.5 μm, achromatic. Pileipellis a hyphoepithelioid, 170–225 μm thick, consists of chains of subglobose to pyriform, hyphae 12–27 μm wide, wall thickness approximately 1 μm, yellowish to achromatic, with narrowly cylindric to subclavate apical cells 7–44 × 7–11 μm. Pileal trama consists of hyphae 9–15 μm wide, wall thickness approximately 1 μm, achromatic. Stipitipellis 76–108 μm thick, consists of emergent hyphae with cylindric apical cells 16–31 × 6–8 μm, wall thickness 0.5–1 μm, achromatic. Stipe trama consists of hyphae 5–10 μm wide, wall thickness approximately 1 μm, yellowish to achromatic. Clamp connections not observed in any tissue.

Known distribution – Hainan Province of China.

Materials examined – China, Hainan Province, Qiongzhong Li and Miao Autonomous County, Limushan of Hainan Tropical Rainforest National Park, 650 m elev., on soil in Fagaceae-dominated forests, solitary, 14 July 2023, N.K. Zeng7620 (FHMU8142, holotype); same locality and date, N.K. Zeng7620-1 (FHMU11636).

Notes – *Hemileccinum lutosum* shares morphological similarities with Chinese *H. albocapillare* and *H. ferrugineipes*. However, *H. albocapillare* has a pileus adorned with whitish capillary squamules and longer basidiospores 10.5–13 × 4–5.5 μm (Wang et al. 2025); *H. ferrugineipes* has a larger pileus, a reddish-brown stipe, and longer basidiospores 11–12.5 × 4.5–5 μm (Li et al. 2021). Moreover, Southeast Asian *X. asperipes* (Corner) E. Horak, *X. cuticulatus* (Corner) E. Horak, and *X. ferruginosporus* (Corner) E. Horak, whose systematic positions require further confirmation, are somewhat similar to *H. lutosum*. However, *X. asperipes* has a smaller, dark brown to fuscous pileus, a floccose or densely furfuraceous stipe, and it is found in forests dominated by dipterocarps (Horak 2011); *X. cuticulatus* has a brown to fuscous pileus and a brown stipe with furfuraceous-pruinose (Horak 2011); *X. ferruginosporus* has a smaller, umber to fuscous pileus, relatively larger basidiospores 16.5–20 × 5–5.5 μm, and it is found in forests dominated by dipterocarps (Horak 2011). Phylogenetically, *H. lutosum* exhibits close affinity with Chinese *H. albidum* (Fig. 3). However, *H. albidum* has a larger pileus and relatively larger basidiospores 11–12.5 × 4.5–5.5 μm (Li et al. 2021).

***Hemileccinum parvum*** Mei Xiang Li, Zhu L. Yang & G. Wu, J. Fungi 7(10, no. 823): 15, 2021

**MycoBank: MB 840703**

**Synonym** – *Hemileccinum squamipes* N.K. Zeng, Chang Xu & Zhi Q. Liang, Stud. Mycol. 106: 164, 2023

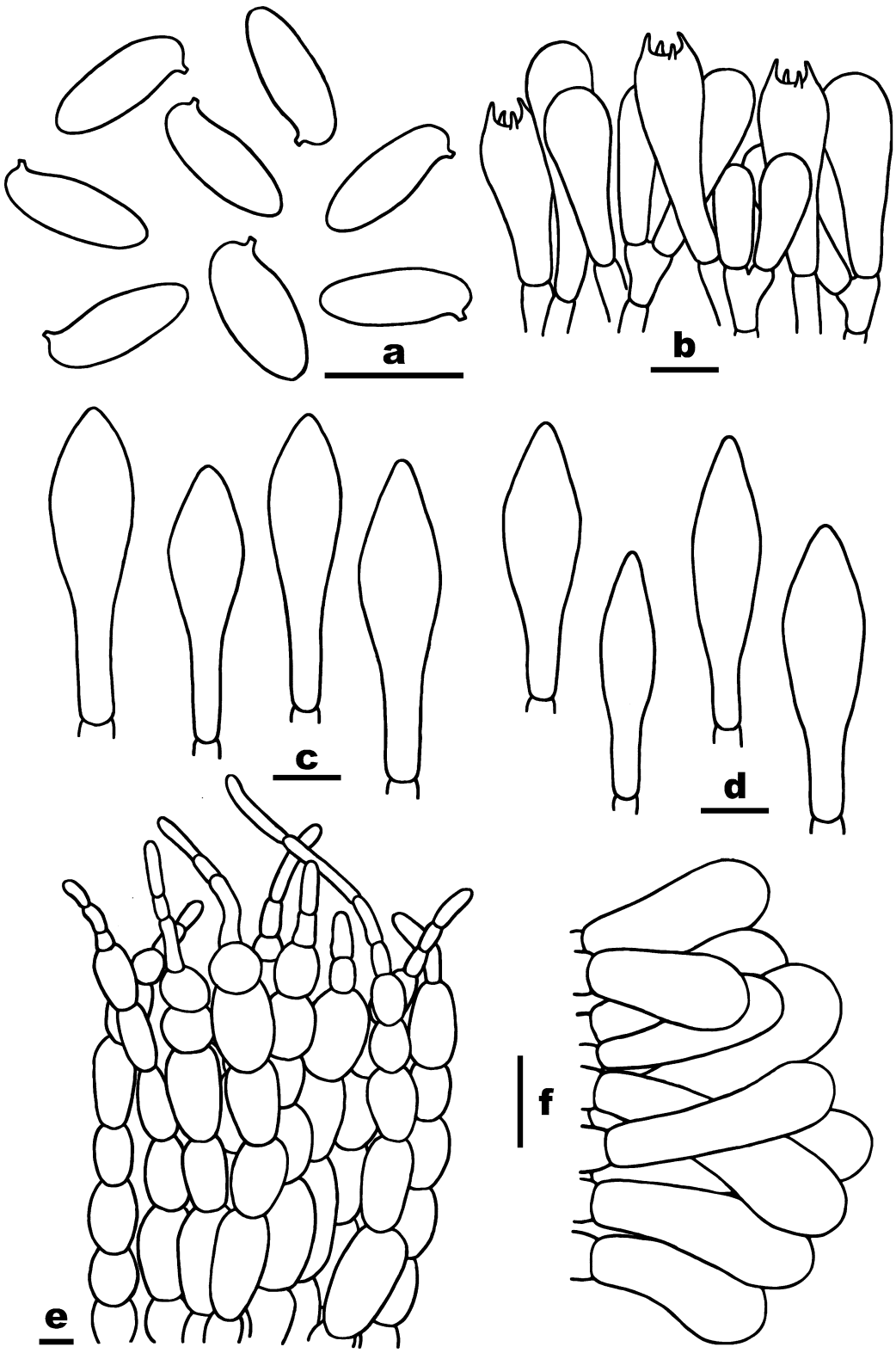


**Figure 35** – Microscopic characters of *Hemileccinum ferrugineipes* (FHMU9184). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

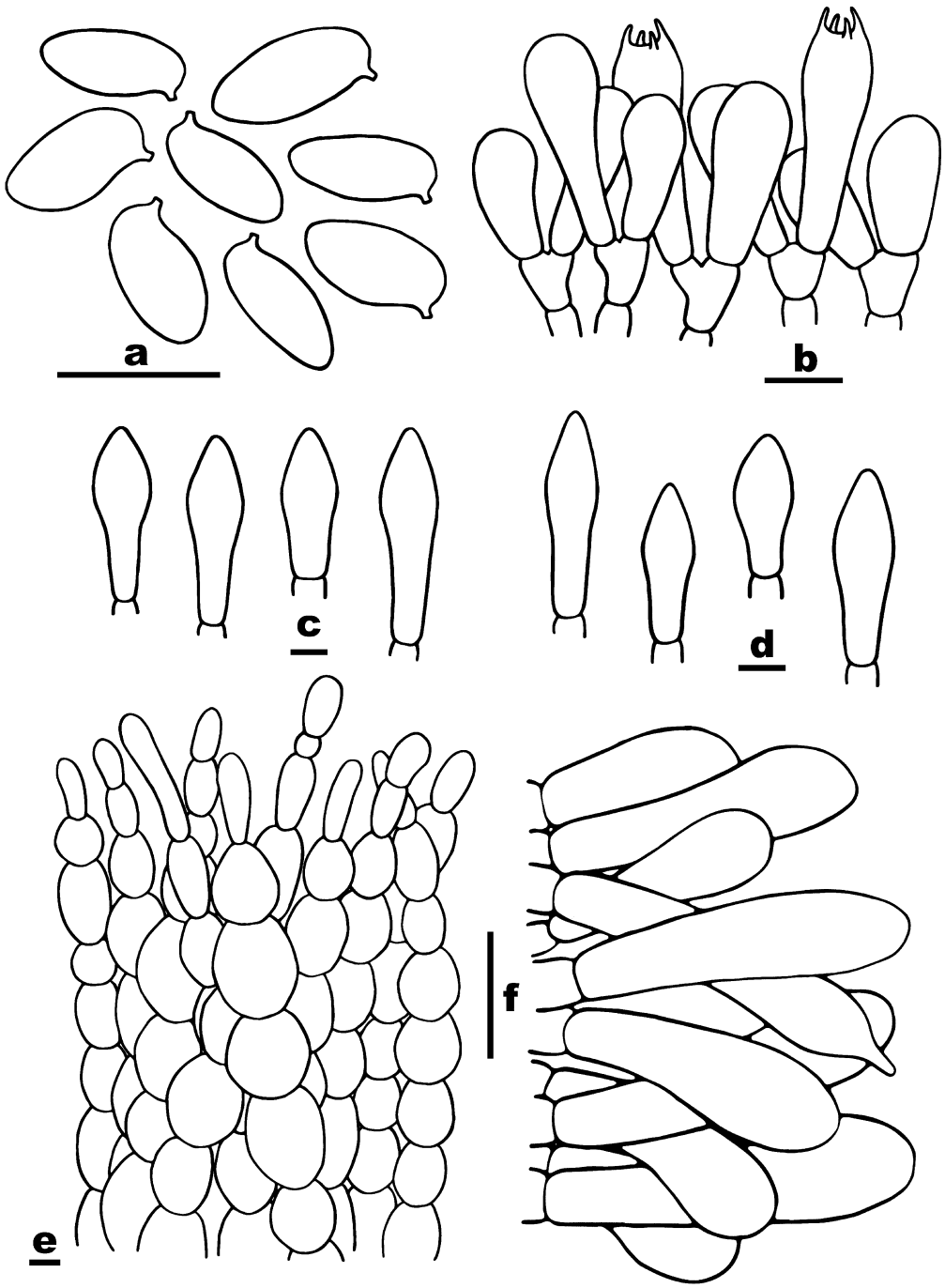


**Figure 36** – Microscopic characters of *Hemileccinum lutosum* (FHMU8142, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Known distribution – Yunnan and Hainan Provinces of China.

Notes – *Hemileccinum parvum* with type locality in Yunnan (Li et al. 2021). Subsequently, *H. squamipes* was published based on collections from Hainan Province in southern China (Xue et al. 2023). While the present study identifies *H. squamipes* as a synonym of *H. parvum* (Fig. 3), this conclusion contradicts that of Xue et al. (2023). A critical re-examination revealed that the *TEF*1 and *RPB*1 sequences of *H. parvum* and related species from Li et al. (2021) were deposited in GenBank in the reverse orientation and marked as "UNVERIFIED". Consequently, the use of these uncorrected

sequences led to an erroneous interpretation in Xue et al. (2023). Our phylogenetic reanalysis, performed after correcting the sequence orientations, confidently supports the synonymy of *H. squamipes* with *H. parvum*. Furthermore, no fundamental morphological distinctions exist between *H. squamipes* and *H. parvum* (Li et al. 2021; Xue et al. 2023).

***Hemileccinum verrucatum*** N.K. Zeng, R.X. Zhao, W.F. Lin & L.G. Hu, sp. nov.

Figs 30m–n, 31q–r, 37

MycoBank: MB 860306; Facesoffungi: FoF 19090

Etymology – Latin "*verrucatum*" signifies its pileus adorned with warts.

Diagnosis – This species can be diagnosed by a coffee-brown pileus adorned with warts, relatively large basidiospores, and a pileipellis consists of chains of cylindric cells, which distinguish it from the closest *Hemileccinum* species.

Basidiomata ranging from small to medium in size. Pileus 4.8–5.2 cm across, hemispherical; surface coffee-brown (5B5), adorned with concolorous warts, dry; margin decurved, entire; context at center 0.9–1.3 cm thick, pale brown (5B3), no color change upon injury. Hymenophore poroid, adnate to slightly decurrent; pores angular to subcircular, yellowish-brown (3B4–5), no color change upon injury; tubes 0.7–1 cm deep, yellowish-brown (3B4), no color change upon injury. Stipe 6.5–7 × 0.9–1 cm, subcylindric, mid-positioned, consolidated; surface yellowish (2A2) in the middle and brown (4B8) in the upper and base, densely adorned with concolorous scales, dry; context pale brown (5B3), no color change upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [20/1/1] 11–11.3–12 (–13) × 4–4.35–5 µm, Q= 2.2–3, Qm = 2.62 ± 0.26, appearing smooth under light microscopy, while displaying bacilliform decorations or microscopic warts in SEM, elongate to subcylindric, wall thickness approximately 1 µm, pale yellowish-brown. Basidia 21–27 × 10–13 µm, 4-spored, clavate, wall thickness approximately 0.5 µm, yellowish to achromatic; sterigmata 2–4 µm. Cheilocystidia 36–45 × 8–10 µm, fusiform or subfusiform, numerous, wall thickness approximately 0.5 µm, yellowish, without incrustations. Pleurocystidia 61–71 × 12–15 µm, fusiform or subfusiform, numerous, wall thickness approximately 0.5 µm, yellowish, without incrustations. Hymenophoral trama consists of hyphae 8–14 µm wide, wall thickness 0.5–1 µm, achromatic. Pileipellis a hyphoepithelium, 124–138 µm thick, consists of chains of inflated clavate, hyphae 8–17 µm wide, wall thickness approximately 1 µm, yellowish to yellow, with narrowly cylindric apical cells 33–46 × 4–7 µm. Pileal trama consists of hyphae 11–18 µm wide, wall thickness approximately 1 µm, achromatic. Stipitipellis 61–102 µm thick, consists of emergent hyphae with cylindric apical cells 20–61 × 5–12 µm, with long peak, wall thickness approximately 0.5 µm, yellowish to achromatic. Stipe trama consists of hyphae 7–12 µm wide, wall thickness 0.5–1 µm, yellowish to achromatic. Clamp connections not observed in any tissue.

Known distribution – Zhejiang Province of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1200 m elev., on soil in Fagaceae-dominated forests, solitary, 12 August 2023, N.K. Zeng7731 (FHMU10025, holotype); same locality and date, N.K. Zeng7731-1 (FHMU11637).

Notes – *Hemileccinum verrucatum* shares morphological similarities with *H. albocapillare* and *H. parvum* from China. It can be distinguished from *H. albocapillare* by the latter's pileus adorned with whitish capillary squamules and its pileipellis with a moniliform inner layer (Wang et al. 2025). Furthermore, *H. verrucatum* differs from *H. parvum*, which is characterized by a slightly subtomentose, brownish pileus, a pale yellow stipe, and a pileipellis of moniliform hyphal segments (Li et al. 2021). Moreover, Southeast Asian *X. asperipes*, *X. cuticulatus*, and *X. ferruginosporus*, whose systematic positions require further confirmation, are somewhat similar to *H. verrucatum*. However, *X. asperipes* has a smaller, dark brown to fuscous pileus without warts, a floccose or densely furfuraceous stipe, relatively smaller basidiospores 8–10.5 × 3.5–4.5 µm, and it occurs in tropical lowland dipterocarp forests (Horak 2011); *X. cuticulatus* has a glabrous pileus, a brown and furfuraceous-pruinose stipe, relatively smaller basidiospores 9.5–10.5 × 4.5–5 µm, and it occurs in a tropical region (Horak 2011); *X. ferruginosporus* has a umber to fuscous pileus without warts, a white to slightly brownish stipe, relatively larger basidiospores 16.5–20 × 5–5.5 µm, and it occurs in

tropical lowland dipterocarp forests (Horak 2011). In the phylogenetic tree (Fig. 3), the sister group of *H. verrucatum* remains unresolved, and its resolution requires expanded sampling across the genus in future studies.

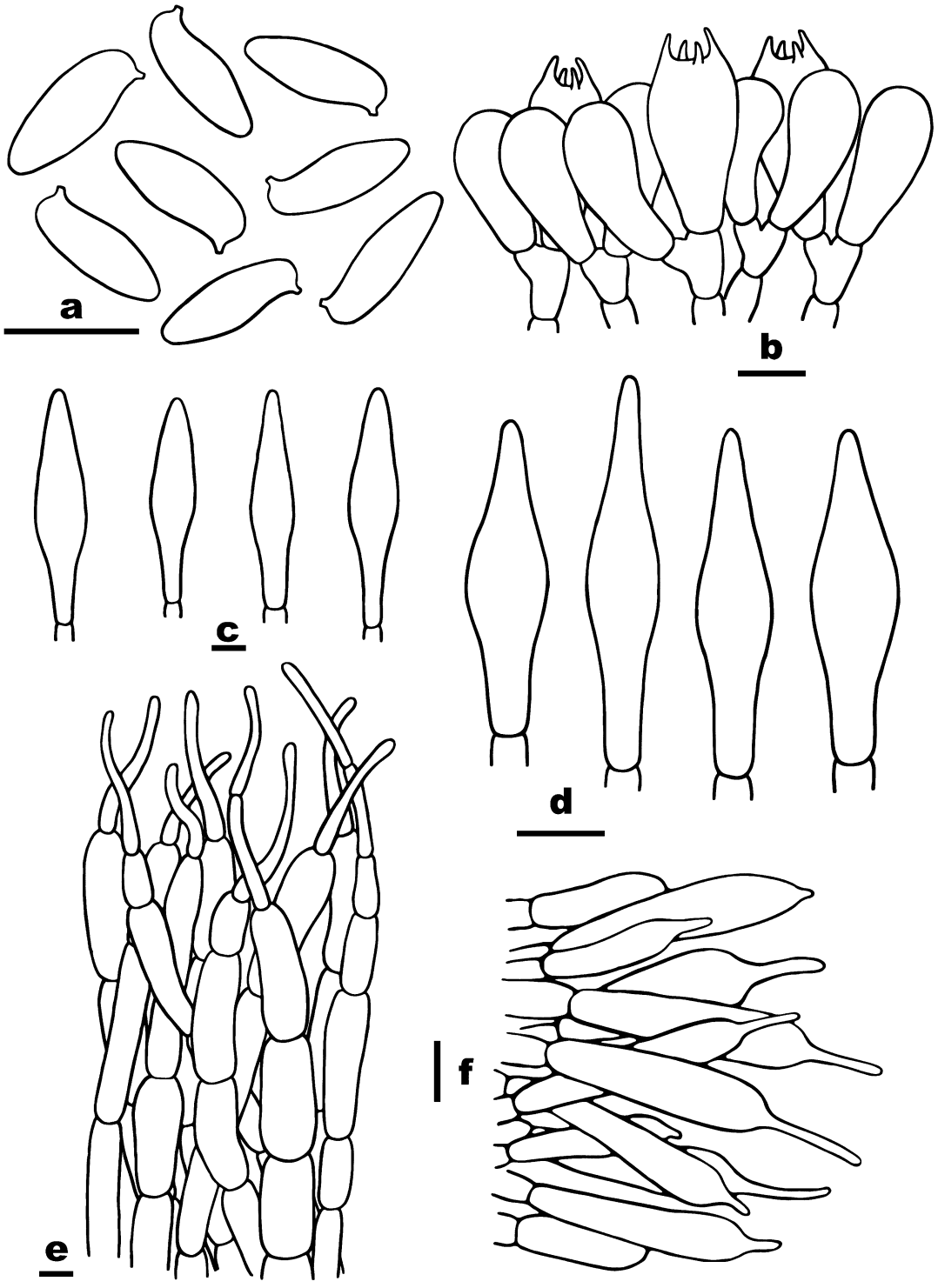


**Figure 37** – Microscopic characters of *Hemileccinum verrucatum* (FHMU10025, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

**Key to accepted species of *Hemileccinum* in China**

1. Pileal surface adorned with squamules ..... 2
1. Pileal surface without squamules ..... 3
2. Pileus surface adorned with irregularly shaped, subconical to conical squamules, stipe featuring a distinct zone ..... *H. indecorum*
2. Pileus surface adorned with whitish capillary squamules, stipe without a zone ..... *H. albocapillare*
3. Pileus up to 4 cm in diameter ..... *H. parvum*
3. Pileus > 4 cm in diameter ..... 4
4. Stipe surface whitish, whitish yellow or whitish brown ..... 5
4. Stipe surface yellowish to yellow, pale yellowish-brown to brown, reddish-brown ..... 8
5. Basidiospores 13–16 × 4–6 μm ..... *H. glutiniceps*
5. Basidiospores up to 12 μm long ..... 6
6. Pileus becoming distinctly rugose with maturity ..... *H. rugosum*
6. Pileus smooth at maturity ..... 7
7. Pileus maximum 9 cm across, surface chrome yellow, pompeian yellow to ochraceous, stipe up to 16 cm ..... *H. albidum*
7. Pileus maximum 5 cm across, surface pale brownish-white, stipe up to 7 cm ..... *H. brunneoalbum*
8. Pileus varying from pale orange, coffee-brown, pale brown to brown, lacking a reddish tinge ..... 9
8. Pileus yellowish-brown tinged with reddish ..... 12
9. Pileus surface adorned with coffee-brown warts ..... *H. verrucatum*
9. Pileus surface without warts ..... 10
10. Pileus strongly rugose, basidiospores 12–15 × 4–6 μm ..... *H. duriusculum*
10. Pileus smooth to slightly rugose, basidiospores up to 12 μm long and 5 μm wide ..... 11
11. Pileus surface adorned with pale brown pruina, context pale green ..... *H. dilutibrunneum*
11. Pileus surface without pruina, context white to yellowish-white ..... *H. lutosum*
12. Pileal surface adorned with a thin layer of whitish pruina ..... *H. pruinatum*
12. Pileal surface without pruina ..... 13
13. Stipe surface yellowish to cream at upper part, yellowish-brown at lower part, adorned with yellowish-brown squamules ..... *H. brevisporum*
13. Stipe surface reddish-brown, light yellow at the apex, densely adorned with whitish squamules ..... *H. ferrugineipes*

***Sudongpoa*** N.K. Zeng, T. Jiang, W.F. Lin & L.G. Hu, gen. nov.

MycoBank: MB 860312; Facesoffungi: FoF 19066

Type species – *Sudongpoa rubicarpos* N.K. Zeng, T. Jiang, W.F. Lin & L.G. Hu

Etymology – "*Sudongpoa*" is in honor of Dongpo Su (1307–1101), a legendary Northern Song dynasty poet, philosopher, and statesman renowned for his literary masterpieces and philosophy of harmony with nature.

Diagnosis – Differentiated from all previously known genera of Xerocomoideae via a suite of morphological traits: a basidioma tinged with red, a stipe adorned with red reticulations, hymenophore and context turning blue upon injury, and smooth basidiospores.

Basidiomata stipitate-pileate, hymenophore tubular. Pileus convex to plano-convex; context yellow, turning blue slowly upon injury. Hymenophoral surface and tubes concolorous, pale yellow, turning blue slowly upon injury. Stipe mid-positioned, consolidated, subcylindric; surface dry, adorned with reticulations; context yellow, turning blue upon injury; Basidiospores smooth, thin-walled; pleuro- and cheilocystidia present; pileipellis a subcutis or an intricate trichoderm. Clamp connections not observed in any tissue.

***Sudongpoa rubicarpos*** N.K. Zeng, T. Jiang, W.F. Lin & L.G. Hu, sp. nov. Figs 38a–b, 39a–b, 40

MycoBank: MB 860313; Facesoffungi: FoF 19091

Etymology – Latin "*rubicarpos*" signifies the red basidiomata of this species.

Diagnosis – *Sudongpoa rubicarpos* is characterized by a basidiocarp with red-tinged, a stipe adorned with reticulations, a hymenophore and context turning blue upon injury, smooth and ellipsoid basidiospores, and it occurs on soil in Fagaceae and *Pinus massoniana* mixed forests.Basidiomata large in size. Pileus 9.5–11 cm across, convex to applanate, slightly depressed in center; surface crimson with pink undertones (10A4–7), slightly rugose, dry; margin decurved, sometimes uplift, entire; contex at center t 0.6–1.3 cm thick, yellow (1A6), turning blue (24B6) slowly upon injury. Hymenophore poroid, shallowly concave near stipe apex, slightly decurrent; pores angular to subcircular, pale yellow (2A3), turning blue (24B6) slowly upon injury; tubes 0.6–1.4 cm deep, pale yellow (2A3), turning blue (24B6) slowly upon injury. Stipe 6–7.5 × 1.7–2 cm, subcylindric, mid-positioned, consolidated; surface light yellow (2A6), adorned with dark salmon red (7A6) reticulations, dry; context brilliant yellow (3A6), turning blue (24B6) slowly upon injury. Basal mycelium whitish (1A1). Odor unremarkable.

Basidiospores [60/3/3] 7.5–7.92–8.5 × 4–4.68–5 (–5.5) µm, Q = 1.36–1.89 (–2), Qm = 1.71 ± 0.21, smooth, ellipsoid to elongate, wall thickness approximately 0.5 µm, pale yellowish-brown. Basidia 22–35× 8–11 µm, 4-spored, subclavate or subcylindric, wall thickness approximately 0.5 µm, yellowish; sterigmata 3–5.5 µm long. Cheilocystidia 48–62 × 9–10 µm, subfusiform, not numerous, wall thickness approximately 0.5 µm, pale yellow or achromatic, without incrustations. Pleurocystidia 40–54 × 8–9 µm, subfusiform, not numerous, wall thickness approximately 0.5 µm, pale yellow or achromatic, without incrustations. Hymenophoral trama consists of hyphae 4–10 µm wide, wall thickness approximately 0.5 µm, yellowish to achromatic. Pileipellis an intricate trichoderm-type, 150–400 µm thick, consists of hyphae 4–11 µm wide, wall thickness approximately 1 µm, achromatic, with clavate or subcylindric apical cells 20–50 × 5–9 µm. Pileus trama consists of interlaced, hyphae 4–14 µm wide, wall thickness approximately 0.5 µm, yellowish. Stipitipellis 130–200 µm thick, consists of hyphae 4–10 µm wide, wall thickness approximately 0.5 µm, achromatic, with clavate to subcylindric apical cells 25–48 × 4–11 µm. Stipe trama consists of hyphae 5–12 µm wide, wall thickness 0.5–1 µm, achromatic. Clamp connections not observed in any tissue.


**Figure 38** – Fresh basidiomata of *Sudongpoa* species. a–b *S. rubicarpos* (FHMU9171, holotype). c–e *S. rubripes* (c from FHMU8529; d from FHMU9661; e from FHMU8771, holotype). Scale bars represent 1 cm.

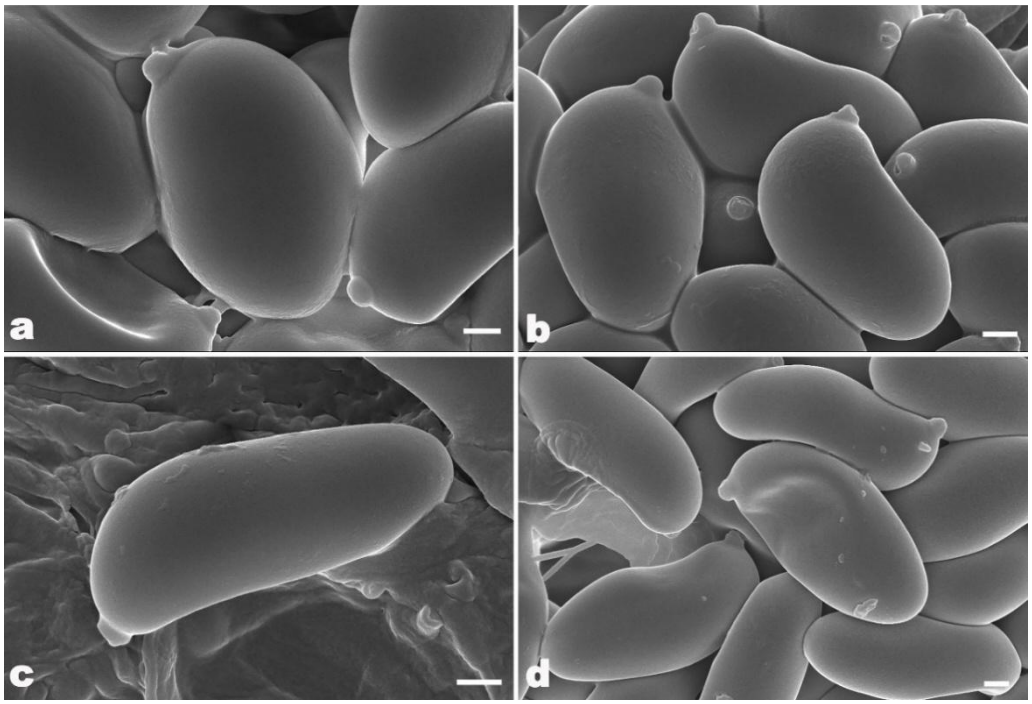


**Figure 39** – Basidiospores of *Sudongpoa* species by SEM. a–b *S. rubicarpos* (FHMU9171, holotype). c–d *S. rubripes* (FHMU8771, holotype). Scale bars represent 1 μm.

Known distribution – Zhejiang Province of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1300 m elev., on soil in Fagaceae and *P. massoniana* mixed forests, gregarious, 21 August 2024, N.K. Zeng10297 (FHMU9171, holotype); same locality and date, Zeng10297-1 (FHMU10548); same locality and date, N.K. Zeng10297-3 (FHMU10549).

Notes – *Boletellus indistinctus* G. Wu et al., *Rubroboletus latisporus* Kuan Zhao & Zhu L. Yang, and *Suillellus subamygdalinus* Kuan Zhao & Zhu L. Yang share morphological similarities with *S. rubicarpos*. However, *Bol. indistinctus* has relatively larger basidiospores 10–13 × 5–6 μm and a pileipellis trichoderm-type (Xue et al. 2023); *R. latisporus* has an orange-red to yellow hymenophore, relatively larger basidiospores 11–14 × 6–7 μm, and a trichoderm-type pileipellis (Zhao et al. 2014b); *S. subamygdalinus* has an orangish-red to brownish-red hymenophore, relatively larger basidiospores 11–16 × 4.5–7 μm, a trichoderm-type pileipellis, and it is found in mixed forests of *Betula*, *Salix* and *Picea* (Wu et al. 2016). Phylogenetically, *S. rubicarpos* exhibits close affinity with *S. rubripes*. However, *S. rubripes* has a lighter and sandy brown pileus, a darker and rosy red stipe, longer basidiospores 9–11.5 × 3.5–5 μm, and it occurs on soil in *Pinus massoniana* and *Phyllostachys edulis* (Carrière) J. Houzeau mixed forests (see below).

***Sudongpoa rubripes*** N.K. Zeng, T. Jiang, W.F. Lin & L.G. Hu, sp. nov. Figs 38c–e, 39c–d, 41

MycoBank: MB 860314; Facesoffungi: FoF 19092

Etymology – Latin "*rubripes*" signifies the rosy red stipe of this species.

Diagnosis – *Sudongpoa rubripes* is characterized by a rosy red stipe, surface adorned with reticulations, a hymenophore and context turning blue upon injury, smooth basidiospores, and it occurs on soil in *Phllostachys edulis* and *Pinus massoniana* mixed forests.

Basidiomata ranging from small to large in size. Pileus 5–10.6 cm across, initially subhemispherical, expanding to convex to plano-convex with age; surface lotus pink (13A2) to light pink (12A3) when young, then sandy brown (3B3), smooth, dry; margin decurved, entire; context at center 0.9–1.7 cm thick, yellowish-white (3A2–4), turning blue (24B6) slowly upon injury. Hymenophore poroid, sinuate to slightly decurrent; pores angular to subcircular, pale yellow (2A2), turning blue (24B6) slowly upon injury; tubes 0.6–1.1 cm in length, yellow (2A3), turning blue (24B6)

slowly upon injury. Stipe 6.8–8.8 × 1.6–2.4 cm, subcylindric, mid-positioned, consolidated, sometimes enlarged at base; surface rosy red (9B2), sometimes with obscurely rugulose-reticulate, then cracking into scabrous scales towards the base, dry; context yellow white (3A2–4), turning blue (24B6) slowly upon injury. Basal mycelium yellow (2A4). Odor unremarkable.

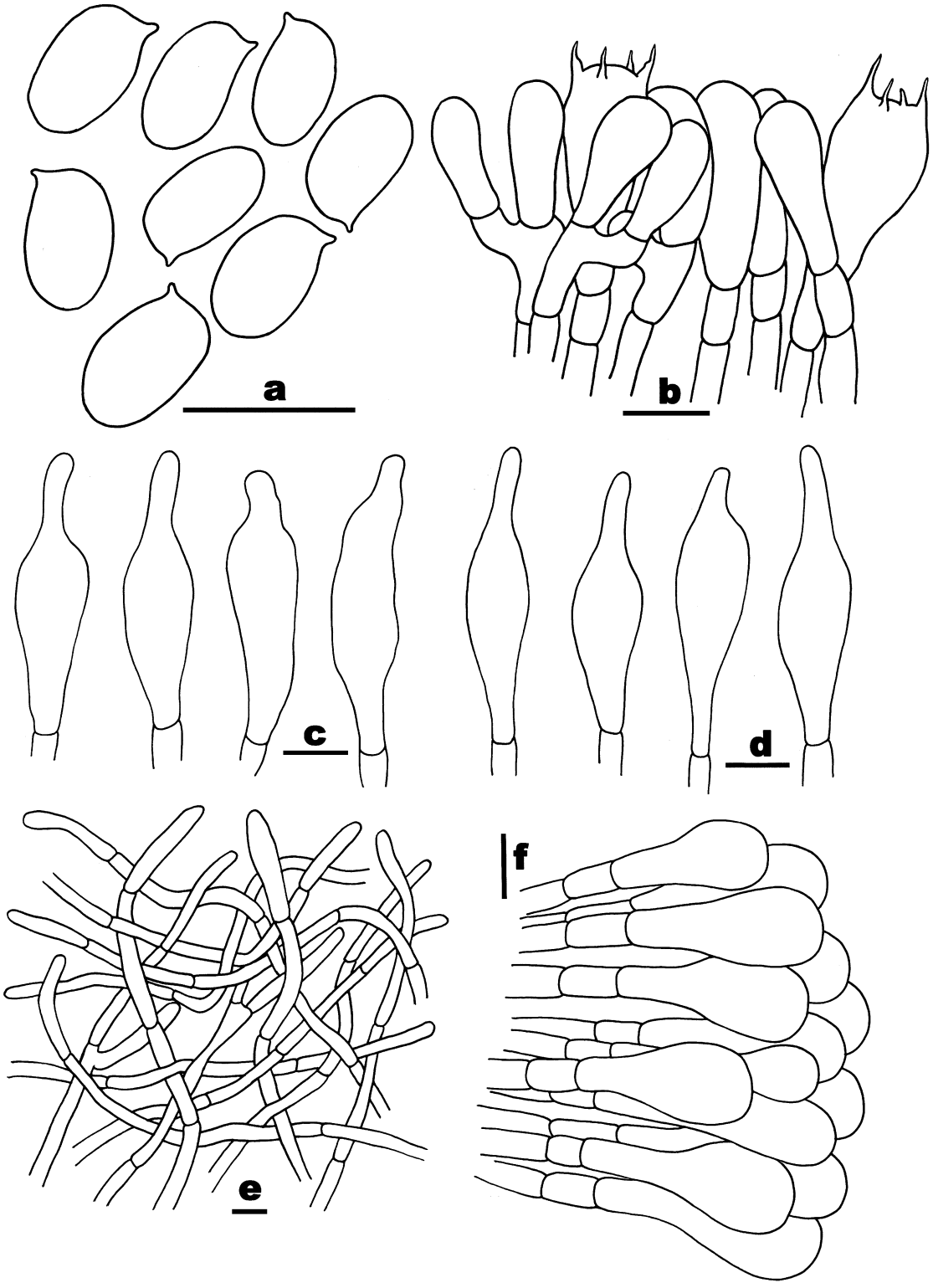


**Figure 40** – Microscopic characters of *Sudongpoa rubicarpos* (FHMU9171, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

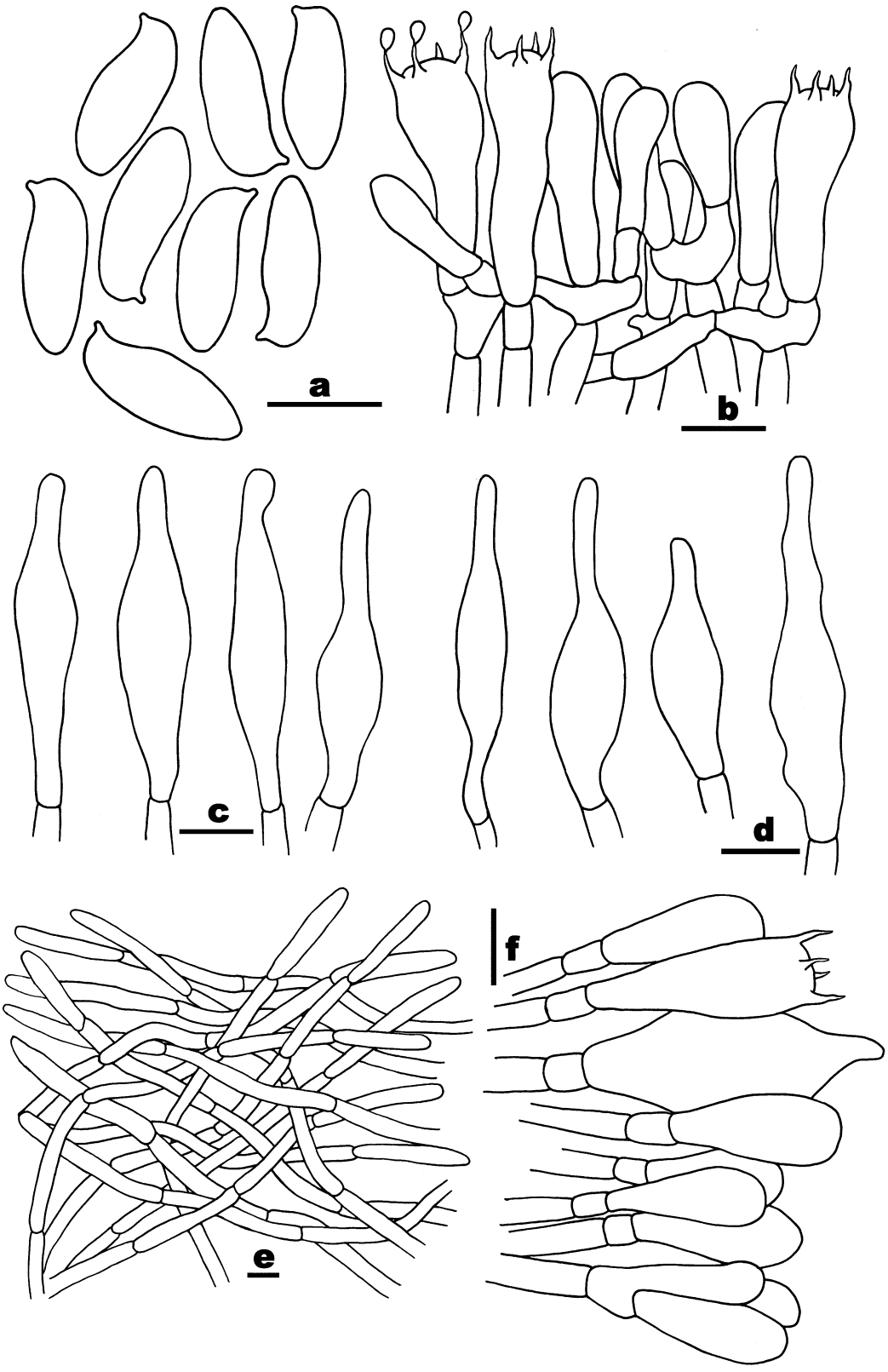


**Figure 41** – Microscopic characters of *Sudongpoa rubripes* (FHMU8771, holotype). a Basidiospores. b Basidia. c Pleurocystidia. d Cheilocystidia. e Pileipellis. f Stipitipellis. Scale bars represent 10 μm.

Basidiospores [60/3/2] 9–10.37–11(11.5) × 3.5–4.15–4.5 (–5) μm, Q = 2.1–2.75 (–2.88), Qm = 2.51 ± 0.2, smooth, fusoid, wall thickness approximately 0.8 μm, pale yellowish-brown. Basidia 24–32 × 8–10 μm, 4-spored, subclavate or subcylindric, slightly thick-walled (0.5–0.8 μm),

yellowish; sterigmata 3–6 µm long. Cheilocystidia 30–55 × 9–10 µm, subfusiform, not numerous, wall thickness approximately 0.5 µm, pale yellow or achromatic, without incrustations. Pleurocystidia 45–70 × 8–9 µm, subfusiform, not numerous, wall thickness approximately 0.8 µm, pale yellow or achromatic, without incrustations. Hymenophoral trama consists of hyphae 5–10 µm wide, slightly thin-walled (up to 0.5 µm, yellowish to achromatic. Pileipellis a subcutis-type, 280–450 µm thick, consists of subparallel to slightly interwoven, hyphae 5–8 µm wide, wall thickness approximately 1 µm, achromatic, with clavate or subcylindric apical cells 30–60 × 5–8 µm. Pileus trama consists of interlaced, hyphae 5–12 µm wide, wall thickness approximately 0.5 µm, yellowish. Stipitipellis 150–300 µm thick, consists of hyphae 5–10 µm wide, wall thickness approximately 0.5 µm, achromatic, with clavate to subcylindric apical cells 30–65 × 4–11 µm. Stipe trama consists of hyphae 5–12 µm wide, wall thickness 0.5–1 µm, achromatic. Clamp connections not observed in any tissue.

Known distribution – Zhejiang Province of China.

Materials examined – China, Zhejiang Province, Qingyuan County, Baishanzu, 1300 m elev., on soil in *Ph. edulis* and *P. massoniana* mixed forests, solitary, 13 August 2023, N.K. Zeng7834 (FHMU9661); same locality, 19 August 2024, N.K. Zeng10181 (FHMU8529); same locality and date, N.K. Zeng10185 (FHMU8771, holotype).

Notes – *Sudongpoa rubripes* shares morphological similarities with *Caloboletus panniformis* (Taneyama & Har. Takah.) Vizzini and *Harrya chromapes* (Frost) Halling et al. However, *C. panniformis* has a yellow, scaly pileus, relatively larger basidiospores 12–19 × 4–6.5 µm, and it occurs on soil in *Abies* and *Picea* forests (Wu et al. 2016); *Ha. chromapes* has a red-bruising pileus, a context with no color change upon injury, and relatively larger basidiospores 13–17.5 × 4–5.5 µm (Halling et al. 2012). *Sudongpoa rubripes* is phylogenetically close to *S. rubicarpos* (Fig. 1); a detailed morphological comparison between these two congeners is provided in the discussion for wthe latter species.

## DISCUSSION

Our phylogenetic analyses confirmed that *Boletellopsis elata* forms a distinct genus-level lineage within the subfamily Xerocomoideae and is separate from the core *Boletellus*, corroborating the findings of Halling et al. (2015). This placement is consistent with its unique morphology, notably the absence of apical spore cracking and the presence of a distinct subapical annular depression, as previously documented (Halling & Ortiz-Santana 2009). Morphologically, *Boletellus* can be distinguished from the new genus *Boletellopsis* by its scaly pileus and the rapid bluing reaction of its hymenophore and context upon injury, in addition to its ornamented basidiospores, which under SEM exhibit apices traversed by continuous or multiple fissures. Phylogenetically, *Boletellopsis* forms a clade with *Alessioporus* Gelardi et al. and *Pulchroboletus* Gelardi et al., albeit with low statistical support. Consequently, its precise phylogenetic relationships warrant clarification through future studies with expanded taxon sampling.

Our new genus *Sudongpoa* is also a member of Xerocomoideae. Combined with current data, Xerocomoideae now encompasses 13 globally recognized genera, with 10 confirmed in China. The genera *Boletellus*, *Heimioporus* E. Horak, *Hemileccinum*, and *Pulchroboletus*, all of which are distributed in China, exhibit morphological similarities to *Sudongpoa*. However, *Boletellus* has a squamose pileus, ornamented basidiospores, and a trichoderm pileipellis (Murrill 1909, Wu et al. 2016, Xue et al. 2023); *Heimioporus* is characterized by reticulate basidiospores with a coarse and net-like ornamentation (Boedijn 1951, Horak 2004, Halling & Fechner 2011, Wu et al. 2016, Zeng et al. 2018, Xue et al. 2023); *Pulchroboletus* is different by a pinkish-lilac pileal context, and a pseudo-annulus commonly found in the mid to upper stipe segments (Gelardi et al. 2014, Xue et al. 2023). Phylogenetically, *Sudongpoa* groups with *Amylotrama* Bloomfield, Davoodian, Trappe & T.Lebel, albeit with low statistical support, and the precise delineation of its sister group must await future studies with broader taxon sampling.

Our phylogenetic analysis could not clearly separate Suillelloideae and Phylloboletelloideae, possibly because only 28S data are available for the type species *Phylloboletellus chloephorus* Singer.

Nevertheless, this ambiguity does not compromise the well-defined status of *Chenrenyua*, which is robustly supported as a distinct genus-level lineage. Based on morphological characteristics, *Chenrenyua* is clearly assigned to the subfamily Suillelloideae. Morphologically, *Chenrenyua* shares similarities with genera in this subfamily, such as *Amoenoboletus* G. Wu et al., *Rubroleccinum* N.K. Zeng et al., and *Sutorius* Halling et al., by having a squamose stipe and smooth basidiospores. However, *Amoenoboletus* can be distinguished by a squamose pileus, a context and hymenophore no color change upon injury, ovoid to ellipsoid basidiospores, and a subcutis-type pileipellis (Wu et al. 2022a); *Rubroleccinum* is different by a reddish-orange to grayish-yellow pileus, a context and hymenophore turning red upon injury, and a trichoderm pileipellis (Qin et al. 2024a); *Sutorius* differs from *Chenrenyua* by a hymenophore tinged with reddish throughout development and tissues with no color change upon injury (Chai et al. 2019). *Chenrenyua* is phylogenetically closely related to *Rugiboletus* G. Wu & Zhu L. Yang. However, *Rugiboletus* has a distinctively wrinkled or gelatinized pileus, a context and hymenophore with no color change upon injury, and ixotrichodermium to interwoven ixotrichodermium pileipellis (Wu et al. 2015).

The genus *Aureoboletus* was proposed in 1957, with *A. gentilis* (Quél.) Pouzar designated as the type species (Pouzar 1957). Species within this genus are widely distributed across temperate to tropical forest ecosystems globally, with particularly high diversity observed in Asia and North America (Zhang et al. 2019, Liu et al. 2024, Qin et al. 2024b). Ecologically, *Aureoboletus* species form ectomycorrhizae with trees of the families Pinaceae and Fagaceae (Klofac 2010, Wu et al. 2016, Zhang et al. 2019, 2022). Combining existing molecular evidence with data from this study, East Asia region serves as the center of species diversity for *Aureoboletus*, with the number of documented species in China alone now increased to 42 (Wu et al. 2016, Zhang et al. 2017, 2019, Zhang et al. 2022, Xue et al. 2023, Liu et al. 2024, Qin et al. 2024b, Wang et al. 2025). Integrative morphological and molecular phylogenetic analyses of newly collected specimens resolved the complex *A. solus* lineage into five distinct taxa, viz. *A. applanatus*, *A. canceriformis*, *A. exiguisquamatus*, *A. magniporus*, and *A. solus*. Additionally, *A. pallidorubellus* was phylogenetically segregated from the *A. rubellus* lineage, establishing its distinct phylogenetic position. Furthermore, ongoing advancements in field exploration and molecular phylogenetic studies are expected to reveal numerous new taxa within this genus in the future.

The genus *Hemileccinum*, established in 2008 and typified by *H. impolitum* (Fr.) Šutara, is morphologically characterized by a leccinoid-type lateral stipe stratum, basidiospores exhibiting irregularly warty ornamentation under scanning electron microscopy, and a bilayered pileipellis structure comprising hyphoepithelium of slender hyphae and subepithelium dominated by inflated hyphae (Šutara 2008, Wu et al. 2014, Wu et al. 2016, Li et al. 2021, Zhao et al. 2025). Currently, a comprehensive understanding of species diversity within the genus remains limited (Wu et al. 2016, Kuo & Ortiz-Santana 2020, Li et al. 2021). Systematic fieldwork and taxonomic revision in subtropical to tropical China led to the discovery of four new *Hemileccinum* species. This work directly enriches the taxonomic research for the genus. Globally, approximately 22 species have been documented, with 14 of these distributed in China, which suggests that China may serve as a diversity center for this genus (Šutara 2008, Wu et al. 2016, Heluta et al. 2019, Kuo & Ortiz-Santana 2020, Farid et al. 2021, Li et al. 2021, Xue et al. 2023, Liu et al. 2024, Vadthanarat et al. 2024, Wang et al. 2025, Zhao et al. 2025).

The Boletaceae family in China has attracted significant attention from mycologists due to its remarkable species diversity and high degree of endemism (Chai et al. 2019, Wang et al. 2020, Xu et al. 2021, Deng et al. 2023, Wu et al. 2023, Xue et al. 2023, 2024, Zhou et al. 2023, Qin et al. 2024a, b). Although the present study was confined to five genera (including three newly described ones, viz. *Boletellopsis*, *Chenrenyua*, and *Sudongpoa*), it led to the discovery of 18 novel species, further reinforcing this consensus. However, these findings represent only a fraction of the family's total diversity, and future investigations into other genera are expected to reveal a much richer species panorama. Moreover, while this research primarily focused on Boletaceae in subtropical and tropical regions of China, temperate zones remain comparatively understudied. Notably, two recent studies conducted in temperate provinces such as Shanxi, Henan, and Jilin have documented 15 new species

within Boletaceae (Mao et al. 2023, Wang et al. 2024). These results underscore the importance of conducting integrated surveys across China's tropical-subtropical-temperate transition zones, where comprehensive inventories would likely uncover numerous undocumented taxa. Such efforts would substantially advance our understanding of Boletaceae systematics and biogeography, provide a scientific basis for conservation strategies, and promote the sustainable utilization of edible and medicinal fungal resources.

**ACKNOWLEDGEMENTS**

This research received financial support from the following sources: the Science and Technology Innovation Team of the National Tropical Agricultural Science Center at the Chinese Academy of Tropical Agricultural Sciences (No. CATASCXTD202524); the Special Fund Project for Environmental Protection of Hainan Province (Investigation and Assessment of Biodiversity in Qiongzhong and Changjiang Counties), initiated by the Department of Ecology and Environment of Hainan Province; Hainan Institute of National Park (HINP, KY-24ZK02); the Hainan Province Science and Technology Special Fund (ZDYF2023RDYL01); and the Hainan Normal University Talent Research Start-up Fund (HSZK-KYQD-202419).

**DECLARATION ON CONFLICT OF INTEREST**

The authors have declared that no competing interests exist.

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**Supplementary Table 1** Species, vouchers, locations, and GenBank accession numbers of the molecular phylogenetic study (published).

| Species | Voucher | Locality | GenBank Accession Nos. | | | |
|---|---|---|---|---|---|---|
| | | | 28S | *TEF*1 | *RPB*1 | *RPB*2 |
| *Abtylopilus scabrosus* | HKAS50211 | Yunnan, SW China | KT990552 | KT990752 | KT990920 | KT990389 |
| *Acyanoboletus controversus* | HKAS126560 | Yunnan, SW China | OQ888714 | OQ873451 | OQ873469 | OQ873490 |
| *Acyanoboletus dissimilis* | ZT14030 | Malaysia | OQ888716 | OQ873453 | OQ873471 | OQ873492 |
| *Afroboletus luteolus* | 00-436 | Africa | KF030238 | KF030397 | KF030392 | — |
| *Afrocastellanoa ivoryana* | Arora 126 | Zimbabwe | KX685721 | KX685715 | — | — |
| *Alessioporus ichnusanus* | AMB 12756 | Italy | KJ729504 | KJ729513 | — | — |
| *Amoenoboletus miraculosus* | ZT14046 | Malaysia | MW520188 | MW566745 | — | — |
| *Amoenoboletus granulopunctatus* | HKAS56280 | Yunnan, SW China | KF112418 | KF112265 | KF112541 | KF112708 |
| *Amylotrama clelandii* | MEL2432546 | Australia | MT459235 | MN413630 | — | — |
| *Anthracoporus holophaeus* | HKAS59407 | China | KT990708 | KT990888 | KT991030 | KT990506 |
| *Anthracoporus nigropurpureus* | HKAS52685 | China | KT990627 | KT990821 | KT990973 | KT990459 |
| *Austroboletus* aff. *fusisporus* | HKAS52683 | Fujian, SE China | KF112484 | KF112213 | KF112571 | KF112766 |
| *Aureoboletus albipes* | N.K. Zeng3276 (FHMU2237) | Fujian, SE China | OP630877 | OP676222 | — | — |
| *Aureoboletus albipes* | N.K. Zeng3267 (FHMU2228) | Fujian, SE China | OP630876 | OP676221 | — | — |
| *Aureoboletus auriflammeus* | DD973 | USA | AY612818 | — | — | — |
| *Aureoboletus auriflammeus* | CFMR BOS-699 | USA | MK601706 | MK721060 | — | — |
| *Aureoboletus auriporus* | 35/97 | USA | DQ534636 | — | — | — |
| *Aureoboletus auriporus* | BDCR0431 | Costa Rica | HQ161871 | — | — | — |
| *Aureoboletus auriporus* | MAN020 | Costa Rica | JQ003659 | — | — | — |
| *Aureoboletus ayuukii* | MEXU-HO 30448 | Mexico | OR421569 | — | — | — |
| *Aureoboletus catenarius* | KUN-HKAS54467 | Yunnan, SW China | KT990510 | KT990711 | — | KT990349 |
| *Aureoboletus catenarius* | KUN-HKAS54463 | Yunnan, SW China | KT990509 | KT990710 | — | KT990348 |
| "*Aureoboletus catenarius*" | GDGM45142 | China | MN204514 | — | — | — |
| *Aureoboletus* cf. *auriporus* | GDGM44404 | USA | MN410705 | — | — | — |
| *Aureoboletus* cf. *venustus* | ZhangM142 | China | MN204558 | MN549668 | — | MN549714 |
| *Aureoboletus* cf. *venustus* | ZhangMA-2 | China | MN204557 | MN549679 | — | MN549713 |
| *Aureoboletus* cf. *venustus* | GDGM42800 | China | MK123463 | — | — | MN549684 |
| *Aureoboletus citriniporus* | REH8719 | USA | KF030298 | — | — | — |
| *Aureoboletus citriniporus* | JLF6091 | USA | MH271618 | — | — | — |
| *Aureoboletus clavatus* | GDGM42963 | Hainan, southern China | KR052046 | KR052054 | — | — |
| *Aureoboletus clavatus* | GDGM42992 | China | MK123462 | MK165847 | — | — |
| *Aureoboletus clavatus* | KUN-HKAS59802 | Hainan, southern China | KR052044 | KR052053 | — | — |
| *Aureoboletus clavatus* | N.K. Zeng3446 (FHMU2885) | Hainan, southern China | OP604278 | OP676225 | — | — |
| *Aureoboletus conicus* | N.K. Zeng4276 (FHMU4730) | Hainan, southern China | OP630878 | — | — | — |
| *Aureoboletus duplicatoporus* | HKAS83115 | Yunnan, SW China | KT990512 | KT990713 | KT990892 | KT990351 |
| *Aureoboletus duplicatoporus* | N.K. Zeng3007 (FHMU1968) | Hainan, southern China | OP605392 | — | — | — |
| *Aureoboletus duplicatoporus* | N.K. Zeng4729-1 (FHMU5398) | Hainan, southern China | OP605394 | OP680535 | — | — |
| *Aureoboletus duplicatoporus* | KUN-HKAS50498 | Yunnan, SW China | KF112361 | KF112230 | — | KF112754 |
| *Aureoboletus duplicatoporus* | JXSB1344 | Jiangxi, eastern China | MK765809 | — | — | — |
| *Aureoboletus elvirae* | 794-ITCV | Mexico | OQ975746 | — | — | OQ938893 |
| *Aureoboletus erythraeus* | N.K. Zeng3434 (FHMU3145) | Hainan, southern China | MT650075 | MT650113 | — | — |
| *Aureoboletus erythraeus* | N.K. Zeng1570 (FHMU1053) | Hainan, southern China | MT650074 | MT650112 | — | — |
| *Aureoboletus erythraeus* | N.K. Zeng3489 (FHMU3144) | Hainan, southern China | MT650076 | MT650114 | — | — |
| *Aureoboletus formosus* | GDGM44441 | Hunan, central China | KT291749 | KT291744 | — | KT291751 |
| *Aureoboletus formosus* | GDGM44444 | Hunan, central China | KT291750 | MK165833 | — | KT291752 |
| *Aureoboletus garciae* | MEXU 29006 | Mexico | MH337251 | — | — | — |
| *Aureoboletus garciae* | MEXU 30133 | Mexico | MT228976 | — | — | — |
| *Aureoboletus gentilis* | MG372a | Italy | KF112344 | KF134014 | — | KF112741 |
| *Aureoboletus gentilis* | Pug1 | Germany | DQ534635 | KF030399 | — | — |
| *Aureoboletus gentilis* | ADK4865 | Thailand | — | KT824027 | — | KT823994 |
| *Aureoboletus glutinosus* | GDGM44477 | Hunan, central China | MH670255 | MH700205 | — | MH700229 |
| *Aureoboletus glutinosus* | GDGM44733 | Hunan, central China | MH670257 | MH700203 | — | MH700231 |
| *Aureoboletus glutinosus* | GDGM44821 | Anhui, central China | MH670258 | — | — | MH700232 |
| *Aureoboletus griseorufescens* | GDGM28490 | Guangdong, southern China | MH670278 | — | — | MH700241 |
| *Aureoboletus griseorufescens* | ZM131 | Hainan, southern China | MH670279 | — | — | MH700242 |
| *Aureoboletus guangdongensis* | N.K. Zeng1310 (FHMU864) | Fujian, SE China | OK327020 | OK357258 | — | — |
| *Aureoboletus guangdongensis* | N.K. Zeng4083 (FHMU3797) | Guangdong, southern China | OK327021 | OM321040 | — | OM280447 |
| *Aureoboletus innixus* | CFMR: BOS-544 | USA | MK601707 | MK721061 | — | — |
| *Aureoboletus innixus* | MB03-104 | USA | KF030239 | KF030400 | — | — |
| *Aureoboletus innixus* | 136/98 | USA | DQ534639 | — | — | — |
| "*Aureoboletus liquidus*" | TNS: F-39710 | Japan | AB972886 | — | — | — |
| "*Aureoboletus liquidus*" | TNS: F-52267 | Japan | AB972885 | — | — | — |
| "*Aureoboletus liquidus*" | TNS: F-52265 | Japan | AB972884 | — | — | — |
| *Aureoboletus longicollis* | N.K. Zeng3288 (FHMU2249) | Fujian, SE China | OP615077 | OP680537 | — | — |
| *Aureoboletus longicollis* | LWF8 (FHMU5851) | Zhejiang, eastern China | OP615078 | OP680538 | — | — |
| *Aureoboletus longicollis* | KUN-HKAS80489 | Guangdong, southern China | KT990523 | KT990727 | — | KT990364 |
| *Aureoboletus longicollis* | N.K. Zeng3136 (FHMU2097) | Hainan, southern China | OP615080 | — | — | — |
| *Aureoboletus longicollis* | KUN-HKAS53398 | Hunan, central China | KF112376 | KF112238 | — | KF112755 |
| *Aureoboletus longicollis* | GDGM53336 | China | MK123460 | MK165844 | — | MN549708 |
| *Aureoboletus longicollis* | KUN-HKAS84679 | Yunnan, SW China | KT990514 | KT990718 | — | KT990356 |
| *Aureoboletus longicollis* | LE315562 | Viet Nam | — | MW033312 | — | — |
| *Aureoboletus marroninus* | GDGM43288 | China | KJ488958 | KT291746 | — | KT291753 |
| *Aureoboletus microcarpus* | N.K. Zeng4467 (FHMU4695) | Hainan, southern China | OK327019 | — | — | — |
| *Aureoboletus microcarpus* | N.K. Zeng4468 (FHMU4688) | Hainan, southern China | OK327017 | — | — | OM280449 |
| *Aureoboletus microcarpus* | N.K. Zeng4465 (FHMU4722) | Hainan, southern China | OK327018 | OM276827 | — | — |
| *Aureoboletus miniatoaurantiacus* | GDGM42855 | Guangdong, southern China | MH670259 | MH700202 | — | MH700233 |

| Species | Voucher | Locality | GenBank Accession Nos. | | | |
|---|---|---|---|---|---|---|
| | | | 28S | *TEF*1 | *RPB*1 | *RPB*2 |
| *Aureoboletus miniatoaurantiacus* | GDGM53350 | Jiangxi, eastern China | MN204532 | MN549678 | — | MN549709 |
| *Aureoboletus miniatoaurantiacus* | KUN-HKAS59694 | Yunnan, SW China | KT990513 | KT990714 | — | KT990352 |
| *Aureoboletus minimus* | GDGM44400 | Vietnam | OP901640 | OP918149 | — | OP918152 |
| *Aureoboletus minimus* | GDGM44401 | Vietnam | OP901641 | OP918150 | — | OP918153 |
| *Aureoboletus mirabilis* | REH8717 | USA | KF030299 | — | — | — |
| *Aureoboletus mirabilis* | REH9765 | USA | KP327661 | KP327661 | — | — |
| *Aureoboletus mirabilis* | CBS-136.60 | Germany | AF050652 | — | — | — |
| "*Aureoboletus mirabilis*" | KUN-HKAS57776 | Yunnan, SW China | KF112360 | KF112229 | — | KF112743 |
| *Aureoboletus moravicus* | Xle1 | Germany | — | KF030403 | — | — |
| *Aureoboletus moravicus* | MG374a | Italy | KF112421 | KF112232 | — | KF112745 |
| *Aureoboletus moravicus* | VDKO1120 | Belgium | — | MG212573 | — | MG212615 |
| *Aureoboletus moravicus* | PARMA 1544/11 | — | KJ676958 | KJ676959 | — | — |
| *Aureoboletus nanlingensis* | GDGM71707 | Guangdong, southern China | MN204556 | — | — | MN549710 |
| *Aureoboletus nanlingensis* | GDGM44729 | Guangdong, southern China | OP901642 | OP918151 | — | OP918154 |
| *Aureoboletus nephrosporus* | KUN-HKAS74929 | Yunnan, SW China | KT990517 | KT990721 | — | KT990358 |
| *Aureoboletus nephrosporus* | DC 16-29 | India | KY412776 | — | — | — |
| *Aureoboletus nephrosporus* | KUN-HKAS67931 | Yunnan, SW China | KT990516 | KT990720 | — | KT990357 |
| *Aureoboletus ornatipes* | N.K. Zeng3020 (FHMU1981) | Hainan, southern China | OP630879 | OP676223 | — | OP676224 |
| *Aureoboletus projectellus* | Sn2Hor | USA | KF030300 | — | — | — |
| *Aureoboletus projectellus* | NYBG13393 | USA | KP327623 | KP327676 | — | — |
| *Aureoboletus projectellus* | MB-03-118 | USA | NG027638 | — | — | — |
| *Aureoboletus pseudoauriporus* | JAB_80 | USA | MW662588 | MW737490 | — | — |
| *Aureoboletus pseudoauriporus* | JAB_320 | USA | MW662585 | MW737489 | — | — |
| *Aureoboletus pseudoauriporus* | Farid_501 | USA | MW662576 | — | — | — |
| "*Aureoboletus pseudorussellii*" | KEF12827 | Zhejiang, eastern China | PQ346298 | PQ352347 | — | — |
| "*Aureoboletus pseudorussellii*" | KEF12828 | Zhejiang, eastern China | PQ346299 | PQ352348 | — | — |
| *Aureoboletus quercus-spinosae* | GDGM43755 | Tibet, western China | KY039967 | MK165836 | — | KY039958 |
| *Aureoboletus quercus-spinosae* | GDGM43786 | Tibet, western China | KY039969 | MK165838 | — | KY039960 |
| *Aureoboletus raphanaceus* | GDGM52543 | Hunan, central China | MH670271 | — | — | MH700237 |
| *Aureoboletus raphanaceus* | GDGM52266 | Jiangxi, eastern China | MN204538 | MN549674 | — | MN549702 |
| *Aureoboletus raphanaceus* | GDGM45911 | Jiangxi, eastern China | MN204535 | — | — | MN549698 |
| *Aureoboletus raphanaceus* | N.K. Zeng2007 (FHMU3597) | Hainan, southern China | OP615090 | OP680542 | — | OP680545 |
| *Aureoboletus raphanaceus* | S.D. Yang211 (FHMU5516) | Yunnan, SW China | OP615092 | OP680544 | — | — |
| *Aureoboletus readii* | MEXU-HO 30443 | Mexico | OR421566 | — | — | — |
| *Aureoboletus readii* | MEXU-HO 30440 | Mexico | OR421567 | — | — | — |
| *Aureoboletus readii* | MEXU-HO 30439 | Mexico | OR421568 | — | — | — |
| *Aureoboletus roxanae* | DS626-7 | USA | KF030311 | KF030402 | — | — |
| *Aureoboletus roxanae* | CFMR BOS-698 | USA | MK601709 | MK721063 | — | — |
| *Aureoboletus roxanae* | Mushroom Observer #283413 | Canada | — | MN124184 | — | — |
| *Aureoboletus rubellus* | KUN-HKAS105266 | Jiangxi, eastern China | MN304783 | — | — | MN304795 |
| *Aureoboletus rubellus* | KUN-HKAS105265 | Jiangxi, eastern China | MN304782 | — | — | MN304794 |
| *Aureoboletus rubellus* | GDGM52382 | China | MH670273 | — | — | MH700239 |
| *Aureoboletus rubellus* | GDGM52367 | China | MH670274 | — | — | MH700240 |
| *Aureoboletus rubellus* | N.K. Zeng4592 (FHMU4877) | Hainan, southern China | OP604280 | OP676226 | — | — |
| *Aureoboletus rubellus* | Y.Q. Fu002 (FHMU4453) | Hainan, southern China | OP604281 | OP676227 | — | — |
| *Aureoboletus rugosus* | G.L. Zhang078 (FHMU2766) | Yunnan, SW China | OK327025 | OK357259 | — | OK357262 |
| *Aureoboletus rugosus* | W.H. Zhang164 (FHMU6509) | Yunnan, SW China | OK327022 | OK357260 | — | OM280448 |
| *Aureoboletus rugosus* | L.P. Tang1679 (FHMU6510) | Yunnan, SW China | OK327024 | — | — | OK357261 |
| *Aureoboletus russellii* | BD391 | USA | HQ161874 | — | — | — |
| *Aureoboletus shichianus* | KUN-HKAS43373 | China | AY647211 | — | — | — |
| *Aureoboletus shichianus* | KUN-HKAS76852 | China | KF112419 | KF112237 | — | KF112756 |
| *Aureoboletus sinobadius* | GDGM71932 | Guangdong, southern China | MN204548 | — | — | — |
| *Aureoboletus sinobadius* | GDGM44730 | Hunan, central China | MH670248 | MH700187 | — | MH700223 |
| *Aureoboletus sinobadius* | GDGM44736 | Guangdong, southern China | MH670249 | MH700188 | — | MH700224 |
| *Aureoboletus sinobadius* | N.K. Zeng3494 (FHMU3117) | Hainan, southern China | OP615107 | OP680546 | — | — |
| *Aureoboletus sinocyanescens* | HKAS 137196 | Yunnan, SW China | — | PQ893480 | — | PQ893511 |
| *Aureoboletus sinocyanescens* | HKAS 145619 | Yunnan, SW China | PQ890371 | PQ893481 | — | PQ893513 |
| *Aureoboletus sinocyanescens* | HKAS 145620 | Yunnan, SW China | PQ890372 | — | — | PQ893512 |
| *Aureoboletus solus* | GDGM70342 | Guangdong, southern China | MN204554 | — | — | — |
| *Aureoboletus solus* | GDGM44759 | Guangdong, southern China | MH670276 | MH700206 | — | — |
| "*Aureoboletus solus*" | N.K. Zeng1064 (FHMU715) | Hainan, southern China | OP615108 | — | — | — |
| "*Aureoboletus solus*" | N.K. Zeng4146-1 (FHMU4377) | Guangdong, southern China | OP615110 | OP680547 | — | — |
| *Aureoboletus* sp. | GDGM49259 | China | MN410706 | — | — | — |
| *Aureoboletus* sp. | L.P. Tang2077 (FHMU5505) | Yunnan, SW China | OP615112 | — | — | — |
| *Aureoboletus* sp. | LAM-0466 | Malaysia | KY091058 | — | — | — |
| *Aureoboletus* sp. | GDGM75305 | China | MN204513 | — | — | — |
| *Aureoboletus* sp. | GDGM70474 | China | MN204511 | — | — | — |
| *Aureoboletus* sp. | GDGM44829 | China | KY039970 | — | — | KY039961 |
| *Aureoboletus* sp. | GDGM72473 | China | MN204512 | — | — | — |
| *Aureoboletus* sp. | GDGM44831 | China | KY039971 | MK165840 | — | MN549696 |
| *Aureoboletus* sp. | GDGM44469 | China | KP319028 | MK165841 | — | MN549690 |
| *Aureoboletus* sp. | GDGM44470 | China | MN204509 | MN549672 | — | MN549680 |
| *Aureoboletus* sp. | GDGM52298 | China | MN204523 | — | — | MN549703 |
| *Aureoboletus* sp. | KUN-HKAS53458 | China | KF112456 | KF112231 | — | KF112742 |

| Species | Voucher | Locality | GenBank Accession Nos. | | | |
|---|---|---|---|---|---|---|
| | | | 28S | *TEF*1 | *RPB*1 | *RPB*2 |
| *Aureoboletus* sp. | N.K. Zeng4666 (FHMU4919) | Hainan, southern China | OP615113 | — | — | — |
| *Aureoboletus* sp. | N.K. Zeng4203 (FHMU6976) | Hainan, southern China | OP615111 | — | — | — |
| *Aureoboletus tenuis* | GDGM42601 | Guangxi, southern China | KF534789 | KT291745 | — | KT291754 |
| *Aureoboletus tenuis* | N.K. Zeng1296 (FHMU850) | Fujian, SE China | KR052052 | — | — | — |
| *Aureoboletus tenuis* | N.K. Zeng3264 (FHMU2225) | Fujian, SE China | OP615201 | — | — | — |
| *Aureoboletus tenuis* | JXSB1775 | Jiangxi, eastern China | MK765811 | — | — | — |
| *Aureoboletus tenuis* | KUN-HKAS75104 | China | KT990518 | KT990722 | — | KT990359 |
| *Aureoboletus thibetanus* | KUN-HKAS76655 | Yunnan, SW China | KF112420 | KF112236 | — | KF112752 |
| *Aureoboletus thibetanus* | KUN-HKAS89494 | Yunnan, SW China | KT990525 | KT990729 | — | KT990366 |
| *Aureoboletus thibetanus* | KUN-HKAS57692 | Yunnan, SW China | KT990524 | KT990728 | — | KT990365 |
| *Aureoboletus thibetanus* | GDGM43283 | China | KJ907380 | KT291747 | — | KT291755 |
| *Aureoboletus thibetanus* | GDGM43284 | China | KJ90738 | KT291748 | — | KT291756 |
| *Aureoboletus velutipes* | GDGM44713 | Guangdong, southern China | MH670253 | MH700191 | — | MH700226 |
| *Aureoboletus velutipes* | GDGM42608 | Guangxi, southern China | MH670251 | MH700190 | — | MN549683 |
| *Aureoboletus velutipes* | GDGM52409 | Jiangxi, eastern China | MH670252 | — | — | MH700225 |
| *Aureoboletus venustus* | KUN-HKAS77700 | Guangdong, southern China | KU321703 | — | — | — |
| "*Aureoboletus venustus*" | KUN-HKAS82183 | Guangdong, southern China | KU321705 | — | — | — |
| *Aureoboletus venustus* | N.K. Zeng3180-1 (FHMU7494) | Hainan, southern China | OP625205 | — | — | — |
| *Aureoboletus venustus* | S. Jiang256 (FHMU4776) | Hainan, southern China | OP615204 | OP680548 | — | — |
| *Aureoboletus viridiflavus* | DD972 | USA | AY612805 | — | — | — |
| *Aureoboletus stickyipes* | KUN-HKAS77103 | Jiangxi, eastern China | KT990519 | KT990723 | — | KT990360 |
| *Aureoboletus stickyipes* | GDGM44818 | China | MN204510 | — | — | MN549694 |
| *Aureoboletus stickyipes* | GDGM44820 | China | MK123457 | — | — | MN549695 |
| *Aureoboletus stickyipes* | S.D. Yang176 (FHMU5526) | Yunnan, SW China | OP615206 | — | — | — |
| *Aureoboletus wusangongii* | N.K. Zeng7856 (FHMU7701) | Zhejiang, eastern China | PQ278703 | PQ274247 | — | PQ274249 |
| *Aureoboletus wusangongii* | N.K. Zeng7864 (FHMU7702) | Zhejiang, eastern China | PQ278704 | PQ274248 | — | PQ274250 |
| *Aureoboletus yunnanensis* | KUN-HKAS75050 | Yunnan, SW China | KT990520 | KT990724 | — | KT990361 |
| *Aureoboletus yunnanensis* | KUN-HKAS57581 | Yunnan, SW China | KF112422 | KF112233 | — | KF112746 |
| *Aureoboletus yunnanensis* | N.K. Zeng623 (FHMU392) | Fujian, SE China | OP615207 | — | — | — |
| *Aureoboletus yunnanensis* | GDGM26359 | China | MN204560 | MN549670 | — | MN549681 |
| *Aureoboletus zangii* | GDGM75881 | China | MN204563 | — | — | MN549712 |
| *Aureoboletus zangii* | KUN-HKAS74766 | Yunnan, SW China | KT990522 | KT990726 | — | KT990363 |
| *Aureoboletus zangii* | KUN-HKAS74751 | Yunnan, SW China | KT990521 | KT990725 | — | KT990362 |
| *Aureoboletus zangii* | KUN-HKAS63217 | Shannxi, northern China | KT990526 | — | — | — |
| *Baorangia pseudocalopus* | HKAS75739 | Yunnan, SW China | KJ184558 | KJ184570 | KJ184564 | KM605179 |
| *Baorangia rufomaculata* | 4414 | USA | KF030248 | KF030406 | KF030369 | — |
| *Binderoboletus segoi* | Henkel 8035 | Guyana | LC043078 | — | LC043079 | — |
| *Boletellus* aff. *emodensis* | HKAS 52678 | Fujian, SE China | KF112426 | KF112305 | KF112621 | KF112757 |
| *Boletellus indistinctus* | HKAS77623 | Guangdong, southern China | KT990531 | KT990733 | — | KT990371 |
| *Boletinellus merulioides* | AFTOL-ID 575 | USA | AY684153 | DQ056287 | DQ435803 | — |
| *Boletus bainiugan* | HKAS52235 | Yunnan, SW China | KF112457 | KF112203 | KF112587 | KF112705 |
| *Boletus morrisii* | 8206 | USA | KF030326 | KF030433 | — | — |
| *Borofutus dhakanus* | HKAS73789 | Bangladesh | JQ928616 | JQ928576 | JQ928586 | JQ928597 |
| *Bothia fujianensis* | HKAS82694 | Fujian, SE China | KM269193 | KM272860 | — | — |
| *Bothia castanella* | MB03_053 | USA | DQ867117 | KF030421 | KF030382 | — |
| *Brasilioporus olivaceoflavidus* | VIES 9901322 | Brazil | OM068912 | OM160555 | OM160565 | OM160576 |
| *Buchwaldoboletus lignicola* | HKAS76674 | Heilongjiang, NE China | KF112350 | KF112277 | KF112642 | KF112819 |
| *Buchwaldoboletus lignicola* | HKAS84904 | Germany | KT990538 | KT990740 | — | KT990377 |
| *Butyriboletus pseudospeciosus* | HKAS63513 | Yunnan, SW China | KT990541 | KT990743 | KT990909 | KT990380 |
| *Butyriboletus regius* | HKAS84878 | Germany | MT264910 | MT269659 | MT269660 | MT269661 |
| *Butyriboletus subsplendidus* | HKAS50444 | Yunnan, SW China | KT990540 | KT990742 | KT990908 | KT990379 |
| *Buchwaldoboletus xylophilus* | FHMU5931 | Yunnan, SW China | MW783419 | MW897332 | — | MW820941 |
| *Cacaoporus pallidicarneus* | OR1306 | Thailand | — | MK372272 | — | MK372285 |
| *Caloboletus yunnanensis* | HKAS63040 | Yunnan, SW China | KJ605676 | KJ619471 | KJ619480 | KT990395 |
| *Caloboletus calopus* | HKAS74739 | Yunnan, SW China | KF112335 | KF112166 | KF112507 | KF112667 |
| *Carolinigaster bonitoi* | F-62017 | USA | NG_068854 | — | — | — |
| *Chalciporus piperatus* | HKAS84882 | Germany | KT990562 | KT990758 | — | KT990397 |
| *Chalciporus rubinelloides* | HKAS74952 | Yunnan, SW China | KT990565 | KT990761 | — | KT990400 |
| *Chamonixia caespitosa* | OSC-117571 | USA | MK601731 | MK721085 | — | MK766293 |
| *Chiua olivaceoreticulata* | HKAS59706 | Yunnan, SW China | KT990593 | KT990787 | KT990941 | KT990428 |
| *Chiua virens* | HKAS76678 | Sichuan, SW China | KF112438 | KF112272 | KF112582 | KF112793 |
| *Costatisporus cyanescens* | Henkel 9061 | Guyana | — | — | LC053663 | LC053664 |
| *Crocinoboletus rufoaureus* | HKAS59820 | Hainan, southern China | KF112434 | — | KF112532 | KF112709 |
| *Crocinoboletus laetissimus* | HKAS50232 | China | KT990567 | KT990762 | KT990925 | — |
| *Cupreoboletus poikilochromus* | AQUI 7195 | Italy | KT157061 | — | — | — |
| *Cyanoboletus brunneoruber* | HKAS80579-1 | Yunnan, SW China | KT990568 | KT990763 | KT990926 | KT990401 |
| *Cyanoboletus sinopulverulentus* | HKAS59609 | Yunnan, SW China | KF112366 | KF112193 | KF112529 | KF112700 |
| *Erythrophylloporus cinnabarinus* | GDGM70536 | Hainan, southern China | MH374045 | MH378802 | MH374031 | MH374035 |
| *Exsudoporus floridanus* | FLAS-F-59069 | USA | OL960488 | OL960496 | — | OL960503 |
| *Fistulinella olivaceoalba* | HKAS53367 | Fujian, SE China | KF112439 | KF112304 | KF112615 | KF112790 |
| *Fistulinella prunicolor* | REH9502 | Australia | JX889648 | JX889690 | — | MG212630 |
| *Garcileccinum viscosum* | MEXU:HO 3O108 | Mexico | OQ909093 | — | OQ971866 | OQ938917 |
| *Guyanaporus albipodus* | TH8848 | Guyana | HQ161868 | — | HQ161837 | LC043083 |
| *Gymnogaster boletoides* | NY01194009 | Australia | KT990572 | KT990768 | KT990928 | KT990406 |
| *Gyrodon lividus* | REG Gl1 | Germany | — | GU187701 | GU187461 | GU187786 |
| *Gyrodon* sp. | HKAS59448 | Yunnan, SW China | KF112349 | KF112276 | KF112641 | KF112818 |
| *Harrya atrogrisea* | HKAS50542 | Yunnan, SW China | KT990694 | KT990880 | KT991024 | KT990499 |
| *Heimioporus gaojiaocong* | N.K. Zeng2788 (FHMU4425) | Yunnan, SW China | MF962380 | MF962410 | — | — |

| Species | Voucher | Locality | GenBank Accession Nos. | | | |
|---|---|---|---|---|---|---|
| | | | 28S | *TEF*1 | *RPB*1 | *RPB*2 |
| *Heimioporus gaojiaocong* | N.K. Zeng2790 (FHMU3904) | Yunnan, SW China | MF962382 | MF962411 | — | — |
| *Heimioporus japonicus* | HKAS52237 | Yunnan, SW China | KF112347 | KF112228 | KF112618 | KF112806 |
| *Heimioporus japonicus* | N.K. Zeng1329 (FHMU4429) | Fujian, SE China | MF962387 | MF962417 | — | — |
| *Heimioporus japonicus* | N.K. Zeng1335 (FHMU887) | Fujian, SE China | MF962388 | MF962418 | — | — |
| *Heimioporus subretisporus* | KUN-HKAS80581 | Yunnan, SW China | KT990573 | KT990769 | — | KT990407 |
| *Heimioporus subretisporus* | KUN-HKAS80582 | Yunnan, SW China | KT990574 | KT990770 | — | KT990409 |
| *Hemileccinum albidum* | KUN-HKAS81120 | Yunnan, SW China | MZ923766 | MZ936352 | MZ936339 | MZ936320 |
| *Hemileccinum albidum* | KUN-HKAS50503 | Yunnan, SW China | MZ923767 | MZ936355 | MZ936335 | MZ936319 |
| *Hemileccinum brevisporum* | KUN-HKAS89150 | Yunnan, SW China | MZ923764 | MZ936362 | MZ936345 | MZ936328 |
| *Hemileccinum brevisporum* | KUN-HKAS67896 | Yunnan, SW China | MZ923765 | MZ936363 | — | — |
| *Hemileccinum depilatum* | AF2845 | Belgium | — | MG212591 | — | — |
| *Hemileccinum duriusculum* | HKAS125907 | Zhejiang, eastern China | OQ600185 | OQ718485 | OQ750574 | — |
| *Hemileccinum ferrugineipes* | KUN-HKAS115554 | Yunnan, SW China | MZ923773 | MZ973011 | MZ936350 | MZ936330 |
| *Hemileccinum ferrugineipes* | KUN-HKAS93310 | Yunnan, SW China | — | MZ973012 | MZ936347 | MZ936331 |
| *Hemileccinum floridanum* | AB16 | USA | — | MW737481 | — | — |
| *Hemileccinum hortonii* | MICH KUO-07050706 | USA | MK601821 | MK721175 | — | MK766377 |
| *Hemileccinum impolitum* | ADK4078 | Belgium | — | MG212592 | — | MG212634 |
| *Hemileccinum impolitum* | HKAS84869 | Germany | KT990575 | KT990771 | KT990930 | KT990410 |
| *Hemileccinum indecorum* | OR0863 | Thailand | — | MH614726 | — | MH614772 |
| *Hemileccinum indecorum* | KUN-HKAS63126 | Hainan, southern China | JN205457 | — | — | JN205455 |
| *Hemileccinum indecorum* | KUN-HKAS63127 | Hainan, southern China | JN205458 | — | — | — |
| *Hemileccinum inferius* | BR0260 | Thailand | — | OP358319 | — | OP358312 |
| *Hemileccinum parvum* | KUN-HKAS99764 | Yunnan, SW China | MZ923771 | MZ973009 | MZ936349 | MZ936332 |
| *Hemileccinum parvum* | KUN-HKAS115553 | Yunnan, SW China | MZ923772 | MZ973010 | MZ936348 | MZ936333 |
| *Hemileccinum pruinatum* | HKAS53421 | China | KF112432 | — | KF112565 | KF112751 |
| *Hemileccinum pruinatum* | N.K. Zeng7970 (FHMU7720) | Fujian, SE China | PQ346060 | PQ355451 | — | — |
| *Hemileccinum pruinatum* | N.K. Zeng7977 (FHMU7721) | Fujian, SE China | PQ346061 | PQ355452 | — | — |
| *Hemileccinum pruinatum* | N.K. Zeng7993 (FHMU7722) | Fujian, SE China | PQ346063 | PQ355454 | — | — |
| *Hemileccinum pruinatum* | N.K. Zeng7996 (FHMU7723) | Fujian, SE China | PQ346064 | PQ355455 | — | — |
| *Hemileccinum pruinatum* | N.K. Zeng8004 (FHMU7724) | Fujian, SE China | PQ346066 | PQ355457 | — | — |
| *Hemileccinum pruinatum* | N.K. Zeng8021 (FHMU7725) | Fujian, SE China | PQ346067 | PQ355458 | — | — |
| *Hemileccinum pruinatum* | N.K. Zeng8022 (FHMU7726) | Fujian, SE China | PQ346068 | PQ355459 | — | — |
| *Hemileccinum rubropunctum* | REH8501 | USA | MK601768 | MK721122 | — | MK766327 |
| *Hemileccinum rugosum* | KUN-HKAS84355 | Yunnan, SW China | KT990578 | KT990774 | KT990931 | KT990413 |
| *Hemileccinum rugosum* | KUN-HKAS84970 | Yunnan, SW China | KT990577 | KT990773 | — | KT990412 |
| *Hemileccinum rugosum* | KUN-HKAS50284 | China | KT990576 | KT990772 | — | KT990411 |
| *Hemileccinum rugosum* | N.K. Zeng3388 (FHMU2966) | Hainan, southern China | OP630826 | OP676218 | — | — |
| *Hemileccinum* sp. | KUN-HKAS59445 | China | KT990579 | KT990775 | KT990932 | KT990414 |
| *Hemileccinum* sp. | Mushroom Observer #244341 | USA | MH236107 | — | — | — |
| *"Hemileccinum squamipes"* | N.K. Zeng4586 (FHMU4902) | Hainan, southern China | OP630820 | OP676213 | — | — |
| *"Hemileccinum squamipes"* | N.K. Zeng2572 (FHMU1679) | Hainan, southern China | OP630821 | OP676214 | — | — |
| *Hemileccinum subglabripes* | MICH KUO-08301402 | USA | MK601739 | MK721093 | — | MK766301 |
| *Hemileccinum subglabripes* | MICH KUO-07230802 | USA | MK601738 | MK721092 | — | MK766300 |
| *Hemileccinum subglabripes* | MICH KUO-07070702 | USA | MK601737 | MK721091 | — | MK766299 |
| *Hemileccinum subglabripes* | Mushroom Observer #294169 | USA | MN128238 | — | — | — |
| *Heliogaster columellifer* | KPM-NC 23012 | Japan | KX685724 | KX685718 | — | — |
| *Hemilanmaoa retistipitatus* | HMJAU 60052 (H3624) | Guizhou, SW China | OP380695 | OP495816 | OP495812 | OP495814 |
| *Hemilanmaoa retistipitatus* | HMJAU 60053 (H3633) | Guizhou, SW China | OP380696 | OP495817 | OP495813 | OP495815 |
| *Hemiaustroboletus vinaceobrunneus* | MEXU_30051 | Mexico | MN200222 | — | — | — |
| *Hongoboletus ventricosus* | HKAS59660 | Yunnan, SW China | KF112358 | KF112153 | KF112503 | KF112664 |
| *Hongoboletus ventricosus* | HKAS63598 | Yunnan, SW China | OQ888735 | KF112152 | KF112502 | KF112663 |
| *Hortiboletus subpaludosus* | HKAS59608 | Yunnan, SW China | KF112371 | KF112185 | KF112551 | KF112696 |
| *Hourangia cheoi* | HKAS52269 | Yunnan, SW China | KF112385 | KF112286 | KF112628 | KF112773 |
| *Hourangia cheoi* | HKAS74774 | Yunnan, SW China | KF112384 | KF112285 | KF112627 | KF112772 |
| *Hymenoboletus luteopurpureus* | HKAS46334 | Yunnan, SW China | KF112471 | KF112271 | KF112581 | KF112795 |
| *Imleria badia* | HKAS74714 | Germany | KC215212 | KC215242 | KC215224 | — |
| *Imleria obscurebrunnea* | HKAS52557 | Yunnan, SW China | KC215220 | KC215243 | KC215225 | KC215234 |
| *Imperator torosus* | MB000258 | Germany | — | MW566748 | — | MW560082 |
| *Indoporus shoreae* | AP 6693 | India | MK123973 | — | — | MK243367 |
| *Ionosporus longipes* | Lee1180 | Singapore | — | MT085471 | — | MH712031 |
| *Jimtrappea guyanensis* | Henkel 9163 | Guyana | LC053660 | — | LC053661 | — |
| *Kaziboletus rufescens* | HKAS74705 | Bangladesh | JQ928620 | JQ928579 | JQ928589 | JQ928599 |
| *Kgaria cyanogranulifer* | REH9508 | Australia | JX889646 | JX889688 | — | OR263680 |
| *Kombocles bakaiana* | THDJA 136 | Cameroon | KX827003 | — | — | — |
| *Lanmaoa asiatica* | HKAS54094 | Yunnan, SW China | KF112353 | KF112161 | KF112522 | KF112682 |
| *Lanmaoa angustispora* | HKAS74752 | Yunnan, SW China | KM605139 | KM605154 | KM605166 | KM605177 |
| *Leccinellum corsicum* | Buf4507 | USA | KF030347 | KF030435 | KF030389 | — |
| *Leccinellum citrinum* | HKAS53427 | Hunan, central China | KF112488 | KF112253 | KF112596 | — |
| *Leccinum quercinum* | HKAS63502 | Yunnan, SW China | KF112444 | KF112250 | KF112593 | KF112724 |
| *Leccinum scabrum* | HKAS56371 | Yunnan, SW China | KT990587 | KT990782 | — | KT990423 |
| *Leccinum variicolor* | HKAS57758 | Yunnan, SW China | KF112445 | KF112251 | KF112591 | KF112725 |
| *Mucilopilus castaneiceps* | HKAS71039 | Japan | KT990547 | KT990748 | KT990915 | KT990385 |
| *Mucilopilus castaneiceps* | HKAS50338 | Yunnan, SW China | KT990555 | KT990755 | KT990922 | KT990391 |
| *Mucilopilus cinnamomeus* | HKAS50229 | Yunnan, SW China | KF112423 | KF112216 | KF112574 | KF112769 |
| *Mycoamaranthus* sp. | NN22-11107 | USA | — | — | — | OR099720 |
| *Neoboletus thibetanus* | HKAS57093 | Tibet, SW China | KF112326 | — | KF112496 | KF112655 |
| *Neotropicomus australis* | ACM1138 | Brazil | OM068916 | — | OM160572 | — |
| *Nevesoporus nigrostipitatus* | VIES 9901383 | Brazil | OM068918 | OM160562 | — | — |
| *Nevesoporus nigrostipitatus* | VIES 9901384 | Brazil | OM068919 | — | — | — |
| *Nigroboletus roseonigrescens* | ZT 13553 | Guangdong, southern China | KT220589 | KT220596 | KT220592 | KT220594 |

| Species | Voucher | Locality | GenBank Accession Nos. | | | |
|---|---|---|---|---|---|---|
| | | | 28S | *TEF*1 | *RPB*1 | *RPB*2 |
| *Octaviania japonimontana* | KPM-NC-0017812 | Japan | JN378486 | JN378428 | — | — |
| *Octaviania tasmanica* | OSC132097 | Australia | JN378494 | JN378435 | — | — |
| *Parvixerocomus pseudoaokii* | HKAS52633 | Yunnan, SW China | KF112379 | KF112267 | KF112598 | KF112736 |
| *Paxilloboletus africanus* | SAB0716 | Guinea | MZ702479 | MZ707865 | MZ707878 | MZ707869 |
| *Paxillus ammoniavirescens* | Pou09.1 | France | — | KF261533 | — | — |
| *Paxillus involutus* | SCV11.1 | France | — | KF261544 | — | — |
| *Paxillus rubicundulus* | Ve08.2h10 | France | — | KF261553 | — | — |
| *Phlebopus portentosus* | FHMU5935 | Yunnan, SW China | MW783432 | MW897345 | — | — |
| *Phlebopus portentosus* | Php1 | Africa | AF336260 | GU187735 | FJ536606 | GU187801 |
| *Phylloboletellus chloephorus* | 3388 | Mexico | DQ534658 | — | — | — |
| *Phylloporopsis boletinoides* | JBSD127411 | Dominican Republic | MH571711 | MH588312 | — | — |
| *Phylloporus imbricatus* | KUN-HKAS68642 | Yunnan, SW China | KF112398 | KF112299 | — | KF112786 |
| *Phylloporus maculatus* | HKAS56683 | Yunnan, SW China | JQ967210 | JQ967167 | — | — |
| *Phylloporus rubeolus* | HKAS52573 | Yunnan, SW China | JQ967216 | JQ967172 | — | — |
| *Phylloporus rubrosquamosus* | HKAS 54559 | Yunnan, SW China | JQ967219 | JQ967175 | — | — |
| *Porphyrellus castaneus* | HKAS52554 | Yunnan, SW China | KT990697 | KT990883 | KT991026 | KT990502 |
| *Porphyrellus porphyrosporus* | HKAS76671 | Jilin, NE China | KF112482 | KF112243 | KF112611 | KF112718 |
| *Pseudoaustroboletus valens* | HKAS82644 | China | — | MT110359 | MT110396 | MT110431 |
| *Pseudoaustroboletus valens* | HKAS52603 | Yunnan, SW China | KM274869 | KM274877 | — | — |
| *Pseudoboletus parasiticus* | Xpa1 | Germany | AF050646 | KF030443 | KF030394 | — |
| *Pseudophylloporus baishanzuensis* | N.K. Zeng7702 (FHMU7694) | Zhejiang, eastern China | PQ330210 | PQ330110 | — | PQ330114 |
| *Pseudophylloporus baishanzuensis* | N.K. Zeng7703 (FHMU7695) | Zhejiang, eastern China | PQ330211 | PQ330111 | — | PQ330115 |
| *Pseudophylloporus baishanzuensis* | N.K. Zeng7705 (FHMU7696) | Zhejiang, eastern China | PQ330212 | PQ330112 | — | PQ330116 |
| *Pseudophylloporus baishanzuensis* | N.K. Zeng7746 (FHMU7697) | Zhejiang, eastern China | PQ330213 | PQ330113 | — | PQ330117 |
| *Pulveroboletus brunneopunctatus* | HKAS55369 | Yunnan, SW China | KT990620 | KT990814 | — | KT990455 |
| *Pulveroboletus mirus* | HKAS57628 | Yunnan, SW China | KT990618 | KT990812 | — | KT990453 |
| *Pulchroboletus roseoalbidus* | AMB 12757 | Italy | KJ729499 | KJ729512 | — | — |
| *Retiboletus brunneolus* | HKAS52680 | Fujian, SE China | KF112424 | KF112179 | — | KF112690 |
| *Retiboletus fuscus* | HKAS63590 | Yunnan, SW China | KF112417 | KF112178 | KF112537 | KF112691 |
| *Rhodactina rostratispora* | SV208 | Thailand | — | MG212606 | — | MG212646 |
| *Rossbeevera yunnanensis* | HKAS70601 | Yunnan, SW China | KF112448 | — | — | KF112729 |
| *Rossbeevera vittatispora* | OSC61484 | Australia | JN378506 | JN378446 | — | — |
| *Rostrupomyces sisongkhramensis* | SV0155 | Thailand | — | OP358324 | — | OP358316 |
| *Rostrupomyces sisongkhramensis* | SV0219 | Thailand | — | OP358325 | — | OP358317 |
| *Royoungia boletoides* | Trappe 27456 | Australia | JX889655 | JX889696 | — | — |
| *Royoungia palumanus* | REH9421 | Australia | JX889675 | JX889685 | — | — |
| *Rubinosporus auriporus* | SV0101 | Thailand | — | MZ355902 | — | MZ355904 |
| *Rubroboletus latisporus* | HKAS80358 | Chongqing, SW China | KP055023 | KP055020 | KP055026 | KP055029 |
| *Rubinoboletus rubinus* | AF2835 | Belgium | — | KT824028 | — | KT823995 |
| *Rubroboletus sinicus* | HKAS68620 | Yunnan, SW China | KF112319 | KF112146 | KF112504 | KF112661 |
| *Rubroleccinum latisporus* | N.K. Zeng7988 (FHMU7698) | Fujian, SE China | PQ325253 | PQ330106 | — | PQ330108 |
| *Rubroleccinum latisporus* | N.K. Zeng8006 (FHMU7699) | Fujian, SE China | PQ325254 | PQ330107 | — | PQ330109 |
| *Rufoboletus hainanensis* | KUN-HKAS 59814 | Hainan, southern China | KF112336 | KF112199 | KF112546 | KF112699 |
| *Rufoboletus hainanensis* | N.K. Zeng2418 (FHMU2437) | Hainan, southern China | KU961652 | KU961656 | — | KX453856 |
| *Rugiboletus extremiorientalis* | HKAS74754 | China | KT990639 | KT990832 | KT990982 | KT990469 |
| *Rugiboletus brunneiporus* | HKAS83209 | Tibet, SW China | KM605134 | KM605144 | KM605158 | KM605168 |
| *Singerocomus rubriflavus* | Henkel 9585 | Guyana | LC043093 | MH645597 | LC043094 | — |
| *Solioccasus polychromus* | R.E. Halling 9417 | Australia | JQ287642 | JQ287644 | — | — |
| *Spongispora temasekensis* | SING 0206334 | Singapore | MG979397 | MG979392 | MG979393 | MG979394 |
| *Spongiforma thailandica* | DED7873 | Thailand | EU685108 | KF030436 | KF030387 | — |
| *Strobilomyces atrosquamosus* | HKAS55368 | Yunnan, SW China | KT990648 | KT990839 | KT990989 | KT990476 |
| *Strobilomyces seminudus* | HKAS59461 | Yunnan, SW China | KF112479 | KF112260 | KF112606 | KF112815 |
| *Suillellus amygdalinus* | NY00035656 | USA | KT990650 | KT990840 | KT990990 | KT990477 |
| *Suillellus subamygdalinus* | HKAS57953 | Tibet, SW China | KT990652 | KT990842 | KT990992 | — |
| *Sutorius brunneissimus* | HKAS57451 | Yunnan, SW China | KM605137 | KM605149 | KM605161 | KM605172 |
| *Sutorius brunneissimus* | HKAS50538 | Yunnan, SW China | KM605138 | KM605150 | KM605162 | KM605173 |
| *Sutorius eximius* | HKAS59657 | Yunnan, SW China | KT990707 | KT990887 | KT991029 | KT990505 |
| *Sutorius hainanensis* | HKAS59469 | Yunnan, SW China | KF112359 | KF112175 | KF112500 | KF112669 |
| *Tengioboletus glutinosus* | HKAS53425 | Hunan, central China | KF112341 | KF112204 | KF112578 | KF112800 |
| *Tengioboletus reticulatus* | HKAS53426 | Hunan, central China | KF112491 | KF112313 | KF112649 | KF112828 |
| *Turmalinea yuwanensis* | KPM-NC-0018011 | Japan | KC552046 | KC552089 | — | — |
| *Tylocinum griseolum* | HKAS52612 | Yunnan, SW China | KT990631 | KT990825 | — | — |
| *Tylocinum griseolum* | HKAS50281 | Yunnan, SW China | KF112451 | KF112284 | — | KF112730 |
| *Tylopilus* aff. *chromapes* | 01-513 | Zambia | JX889672 | JX889682 | — | — |
| *Tylopilus* aff. *virens* | 01-541 | Zambia | JX889677 | JX889687 | — | — |
| *Tylopilus otsuensis* | HKAS50240 | Yunnan, SW China | KT990553 | KT990753 | KT990921 | MT110417 |
| *Tylopilus violaceobrunneus* | HKAS89443 | Shandong, eastern China | KT990702 | KT990886 | KT991028 | KT990504 |
| *Veloporphyrellus velatus* | HKAS63668 | Hainan, southern China | JX984546 | JX984554 | — | — |
| *Veloboletus limbatus* | REH9228 | Australia | — | MN413636 | — | MT747397 |
| *Veloporphyrellus gracilioides* | HKAS53590 | Sichuan, SW China | KF112381 | KF112210 | KF112556 | KF112734 |
| *Veloporphyrellus pseudovelatus* | HKAS52258 | Yunnan, SW China | JX984540 | JX984551 | MT110402 | MT110439 |
| *Villoboletus persicinus* | BJTC FM1869 | Shanxi, northern China | OP793898 | OP792035 | OP792029 | OP792032 |
| *Xanthoconium affine* | NY00815399 | USA | KT990661 | KT990850 | KT990999 | KT990486 |
| *Xanthoconium porophyllum* | HKAS90217 | Guangdong, southern China | KT990662 | KT990851 | KT991000 | KT990487 |
| *Xerocomellus chrysenteron* | HKAS56494 | China | KF112357 | KF112172 | KF112526 | KF112685 |
| *Xerocomellus corneri* | HKAS52503 | Yunnan, SW China | KT990668 | KT990856 | KT991006 | KT990492 |
| *Xerocomellus communis* | HKAS68204 | Yunnan, SW China | KT990671 | KT990859 | KT991009 | KT990495 |
| *Xerocomus* aff. *subtomentosus* | KUN-HKAS58865 | Yunnan, SW China | KF112389 | KF112294 | — | KF112784 |
| *Xerocomus* sp. | N.K. Zeng3180 (FHMU2141) | Hainan, southern China | OP615114 | — | — | — |
| *Xerocomus subparvus* | HKAS53387 | Fujian, SE China | KF112397 | KF112297 | KF112634 | KF112788 |
| *Xerocomus yunnanensis* | HKAS68420 | Yunnan, SW China | KT990690 | KT990877 | KT991021 | — |

| Species | Voucher | Locality | GenBank Accession Nos. | | | |
|---|---|---|---|---|---|---|
| | | | 28S | *TEF*1 | *RPB*1 | *RPB*2 |
| *Zangia olivaceobrunnea* | HKAS52275 | Yunnan, SW China | HQ326947 | HQ326875 | — | — |
| *Zangia roseola* | HKAS75046 | Yunnan, SW China | KF112414 | KF112269 | KF112579 | KF112791 |

NE: Northeastern, SE: Southeastern, SW: Southwestern.