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# Three new *Xenasmatella* (Polyporales, Basidiomycota) species from China

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## Abstract

Three new wood-inhabiting fungal species, *Xenasmatella rhizomorpha*, *X. tenuis* and *X. xinpingensis spp. nov.*, are proposed based on a combination of morphological characteristics and molecular BLAST analyses. *Xenasmatella rhizomorpha* is characterized by annual, resupinate, gossypine basidiomata with rhizomorphs, a monomitic hyphal system with clamped generative hyphae and ellipsoid, thin-walled, warted basidiospores measuring 3.1–4.9 × 2.3–3.3 µm. *Xenasmatella tenuis* is characterized by annual, resupinate, very thin basidiomata with ceraceous to membranous, white to lilac hymenial surface, a monomitic hyphal system with clamped generative hyphae and ellipsoid, thin-walled, warted basidiospores. *Xenasmatella xinpingensis* is characterized by annual, resupinate basidiomata, a monomitic hyphal system with clamped generative hyphae and subglobose to globose, thin-walled, warted basidiospores (3.5–4.9 × 3–4.2 µm).

**Keywords:** China, corticioid fungi, taxonomy, wood-rotting fungi

## Introduction

*Xenasmatella* Oberw. (1966: 28) was typified by *X. subflavidogrisea* (Litsch.) Oberw. ex Jülich (1979: 335), which is a genus characterized by a combination of resupinate to effused basidiomata with a ceraceous to subgelatinous consistency, hymenophore smooth to porulose, reticulate, grandinioid, a monomitic hyphal structure with clamped generative hyphae, basidia pleural and basidiospores hyaline, thin to slightly thick-walled, warted, globose, subglobose, ellipsoid, cylindrical (Oberwinkler 1966, Bernicchia & Gorjón 2010). So far about 14 species have been accepted in the genus worldwide (Oberwinkler 1966, Stalpers 1996, Hjortstam & Ryvarden 2005, Bernicchia & Gorjón 2010, Duhem 2010, Huang *et al.* 2019, Larsson *et al.* 2020).

During our investigations on the diversity of wood-rotting fungi in southern China, three undescribed species belonging to *Xenasmatella* were found. To confirm the placement of the undescribed species of *Xenasmatella*, the authors included samplings from previous studies to examine morphological characters of new species within the genus.

## Materials and methods

### *Morphology*

The studied specimens are deposited at the herbarium of Southwest Forestry University (SWFC), Kunming, Yunnan Province, P.R. China. Macromorphological descriptions are based on field notes. Special colour terms follow Petersen (1996). Micromorphological data were obtained from the dried specimens, and observed under a light microscope following Dai (2012). The following abbreviations were used: KOH = 5% potassium hydroxide; CB = Cotton Blue, CB– = acyanophilous; IKI = Melzer's reagent, IKI– = both inamyloid and indextrinoid, L = mean spore length

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(arithmetic average of all spores), W = mean spore width (arithmetic average of all spores), Q = variation in the L/W ratios between the specimens studied, n (a/b) = number of spores (a) measured from given number (b) of specimens. The spore ornamentation is included in the given dimensions.

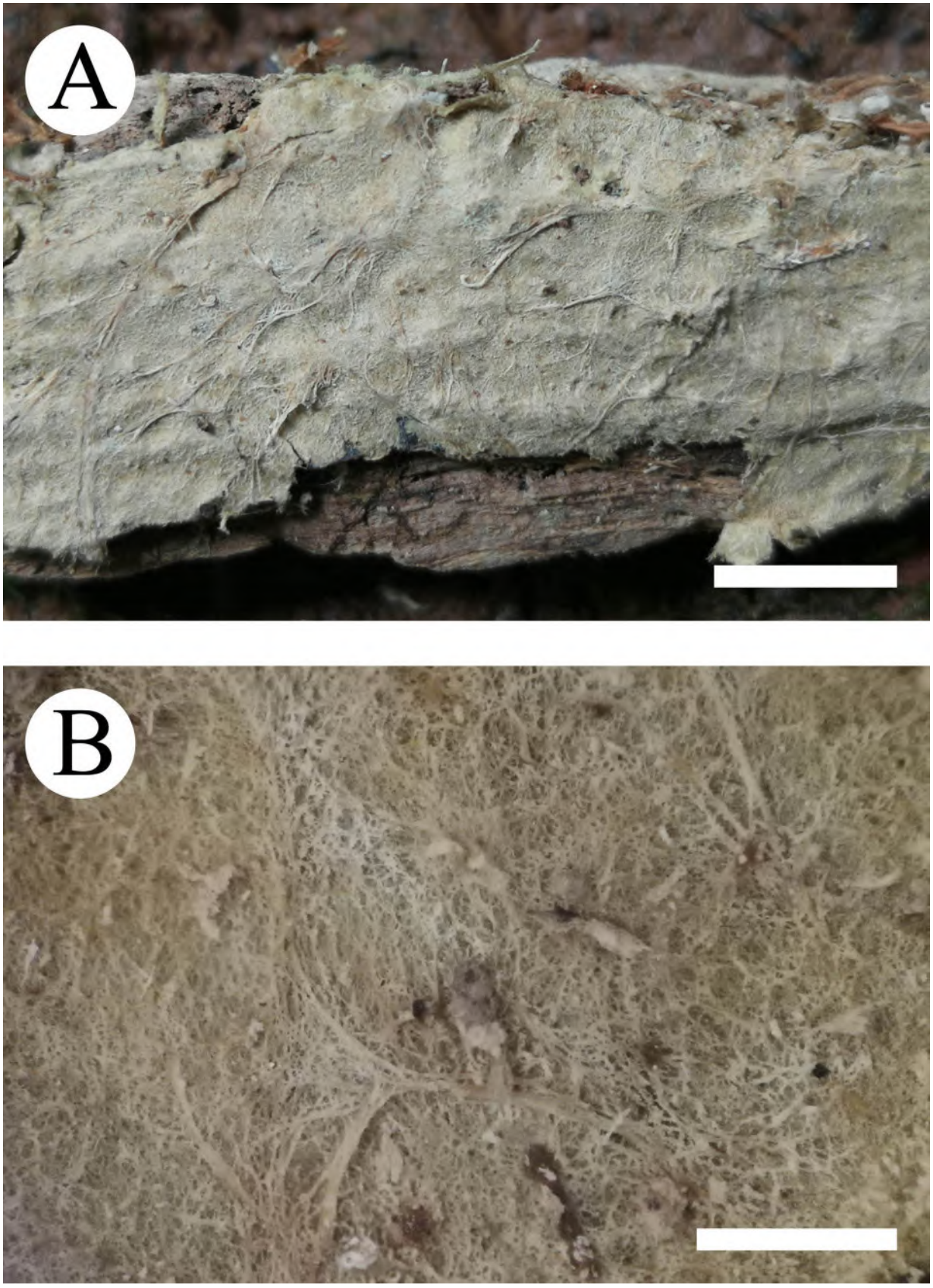


**FIGURE 1.** A basidiomata of *Xenasmatella rhizomorpha* (holotype). Bar: A = 0.5 cm; B = 1 mm.

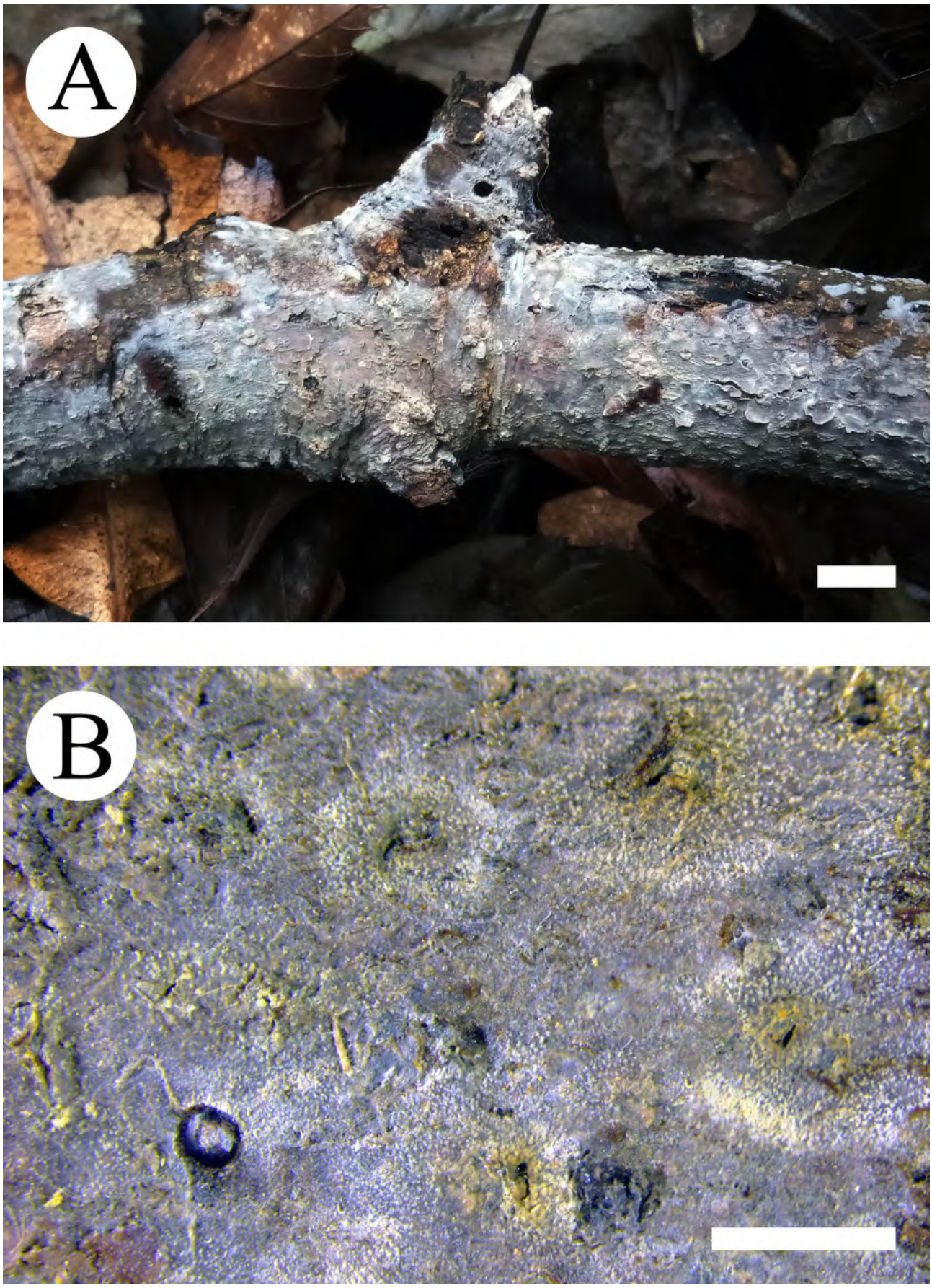


**FIGURE 2.** A basidiomata of *Xenasmatella tenuis* (holotype). Bar: A = 1 cm; B = 1 mm.

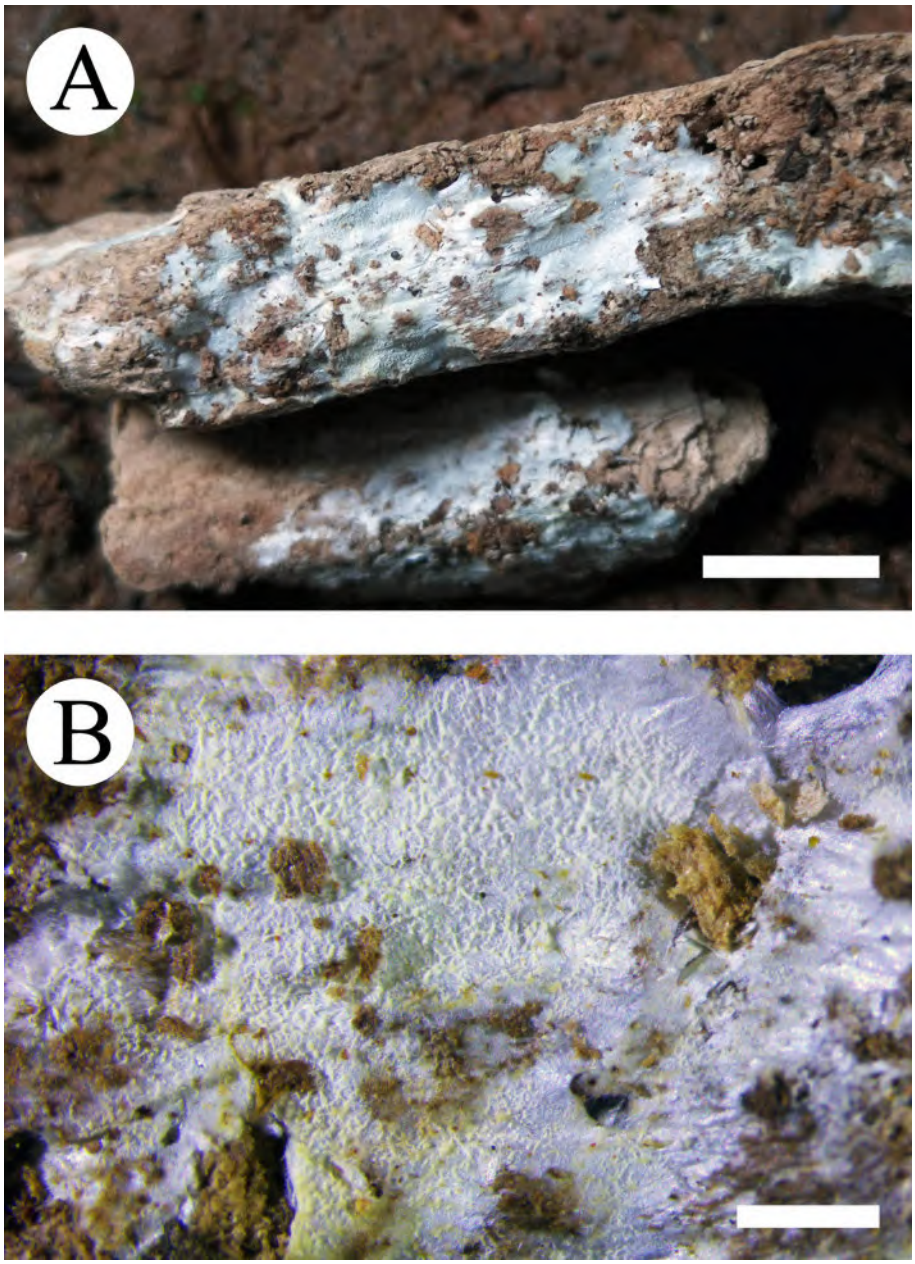


**FIGURE 3.** A basidiomata of *Xenasmatella xinpingensis* (holotype). Bar: A = 0.5 cm; B = 1 mm.

*Molecular study*

CTAB rapid plant genome extraction kit-DN14 (Aidlab Biotechnologies Co., Ltd, Beijing) was used to obtain genomic DNA from dried specimens, according to the manufacturer's instructions followed previous study (Zhao & Wu 2017). ITS region was amplified with primer pair ITS5 and ITS4 (White *et al.* 1990). The PCR procedure for ITS was as follows: initial denaturation at 95 °C for 3 min, followed by 35 cycles at 94 °C for 40 s, 58 °C for 45 s and 72 °C for 1 min, and a final extension of 72 °C for 10 min. The PCR products were purified and directly sequenced at Kunming Tsingke Biological Technology Limited Company, Kunming, Yunnan Province, P.R. China.

## Results

### Molecular BLAST

The results of BLAST queries in NCBI based on ITS for *Xenasmatella rhizomorpha*, *X. tenuis* and *X. xinpingensis*

separately showed the sequences producing significant alignments descriptions: in *X. rhizomorpha* blast results, the top ten records for *X. borealis* (K.H. Larss. & Hjortstam) Duhem (2010: 147) (Maximum record descriptions: Max score 981; Total score 981; Query cover 96%; E value 0; Ident 97.09%) and *X. christiansenii* (Parmasto) Stalpers (1996: 37) (Maximum record descriptions: Max score 965; Total score 965; Query cover 95%; E value 0; Ident 96.58%). In *X. tenuis* blast results, the top ten records for *X. ardosiaca* (Bourdot & Galzin) Stalpers (1996: 37) (Maximum record descriptions: Max score 811; Total score 811; Query cover 96%; E value 0; Ident 91.53%). In *X. xinpingensis* blast results, the top ten records for *Phlebiella byssinella* (Bourdot) Bondartsev & Singer (1953: 51) (Maximum record descriptions: Max score 937; Total score 937; Query cover 95%; E value 0; Ident 95.75%) and *X. borealis* (Maximum record descriptions: Max score 933; Total score 933; Query cover 96%; E value 0; Ident 95.42%).

## Taxonomy

***Xenasmatella rhizomorpha*** C.L. Zhao, ***sp. nov.*** Figs. 1, 4
MycoBank no.: MB 836455

Holotype:—**CHINA**. Yunnan Province, Puer, Jingdong County, Wuliangshan National Nature Reserve, on angiosperm trunk, 7 January 2019, *CLZhao 9847* (SWFC!), GenBank No. (MT832953, ITS).

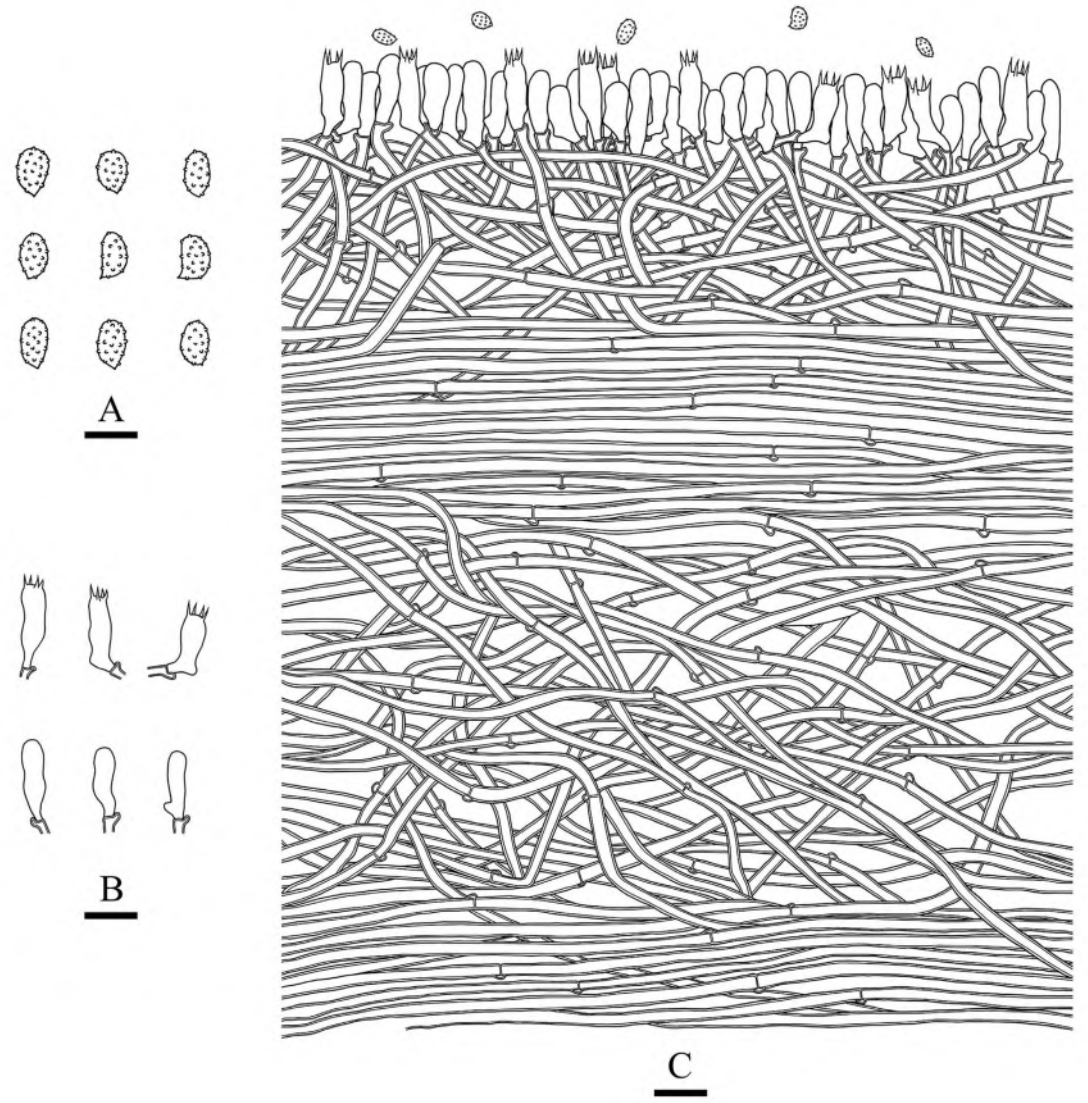


**FIGURE 4.** Microscopic structures of *Xenasmatella rhizomorpha* (drawn from the holotype). A. Basidiospores. B. Basidia and basidioles. C. A section of hymenium. Bars: A = 5 μm; B, C = 10 μm.

*Etymology*:—*Rhizomorpha* (Lat.): referring to rhizomorphic basidiomata.

*Fruiting body*:—Basidiomata annual, resupinate, becoming gossypine when fresh, membranaceous upon drying, up to 8 cm long, 200–600 µm thick. Hymenial surface byssaceous to reticulate, white to olivaceous buff when fresh, clay-buff to cinnamon upon drying. Color unchanged with alkali. Rhizomorphs present, white.

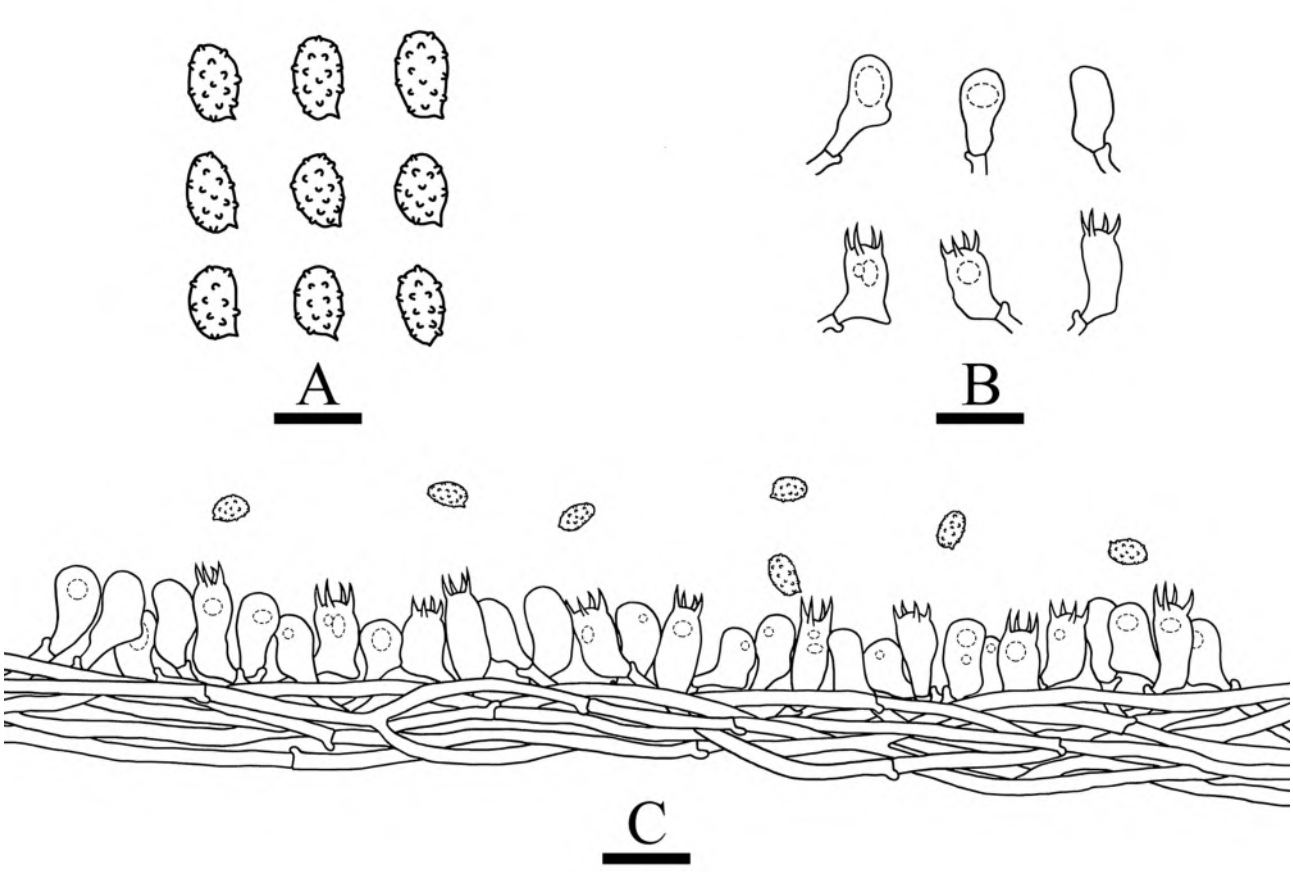


**FIGURE 5.** Microscopic structures of *Xenasmatella tenuis* (drawn from the holotype). A. Basidiospores. B. Basidia and basidioles. C. A section of hymenium. Bars: A = 5 µm; B, C = 10 µm.

*Hyphal structure*:—Hyphal system monomitic; generative hyphae with clamp connections, thick-walled, unbranched, 1.5–3.5 µm in diam., IKI–, CB–, tissues unchanged in KOH.

*Hymenium*:—Cystidia and cystidioles absent; basidia pleural, clavate, with 4 sterigmata and a basal clamp connection, 10.5–17.5 × 3.5–6.5 µm; basidioles dominant, in shape similar to basidia, but slightly smaller.

*Spores*:—Basidiospores ellipsoid, hyaline, thin-walled, warted throughout, asperulate with blunt spines up to 0.2 µm long, IKI–, CB–, 3.1–4.9 × 2.3–3.3 µm, L = 4.09 µm, W = 2.82 µm, Q = 1.35–1.64 (n = 180/6).

*Rot type*:—White rot.

*Additional specimens examined*:—**CHINA**. Yunnan Province, Yuxi, Xinping County, Jinshan Primeval Forest Park, on angiosperm trunk, 2 January 2019, *CLZhao 9156* (GenBank No. MT832954, ITS), *CLZhao 9170* (GenBank No. MT832955, ITS), *CLZhao 9172* (GenBank No. MT832956, ITS); 6 January 2019, *CLZhao 9734* (GenBank No. MT832957, ITS); 7 January 2019, *CLZhao 9885* (GenBank No. MT832958, ITS) (SWFC!).

***Xenasmatella tenuis*** C.L. Zhao, ***sp. nov.*** Figs. 2, 5

MycoBank no.: MB 836456

Holotype:—**CHINA**. Yunnan Province, Wenshan, Xichou County, Xiaoqiaogou National Nature Reserve, on fallen angiosperm branch, 16 January 2019, *CLZhao 11258* (SWFC!), (Genbank MT832959, ITS).

*Etymology*:—*Tenuis* (Lat.): referring to very thin basidiomata.

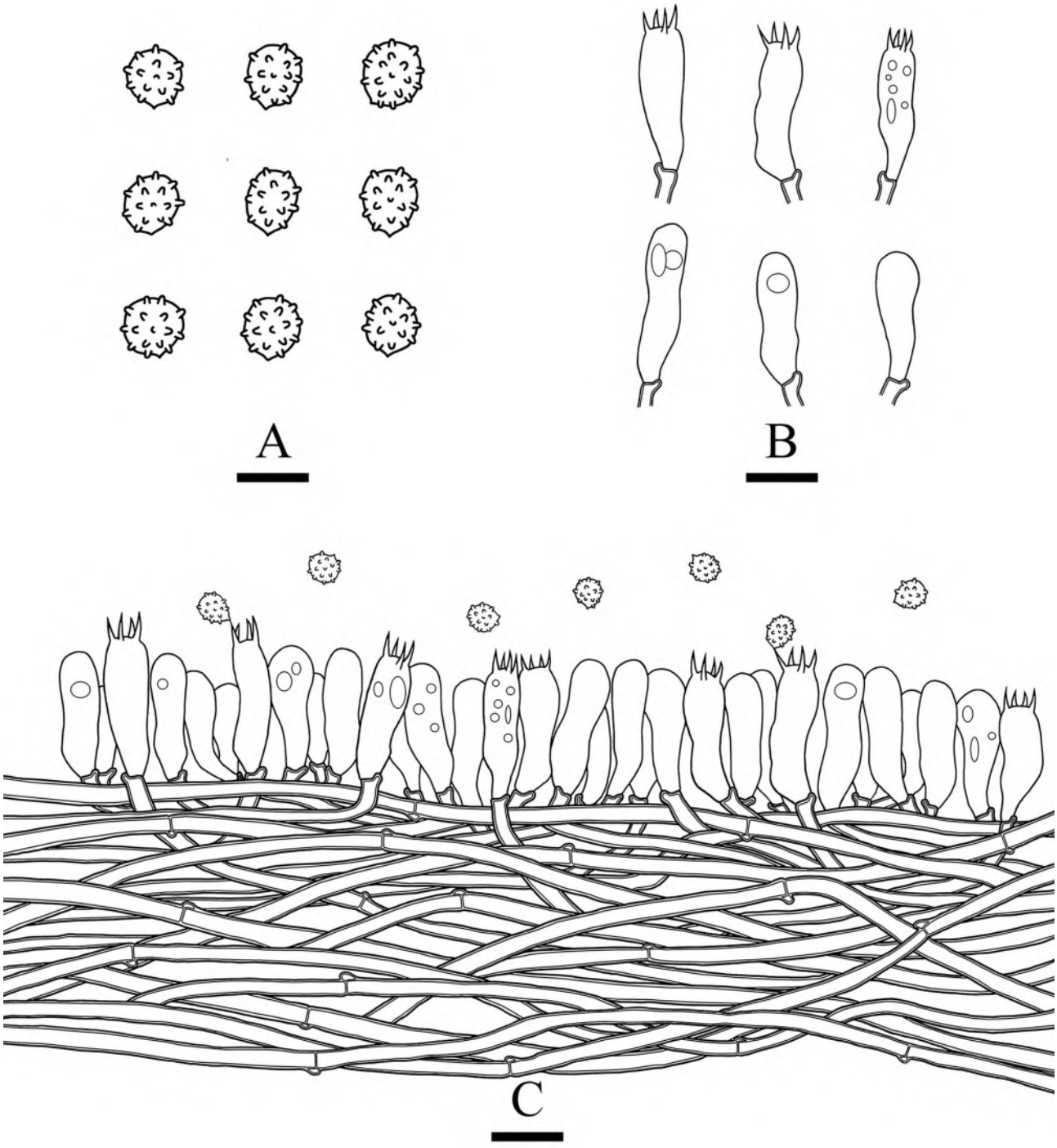


**FIGURE 6.** Microscopic structures of *Xenasmatella xinpingensis* (drawn from the holotype). A. Basidiospores. B. Basidia and basidioles. C. A section of hymenium. Bars: A = 5 μm; B, C = 10 μm.

*Fruiting body*:—Basidiomata annual, resupinate, adnate, very thin, without odor or taste, and becoming ceraceous when fresh, ceraceous to membranous upon drying, up to 10 cm long, less than 100 μm thick. Hymenial surface white when fresh, white to lilac upon drying. Margin sterile, indistinct, white.

*Hyphal structure*:—Hyphal system monomitic; generative hyphae with clamp connections, hyaline, thin-walled, branched, 1–2.5 μm in diam., IKI–, CB–, tissues unchanged in KOH.

*Hymenium*:—Cystidia and cystidioles absent; basidia pleural, barrel-shaped, with 4 sterigmata and a basal clamp connection, 9–12.5 × 3.5–6 μm; basidioles dominant, in shape similar to basidia, but slightly smaller.

*Spores*:—Basidiospores ellipsoid, hyaline, thin-walled, warted throughout, asperulate with blunt spines up to 0.3 μm long, IKI–, CB–, 3.3–4.8 × 2.3–3.4(–3.6) μm, L = 4.13 μm, W = 2.96 μm, Q = 1.38–1.41 (n = 60/2).

*Rot type*:—White rot.

*Additional specimen examined*:—**CHINA**. Yunnan Province, Puer, Jingdong County, Wuliangshan National Forestry Reserve, on fallen angiosperm branch, 6 October 2017, *CLZhao 4528* (GenBank No. MT832960, ITS) (SWFC!).

***Xenasmatella xinpingensis*** C.L. Zhao, ***sp. nov.*** Figs. 3, 6
MycoBank no.: MB 836457

Holotype:—**CHINA**. Yunnan Province, Yuxi, Xinping County, Mopanshan National Forestry Park, on fallen angiosperm branch, 18 August 2017, *CLZhao 2216* (SWFC!), Genbank (MT832961, ITS).

*Etymology*:—*Xinpingensis* (Lat.): referring to the locality (Xinping County) of the type specimens.

*Fruiting body*:—Basidiomata annual, resupinate, without odor or taste, and becoming soft ceraceous when fresh, irregularly reticulate or somewhat wrinkled upon drying, up to 7 cm long, 100–300 µm thick. Hymenial surface white when fresh and upon drying. Margin sterile, distinct, white.

*Hyphal structure*:—Hyphal system monomitic; generative hyphae with clamp connections, slightly thick-walled, unbranched, 1.5–3.5 µm in diam., IKI–, CB–, tissues unchanged in KOH.

*Hymenium*:—Cystidia and cystidioles absent; basidia clavate, with 4 sterigmata and a basal clamp connection, 15.5–20 × 4.5–6.5 µm; basidioles dominant, in shape similar to basidia, but slightly smaller, with oildrops.

*Spores*:—Basidiospores subglobose to globose, hyaline, thin-walled, warted throughout, asperulate with blunt spines up to 0.7 µm long, IKI–, CB–, 3.5–4.9 × (2.8–)3–4.2 µm, L = 4.13 µm, W = 3.55 µm, Q = 1.15–1.19 (n = 90/3).

*Rot type*:—White rot.

*Additional specimens examined*:—**CHINA**. Yunnan Province, Yuxi, Xinping County, Mopanshan National Forestry Park, on the trunk of *Quercus semecarpifolia*, 19 August 2017, *CLZhao 2467* (GenBank No. MT832962, ITS); Shimenxia Forestry Park, on angiosperm trunk, 21 August 2017, *CLZhao 2792* (GenBank No. MK343491, ITS) (SWFC!).

***Xenasmatella ailaoshanensis*** (C.L. Zhao) C.L. Zhao & T.K. Zong, ***comb. nov.***
MycoBank no.: MB 836458

Basionyme : *Phlebiella ailaoshanensis* C.L. Zhao, *Phytotaxa* 419(1): 106 (2019).

## Discussion

In the present study, three new species, *Xenasmatella rhizomorpha*, *X. tenuis* and *X. xinpingensis spp. nov.*, are described based on BLAST analyses and morphological characters.

Morphologically, *Xenasmatella rhizomorpha* is similar to *X. fibrillosa* (Hallenb.) Stalpers (1996: 37) and *X. vaga* (Fr.) Stalpers (1996: 37) having fertile threads running over the hymenophore and rhizomorphs. However, *Xenasmatella fibrillosa* differs from *X. rhizomorpha* by having white to yellowish white hymenial surface and heavily encrusted generative hyphae (Bernicchia & Gorjón 2010). *Xenasmatella vaga* differs in having the hymenophore turning dark red or purplish with KOH and larger basidiospores (5–5.5 × 4–4.5 µm, Bernicchia & Gorjón 2010).

*Xenasmatella tenuis* is similar to *X. ailaoshanensis* (C.L. Zhao) C.L. Zhao & T.K. Zong (2019: 106), *X. californica* (Liberta) Hjortstam (1983: 580) and *X. gaspesica* (Liberta) Hjortstam (1983: 581) by having very thin basidiomata. However, *Xenasmatella ailaoshanensis* can be distinguished by white to greyish hymenial surface and wider basidiospores (4–5 × 3.5–4.5 µm, Huang *et al.* 2019). *Xenasmatella californica* differs from *X. tenuis* by having the bluish-gray hymenial surface and larger basidiospores (5.5–7 × 3–4 µm, Liberta 1965). *Xenasmatella gaspesica* differs in its effused basidiomata and cylindrical basidiospores (5.5–7 × 1.5–2 µm, Hjortstam & Larsson 1987).

*Xenasmatella xinpingensis* is similar to *X. ardosiaca* and *X. christiansenii* on the basis of having pruinose to cottony hymenophore, but *X. ardosiaca* differs from *X. xinpingensis* by having both larger and thick-walled basidiospores (5–6 × 5–5.5 µm, Hjortstam & Larsson 1987, Bernicchia & Gorjón 2010). *Xenasmatella christiansenii* differs in having the white to greyish hymenial surface and larger basidiospores (6–7 × 4–4.5 µm, Hjortstam & Larsson 1987, Bernicchia & Gorjón 2010). Additionally, *Xenasmatella xinpingensis* is similar to *X. ailaoshanensis* in microscopical characters, but

*X. ailaoshanensis* differs in its pruinose to farinaceous basidiomata with white to greyish hymenial surface (Huang *et al.* 2019). *Xenasmatella globigera* (Hjortstam & Ryvarden) Duhem (2005: 39) shares the similar character of globose basidiospores from Venezuela with *X. xinpingensis*. However, *Xenasmatella globigera* differs from *X. xinpingensis* by thick-walled basidiospores (Hjortstam & Ryvarden 2005).

On the basis of the molecular BLAST analyses, *Xenasmatella rhizomorpha* is close to *X. borealis* and *X. christiansenii*; *X. tenuis* is similar to *X. ardosiaca*; *X. xinpingensis* is close to *Phlebiella byssinella*. However, morphologically, *X. borealis* differs from *X. rhizomorpha* by having the larger basidiospores (5–6 × 3–4 µm, Duhem 2010); *X. christiansenii* differs in its white to greyish hymenial surface and larger basidiospores (6–7 × 4–4.5 µm, Bernicchia & Gorjón 2010). *Xenasmatella ardosiaca* differs from *X. tenuis* by having the cream to greyish hymenial surface and globose, larger basidiospores (5–6 × 5–6 µm, Bernicchia & Gorjón 2010). *Phlebiella byssinella* differs from *X. xinpingensis* by having the generative hyphae encrusted with numerous bypyramidal aggregated crystals and smooth, thin- to slightly thick-walled, narrowly ellipsoid basidiospores (3–4.5 × 2–2.5 µm, Liberta 1966).

In geographical distribution, five species of *Xenasmatella* were reported from this region (Dai 2011, Huang *et al.* 2019). The diversity of *Xenasmatella* in China is still not well known, especially in the subtropical and tropical regions and many recently described taxa of wood-rotting fungi were from these areas (Zhao & Cui 2013, 2014, Zhao *et al.* 2017, Huang *et al.* 2019, Liu *et al.* 2019, Luo *et al.* 2019, Wu *et al.* 2019). *Xenasmatella rhizomorpha*, *X. tenuis* and *X. xinpingensis*, are also from the subtropics. It is possible that new taxa will be found after further investigations.

## Acknowledgements

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