

Fungal Biodiversity Profiles 71-80

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Abstract – In this new series of Fungal Biodiversity Profiles, the author describes ten basidiomycetes, all new species of *Lactarius* subg. *Russularia* from China, using both morphological and ITS sequence data. Descriptions are provided for *L. albidigalus*, *L. asiaeo-orientalis*, *L. conglutinatus*, *L. fulvihirtipes*, *L. marasmoides*, *L. neglectus*, *L. qinlingensis*, *L. subatlanticus*, *L. subgracilis* and *L. tuberculatus*.

Russulales / ITS / Lactarius / phylogeny / southern China / subg. Russularia / taxonomy

71. *Lactarius albidigalus* X.H. Wang, sp. nov.

Fig 2

Mycobank: MB 828927

GenBank: MK253475–MK253477 (ITS)

Systematic position: Basidiomycota, Agaricomycetes, Russulales, Russulaceae.

Etymology: albidi- = white, -galus = milk, referring to the white milk that turns into white granules when dry.

Diagnosis: A small to medium-sized species characterized by the reddish brown fruiting bodies, white latex changing to white granules on lamellae and context when dry, globose subreticulate spores, pileipellis a hyphoepithelium with broad terminal hyphae, and the presence of pleuromacrocytidia.

Holotype: CHINA. Guangdong Prov.: Fengkai Co., Heishiding nature reserve, Shimentang, 520 m a.s.l., in mixed forest of *Pinus massoniana* and fagaceous trees, 25 December 2012, coll. F. Li, no. 1148 (HKAS 78310, KUN!).

Basidiomata small to medium sized. *Pileus* 20–45 mm in diam., at first convex with a strongly decurved margin (button-like), later aplano-convex with a depressed center; surface dry, rugulose, when young with pruinose tomentum, dark reddish brown, then reddish brown with small darker patches or orange brown, center concolorous or darker. *Context* 1.5 mm thick, pale reddish brown. *Lamellae* 1–4 mm broad, medium distant, broadly adnate to decurrent, grayish orange when young, then reddish brown. *Stipe* 25–30 × 6–7 mm, cylindrical, equal or tapering downwards, stuffed inside; surface nearly smooth, dry, brownish orange, paler than the pileus. *Latex* white, changing to white granules on lamellae and exposed context when dry, mild. *Spore print* white.

Basidiospores (80/4/3) (6.0) 6.5–**6.9**–7.5 (8.0) × (5.5) 6.0–**6.5**–7.0 (7.5) µm [Q = (1.00) 1.03–1.11 (1.13), Q = **1.06** ± 0.03] [holotype (40/1/1): (6.0) 6.5–**7.0**–7.5 × (5.5) 6.0–**6.5**–7.0 (7.5) µm, Q = (1.00) 1.03–1.13, Q = **1.07** ± 0.03], globose, subglobose, rarely broadly ellipsoid; ornamentation 0.7–1.0 (1.3) µm high, of medium thick and acute ridges forming a partial or complete reticulum with big meshes, free ends of ridges and isolated warts common, plage inamyloid, rarely distally amyloid. *Basidia* 4-spored, 40–53 × 8–13 µm, clavate. *Pleuromacrocytidia*

scattered to common, projecting up to 35 μm beyond the basidia layer, base originating from the same depth as basidia or higher, 33–70 \times 6–9 μm , fusiform, with strongly refractive agglomerated contents, apex mucronate or moniliform. *Hymenophoral pseudocystidia* common, filiform, 2–5 μm broad, some forking or deformed at the apex, with strongly refractive contents. *Lamella edge* sterile or with basidia; marginal cells 15–30 \times 4–10 μm , clavate, cylindrical; cheilocystidia rare to common, 25–45 \times 5–8 μm , fusiform, with granular contents. *Pileipellis* a hyphoepithelium, 50–120 μm thick; terminal cells of suprapellis 20–75 \times 6–15 μm , cylindrical, ellipsoid, clavate; cells of subpellis 15–50 \times 15–35 μm , globose, subglobose. *Stipitipellis* a cutis, with some hyphal ends projecting outwards; hyphae 3–6 μm broad, thin-walled to slightly thick-walled. *Lactifers* nearly colorless, rare or common. *Pileus and stipe trama* with numerous rosettes.

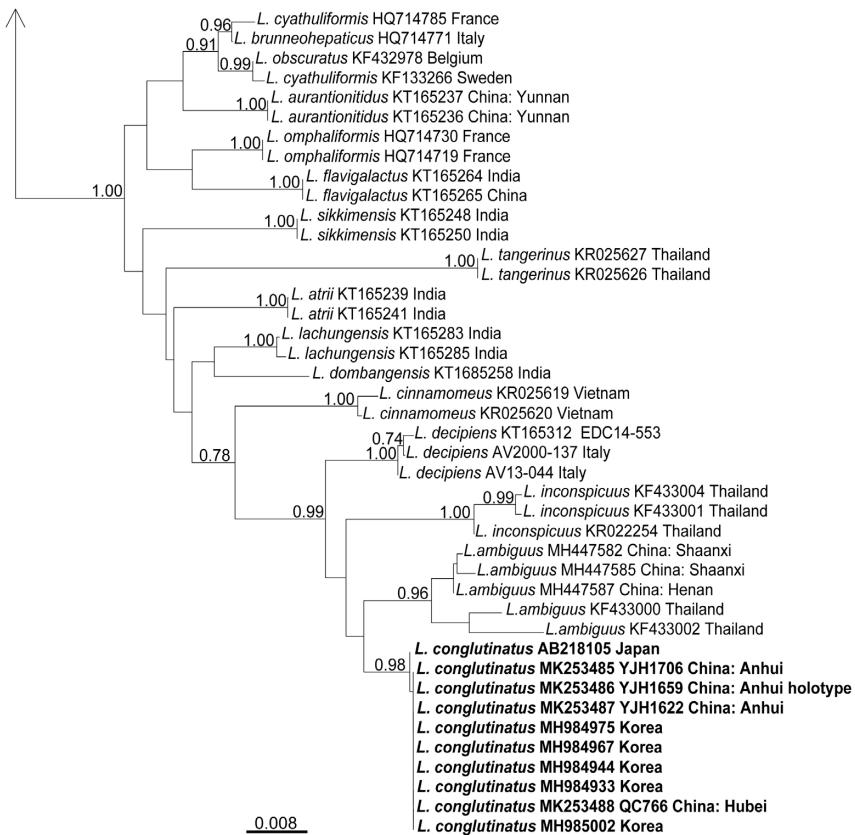


Fig. 1. Original tree generated by Neighbor-Joining (NJ) phylogenetic analysis, rooted with midpoint. NJ analysis was conducted in MEGA X, using bootstrap method (1000 replicates), p-distance as substitution model, transitions and transversions both included, uniform rates among sites, homogeneous pattern among lineages and pairwise deletion for gap treatment. The bootstrap proportions higher than 70% are indicated above the nodes. New species are in bold. Sample labels are provided in the order of species name, GenBank accession, and geographical origin. For new species, sample numbers with initials of collectors are provided after GenBank accessions.

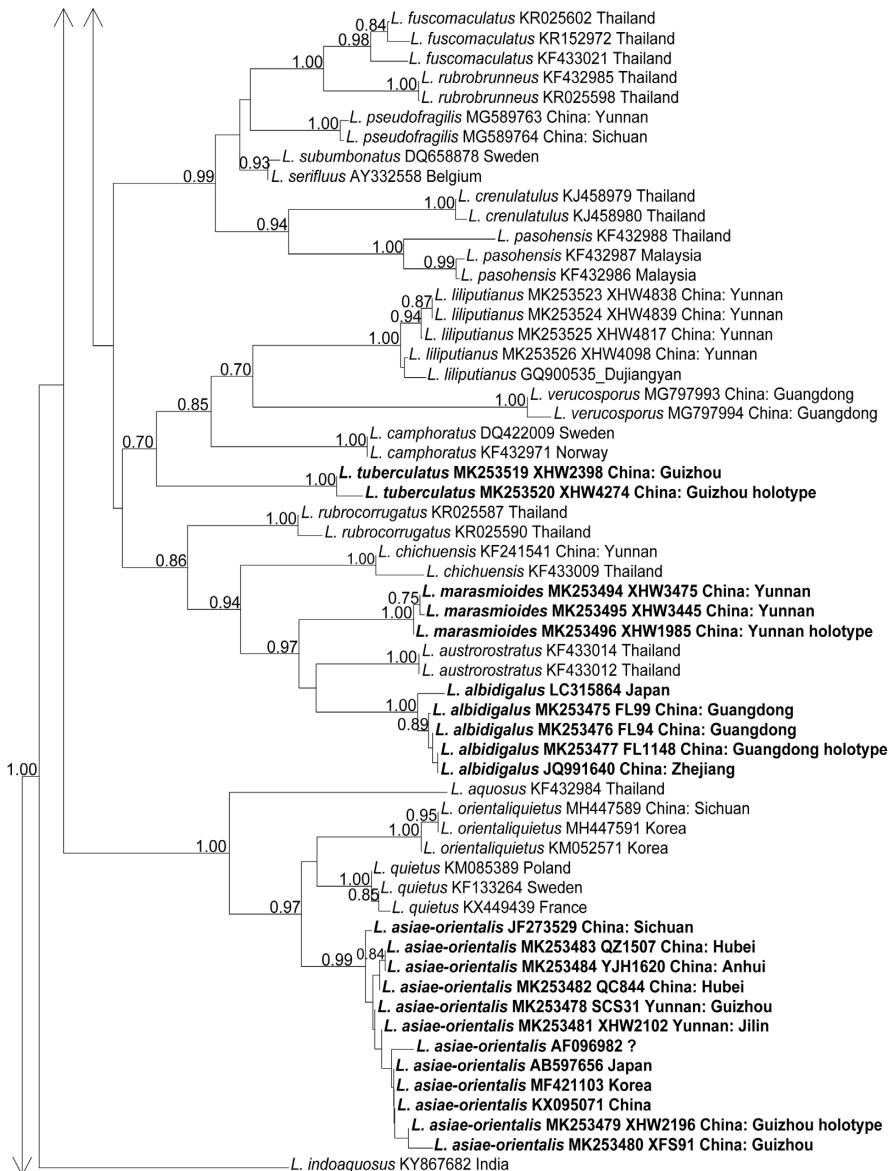


Fig. 1 (continued)

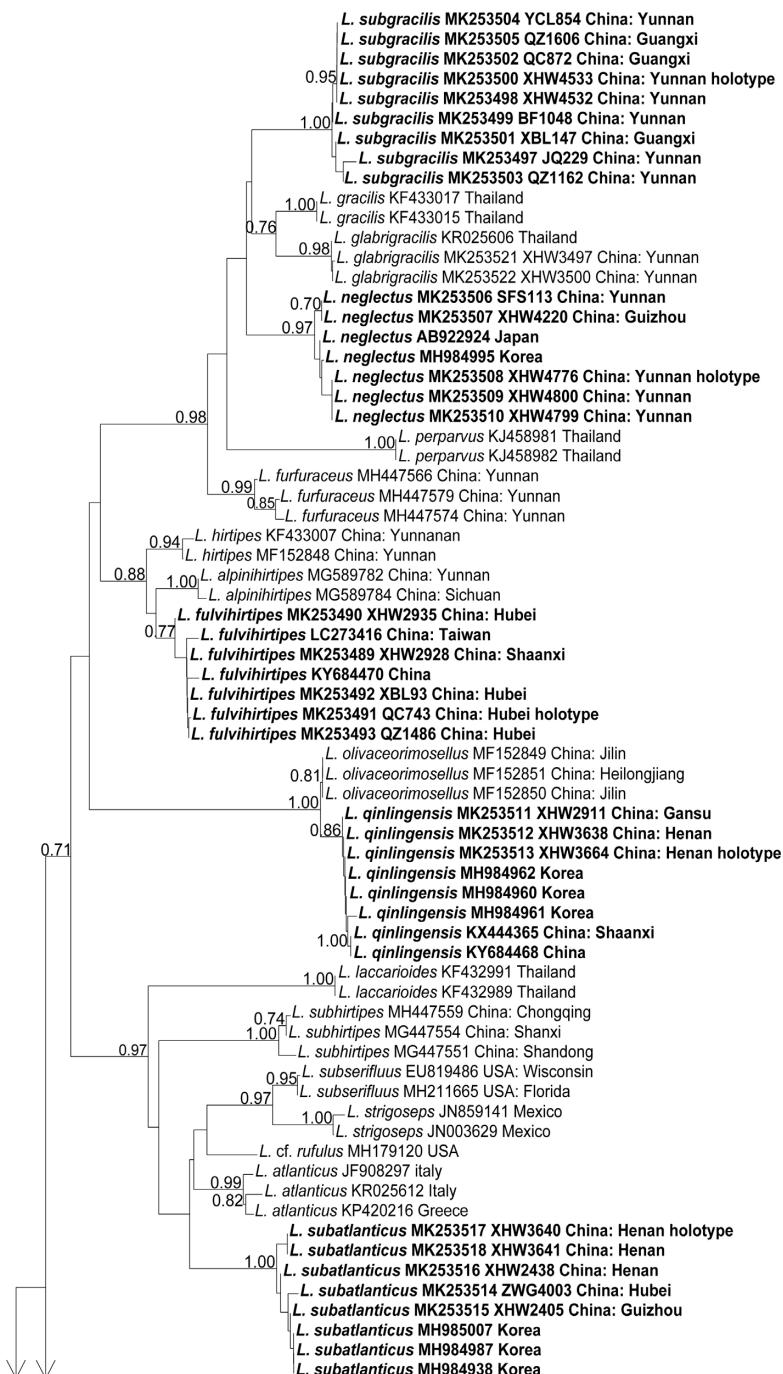


Fig. 1 (continued)

Habit, habitat and distribution: 1–3 individuals growing together, under fagaceous trees. South (Guangdong Prov.) and eastern (Zhejiang Prov.) China and Japan (Murata *et al.* 2017).

Additional specimens examined: CHINA. Guangdong Prov.: Fengkai Co., Heishiding nature reserve, 22 March 2012, coll. F. Li, no. 94 (HKAS 78092, KUN); Fengkai Co., Heishiding nature reserve, near swimming pool, 28 March 2012, coll. F. Li, no. 99 (HKAS 76138, KUN).

Notes: This new species, *L. australrostratus* Wisitrassameewong & Verbeken, *L. chichuensis* W.F. Chiu and *L. marasmoides* described below all have broad hyphae in the suprapellis of pileipellis and latex that turns into white granules when dry (Wang & Liu 2002; Wisitrassameewong *et al.* 2015; own observation on Chinese specimens of *L. australrostratus*). The repent outmost hyphae give a pruinose

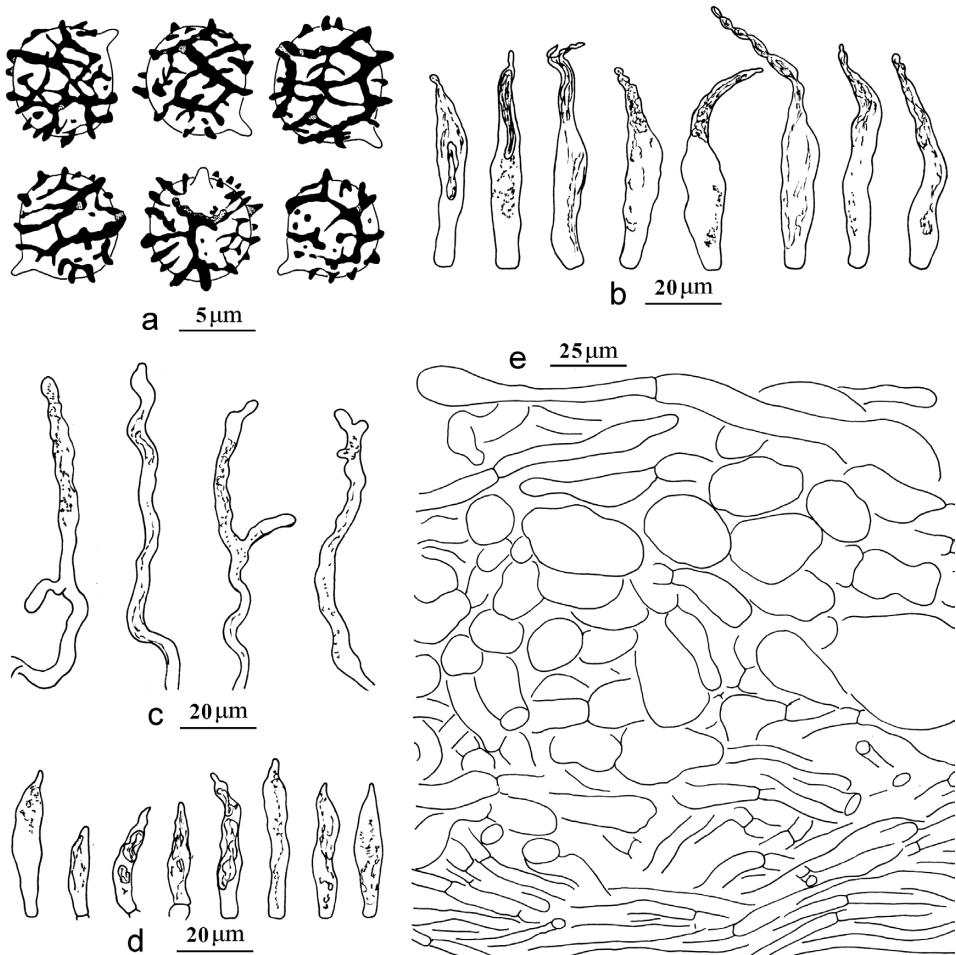


Fig. 2. *Lactarius albidiatus* (HKAS 78310, holotype). **a.** Basidiospores. **b.** Pleuromacrocystidia. **c.** Hymenophoral pseudocystidia. **d.** Cheilomacrocystidia. **e.** pileipellis.

appearance of the pileus surface when dry or young, at least on *L. austrostratus* and *L. albidigalus*. *Lactarius albidigalus* has globose spores whereas those of *L. austrostratus* and *L. chichuensis* are more ellipsoid (Wang & Liu 2002; Wisittrassameewong *et al.* 2015). *Lactarius rubrocorticatus* Wisittrassameewong & Nuytinck is another Asian species similar to this new species, but it has watery latex and does not have pleuromacrocystidia (Wisittrassameewong *et al.* 2015; own observation on Chinese specimens of *L. rubrocorticatus*). For more notes see under *L. marasmioides*.

72. *Lactarius asiae-orientalis* X.H. Wang, sp. nov.

Figs 3, 9a

Mycobank: MB 828928

GenBank: MK253478–MK253484 (ITS)

Systematic position: Basidiomycota, Agaricomycetes, Russulales, Russulaceae.

Etymology: *asiae-* = Asia, *-orientalis* = oriental, referring to the geographical distribution in East Asia.

Diagnosis: A medium-sized species with orange brown to brown zonate pileus, ellipsoid spores with partially connected ornamentation, pileipellis an (ixo-) lattice and presence of macrocystidia. Differing from *L. quietus* in lacking the odor of *Pentamogium* bugs and having narrower hyphae in the pileipellis; distinct from *L. orientaliquetus* by the spore ornamentation with elements less connected.

Holotype: CHINA, Guizhou Prov.: Bijie, Baimashan forest farm, 1650 m a.s.l., in mixed forest of *Pinus massoniana* and fagaceous trees, 17 August 2008, coll. X.H. Wang, no. 2196 (HKAS 61370, KUN!).

Basidiomata medium-sized. *Pileus* 30–70 mm in diam., at first convex with a decurved margin, later applanate with a depressed center, zonate, light brown (5B5), brown (6E6) to dark brown (6E7) at the center, grayish orange (paler than 5B4) to brownish yellow (5B5, 5C5) towards margin, hygrophanous, ± greasy. *Context* 1–1.5 mm thick, yellowish white (4A2, 4A3). *Lamellae* 3–5 mm broad, crowded, short decurrent, pale yellow (4A3) when young, pale yellow to pale orange (4A3–5A3) when mature, discoloring brownish when bruised, with brownish spots when old. *Stipe* 35–80 × 5–15 mm, cylindrical, equal or enlarged downwards, stuffed inside; surface smooth, dry, brownish orange (6C4, 6D4 or paler) to brown (6E4), paler at the base (6C4). *Latex* cream-white or yellowish cream, whey-like or slowly changing to watery, very bitter. *Spore print* not obtained.

Basidiospores (120/6/5) (6.0) 7.0–7.5–8.5 (9.0) × 5.5–5.9–6.5 (7.0) µm [$Q = (1.12) 1.17\text{--}1.40 (1.45)$, $Q = 1.27 \pm 0.07$] [holotype (40/2/1): 7.0–7.7–8.5 (9.0) × 5.5–6.0–6.5 µm, $Q = (1.17) 1.22\text{--}1.42 (1.45)$, $Q = 1.29 \pm 0.07$], ellipsoid, rarely broadly ellipsoid; ornamentation 0.5–1.0 (1.2) µm high, of small warts and short ridges, connected by fine lines, rarely forming a broken reticulum, isolated warts and free ridges common; plage inamyloid, rarely distally amyloid. *Basidia* 4-spored, 35–40 × 8–13 µm, clavate, rarely subfusiform. *Pleuromacrocystidia* common to numerous, emergent, (40) 45–70 × 7–11 µm, fusiform, often with a moniliform apex, with hyaline to yellowish brown, strongly refractive contents. *Lamella edge* sterile, rarely with basidia; marginal cells 8–23 (30) × 4–10 µm, similar to basidioles in shape, clavate, cylindrical, rarely capitate; cheilocystidia common, 25–45 × 5–10 µm, fusiform, with granular or crystalline contents. *Hymenophoral pseudocystidia* scattered to common, 2–4 µm broad, filamentous, rarely forking, with homogeneous refractive contents. *Pileipellis* a lattice or ixo-lattice with very thin slimy layer, 50–120 µm thick, of loosely interwoven hyphae; hyphae in suprapellis 3–5 µm broad, with a round apex, outermost hyphae 13–55 × 3–5 µm,

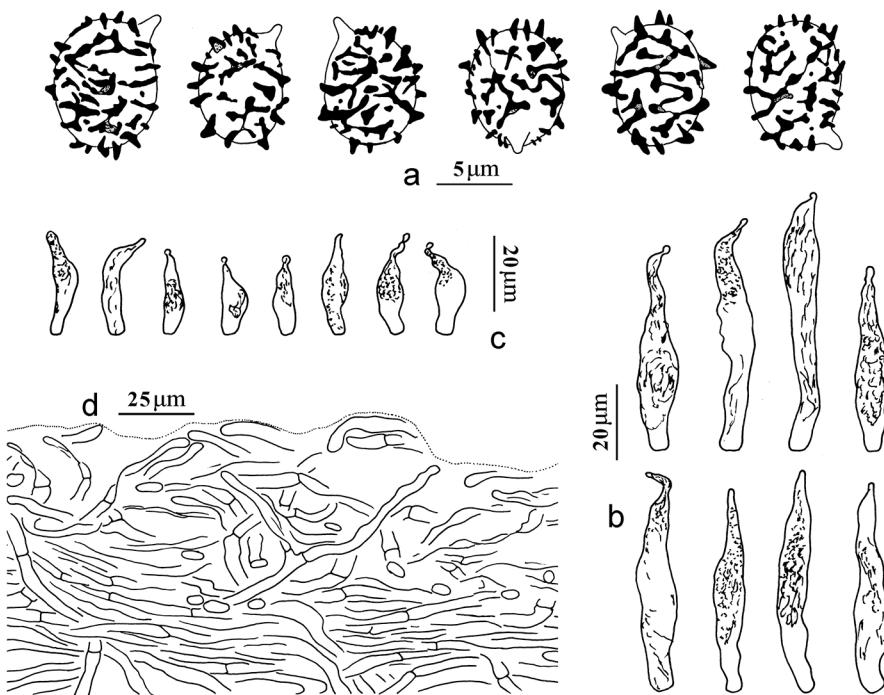


Fig. 3. *Lactarius asiae-orientalis* (HKAS 61370, holotype). **a.** Basidiospores. **b.** Pleuromacrocytidia. **c.** Cheilomacrocytidia. **d.** Pileipellis.

yellowish brown, often projecting outwards; hyphae in subpellis 4–8 µm broad. *Stipitipellis a cutis*, 40–70 µm thick, of closely packed hyphae; hyphae 3–6 µm broad, hyaline to pale yellowish brown, terminal cells 30–65 × 3–4 µm, with a round apex often projecting outwards. *Lactifers* scattered to common, nearly hyaline to yellowish brown. *Pileus and stipe trama* with numerous rosettes.

Habit, habitat and distribution: solitary or scattered, growing in oak forests or mixed forests with fagaceous trees and pines. Southwestern (Guizhou Prov.), central (Hubei Prov.), eastern (Anhui Prov.) and northeastern (Jilin Prov.) China, Japan and Korea.

Additional specimens examined: CHINA. **Anhui Prov.:** Jinzhai Co., Mazongling forest farm, forest to Tiantangzhai, N 31°15'13.94" E 115°42'09.69", 843 m a.s.l., in mixed forest dominated by *Castanea sanguinii* and *Pinus taiwanensis*, 21 September 2017, coll. Y.J. Hao, no. 1620 (HKAS 104198, KUN). **Guizhou Prov.:** Bijie, Yangshan forest park, 12 August 2009, coll. S.C. Shao, no. SSC-31 (HKAS 58112, KUN); Hezhang Co., Longgongping forest park, 1928 m a.s.l., 21 September 2007, coll. X.F. Shi, no. 91 (HKAS 60400, KUN). **Hubei Prov.:** Shengnongjia Forestry District, Shengnongding, near Shennong Hotel, 1960 m a.s.l., under *Quercus* trees, 13 July 2012, coll. Q. Zhao, no. 1507 (HKAS 78766, KUN); Shennongjia Forestry District, Tianyan, N 31°40'50" E 110°26'27", 1900 m a.s.l., under fagaceous trees, 18 July 2012, coll. Q. Cai, no. 844 (HKAS 75578, KUN). **Jilin Prov.:** Fusong Co., Lushuihe, nature reserve for seed bearer of *Pinus koraiensis*,

N 42°29.141' E 127°51.890', 776 m a.s.l., in mixed forest including *P. koraiensis* and *Quercus mongolicum*, 11 September 2006, coll. X. H. Wang, no. 2102 (HKAS 51817, KUN).

Notes: This is a second relative of European *L. quietus* (Fr.: Fr.) Fr. in Asia, after the newly described *L. orientaliquietus* X.H. Wang (Wang *et al.* 2018). Like *L. orientaliquietus*, it was recognized in the field as “*L. quietus*”, but no diagnostic “*Pentamogium* bugs” odor was recorded. Some specimens have greasy pilei (HKAS 61370 and HKAS 78766) as *L. orientaliquietus*. Except for those of HKAS 104198 (av. $6.9 \times 5.7 \mu\text{m}$), the spores of *L. asiae-orientalis* are longer and more ellipsoid compared to the two relatives and elements of the spore ornamentation are smaller and less connected. The hyphae in the subpellis of the pileipellis of *L. asiae-orientalis* and *L. orientaliquietus* are narrower than those of *L. quietus* where these can inflate to $15 \mu\text{m}$ broad (Heilmann-Clausen *et al.* 1998). A sequence retrieved from GenBank MH984969 is mis-labelled as *L. hatsudake*.

72. *Lactarius conglutinatus* X.H. Wang, sp. nov.

Figs 4, 9b

Mycobank: MB 828929

GenBank: MK253485–MK253488 (ITS)

Systematic position: Basidiomycota, Agaricomycetes, Russulales, Russulaceae.

Etymology: *conglutinatus* = united firmly together, referring to the gelatinized hyphae in the pileipellis that are difficult to separate.

Diagnosis: A small to medium sized species characterized by the pale yellowish polished pileus with a much darker center, cream-colored to grayish orange lamellae and stipe, pileipellis an ixo-lattice with strongly gelatinized hyphae that are difficult to separate and spores with variable ornamentation.

Holotype: CHINA. Anhui Prov.: Jinzhai Co., Mazongling forest farm, Yixingdi, N 31°18'86.66" E 115°41'39.15", 1146 m a.s.l., in mixed forest dominated by *Castanea seguinii* and *Pinus taiwanensis*, N 31°18'86.66" E 115°41'39.15", 1146 m a.s.l., 22 September 2017, coll. Y.J. Hao, no. 1659 (HKAS 104200, KUN!).

Basidiomata small to medium-sized. *Pileus* 15–58 mm in diam., at first aplano-convex with a conical umbo, later with a depressed centre, margin ± crenulate; surface glossy when wet, smooth, hygrophanous, at first pale yellowish brown with a brown to dark brown umbo, fading to nearly yellowish white or orange white when fully mature. *Context* 1–2 mm thick, yellowish white. *Lamellae* 2–3 mm broad, adnate with a decurrent tooth, medium crowded, sometimes with transverse veins between lamellae, yellowish white then pale yellow, with grayish orange tinge when fully mature. *Stipe* 40–70 × 4–11 mm, central, equal or slightly enlarged downwards, hollow; surface nearly dry, pale yellow to grayish orange. *Latex* white, neither discoloring nor staining. *Spore print* not obtained.

Basidiospores (80/4/3) (6.0) 6.5–7.1–8.0 × (5.0) 5.5–5.9–6.5 (7.0) μm [$Q = (1.08) 1.11\text{--}1.29 (1.33)$, $Q = 1.20 \pm 0.05$] [holotype (40/2/1): 6.5–7.1–8.0 × (5.0) 5.5–5.9–6.5 μm , $Q = (1.08) 1.12\text{--}1.29 (1.33)$, $Q = 1.21 \pm 0.06$], broadly ellipsoid to ellipsoid, rarely subglobose; ornamentation 0.3–1.0 (1.3) μm high, of medium acute elongate warts and ridges, connected to form few close meshes or a broken reticulum, very rarely forming a nearly complete reticulum, some elements aligned in a subzebroid pattern, isolated warts and free ridges common; plage inamyloid, rarely slightly distally amyloid. *Basidia* 4-spored, 35–50 × 8–11 μm , clavate. *Pleuromacrocystidia* scattered to common, emergent, protruding up to 40 μm beyond the basidia layer, 45–90 × 6–10 μm , fusiform, often with a moniliform apex, with strongly refractive pale yellow granular or crystalline contents. *Hymenophoral*

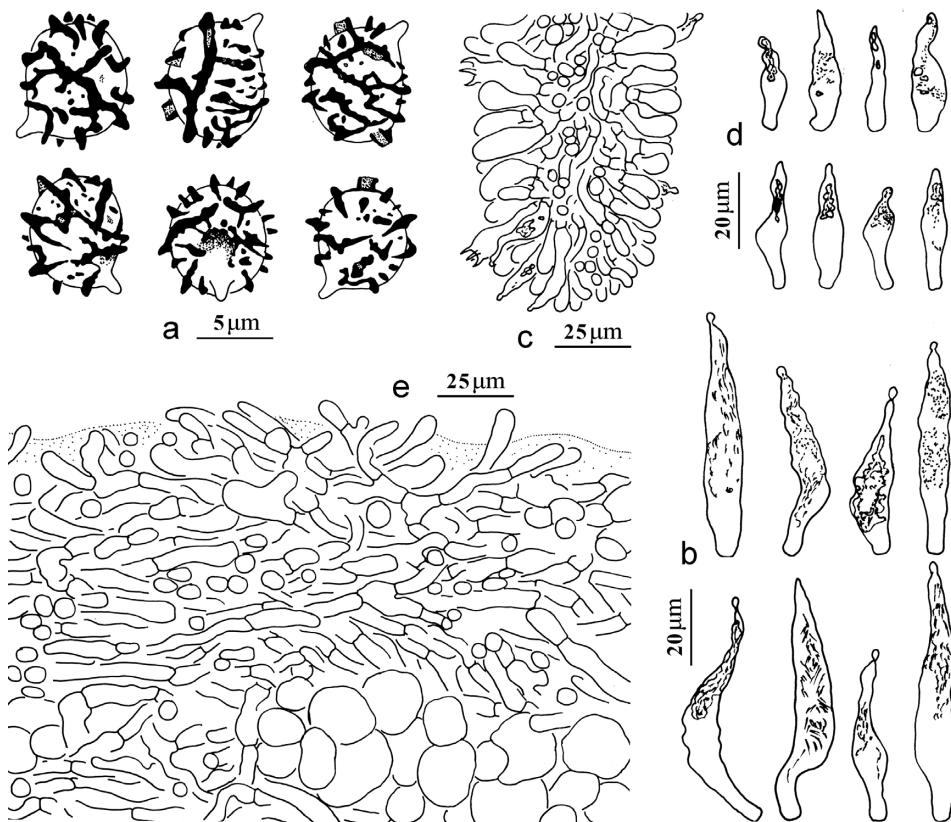


Fig. 4. *Lactarius conglutinatus* (HKAS 104200, holotype). **a.** Basidiospores. **b.** Pleuromacrocytidia. **c.** Lamella edge. **d.** Cheilomacrocytidia. **e.** Pileipellis.

pseudocystidia rare, 2–3 μm broad, not protruding, with refractive amorphous contents. *Lamella edge* sterile; marginal cells $8\text{--}22 \times 3\text{--}7 \mu\text{m}$, similar to basidioles in shape, clavate, cylindrical; cheilomacrocytidia scattered to common, $25\text{--}40 \times 5\text{--}9 \mu\text{m}$, fusiform, some with a moniliform apex, with granular or agglomerated contents at the upper part. *Pileipellis* an (ixo-)lattice, $40\text{--}70 \mu\text{m}$ thick, suprapellis and subpellis not clearly differentiated; hyphae strongly gelatinized, not easily separated, those in upper part $3\text{--}5$ (7) μm broad, cylindrical, equal or slightly enlarged towards apex, terminal cells $22\text{--}50 \times 3\text{--}7 \mu\text{m}$, cylindrical, clavate, ellipsoid, hyphae in lower part $5\text{--}15 \mu\text{m}$ broad, often inflated to ellipsoid or pyriform, more gelatinized. *Stipitipellis* a cutis, $30\text{--}50 \mu\text{m}$ thick, of closely packed hyphae; hyphae $2\text{--}5 \mu\text{m}$ broad, slightly gelatinized and thick-walled. *Lactifers* colorless to yellowish brown. *Trama of pileus and stipe* with typical and numerous rosettes.

Habit, habitat and distribution: 2–4 individuals together, under fagaceous trees or in mixed forests of fagaceous trees and pines, also associated with *Carpinus* (Betulaceae) (GenBank accession AB218105). Central (Hubei Prov.) and eastern (Anhui Prov.) China, Japan, Korea.

Additional specimens examined: CHINA. **Anhui Prov.**: Jinzhai Co., Mazongling forest farm, upstream of Mahong waterfall, N $31^{\circ}17'32.606''$ E $115^{\circ}40'56.668''$, 986 m a.s.l., in mixed forest of *Pinus taiwanensis* and fagaceous trees, 21 September 2017, coll. Y.J. Hao, no. 1622 (HKAS 104199, KUN); Jinzhai Co., Mazongling forest farm, forest to Tiantangzhai, in mixed forest dominated by *P. taiwanensis* and *Castanea seguinii*, 24 July 2017, coll. Y.J. Hao, no. 1706 (HKAS 104201, KUN). **Hubei Prov.**: Shennongjia Forestry District, Shengnongjia, near Shennong villa, 1800–1900 m a.s.l., 13 July 2012, coll. Q. Cai, no. 766 (HKAS 75521, KUN).

Notes: This is a relative of Asian *L. ambiguus* X.H. Wang and *L. inconspicuus* H.T. Le & F. Hampe. All three share yellowish brown subgreasy pileus with gelatinized hyphae in the pileipellis (Wisistrassameewong *et al.* 2015; Wang 2018; observation on Chinese specimens of *L. inconspicuus*). The pileus of *L. ambiguus* often has an olivaceous tinge, which has not been observed in the other two species. The pileus of *L. conglutinatus* is paler than that of *L. inconspicuus* and the spores are more ellipsoid. The yellowing discoloration of the milk in *L. inconspicuus* is not found in *L. conglutinatus*. *Lactarius cinnamomeus* W.F. Chiu (= *L. kesiyae* Verbeken & K. Hyde) is another similar species with (sub)greasy pileus and grayish orange stipe. Its pileus invariably has a grayish green tinge and the spore ornamentation is more reticulate (Wang 2007; Wisistrassameewong *et al.* 2015).

74. *Lactarius fulvihirtipes* X.H. Wang, sp. nov.

Figs 5, 9c

Mycobank: MB 828930

GenBank: MK253489–MK253493 (ITS)

Systematic position: Basidiomycota, Agaricomycetes, Russulales, Russulaceae.

Etymology: fulvi- = yellow, -hirtipes refers to the morphological similarity to *L. hirtipes* but with yellow tinge as dominant color.

Diagnosis: Differing from *L. hirtipes* in having yellowish tinge as the dominant color of the basidiomata, bigger spores and subdistant lamellae; distinct from *L. alpinihirtipes* by the dominant yellow color of the fruiting bodies.

Holotype: CHINA. **Hubei Prov.**: Shengnongjia Forestry District, Muyu, near Shennongjia skiing park, N $31^{\circ}34'55''$ E $110^{\circ}22'39''$, 1800–1900 m a.s.l., 12 July 2012, coll. Q. Cai, no. 743 (HKAS 75498, KUN!).

Basidiomata small to medium sized, slender. *Pileus* 15–40 mm in diam., at first convex with a pointed papilla, becoming aplano-convex with a depressed center when mature; surface slightly greasy when wet, hygrophanous, transparently sulcate when wet and fully mature, margin often crenulate, dull yellow, brownish orange (5C6), brownish yellow (5C7–5C8), uniformly colored. *Context* 1 mm thick, paler than or nearly concolorous with lamellae. *Lamellae* 1–2 mm broad, decurrent, medium distant, nearly concolorous with the pileus (5C6). *Stipe* 40–80 × 5–6 mm, cylindrical, hollow, gradually enlarged towards base; surface dry, smooth, concolorous with the pileus or more orange in the upper part, grayish orange, reddish brown or more brownish in the lower part; base often stribose with cream-colored, reddish brown or brownish orange hairs. *Latex* white, watery, neither discoloring nor staining. *Odor* none. *Spore print* not obtained.

Basidiospores (80/4/3) (7.0) 7.5–8.6–9.5 (10.5) × (6.5) 7.0–7.7–8.5 (9.0) µm [Q = (1.02) 1.04–1.20 (1.29), Q = 1.12 ± 0.05] [holotype (40/1/1): (7.5) 8.0–8.9–9.5 (10.5) × (7.0) 7.5–7.9–8.5 (9.0) µm, Q = (1.03) 1.06–1.19 (1.29), Q = 1.13 ± 0.05], subglobose, broadly ellipsoid; ornamentation 0.3–1.3 (1.5) µm high, of medium broad ridges, connected to form a broken reticulum, with numerous

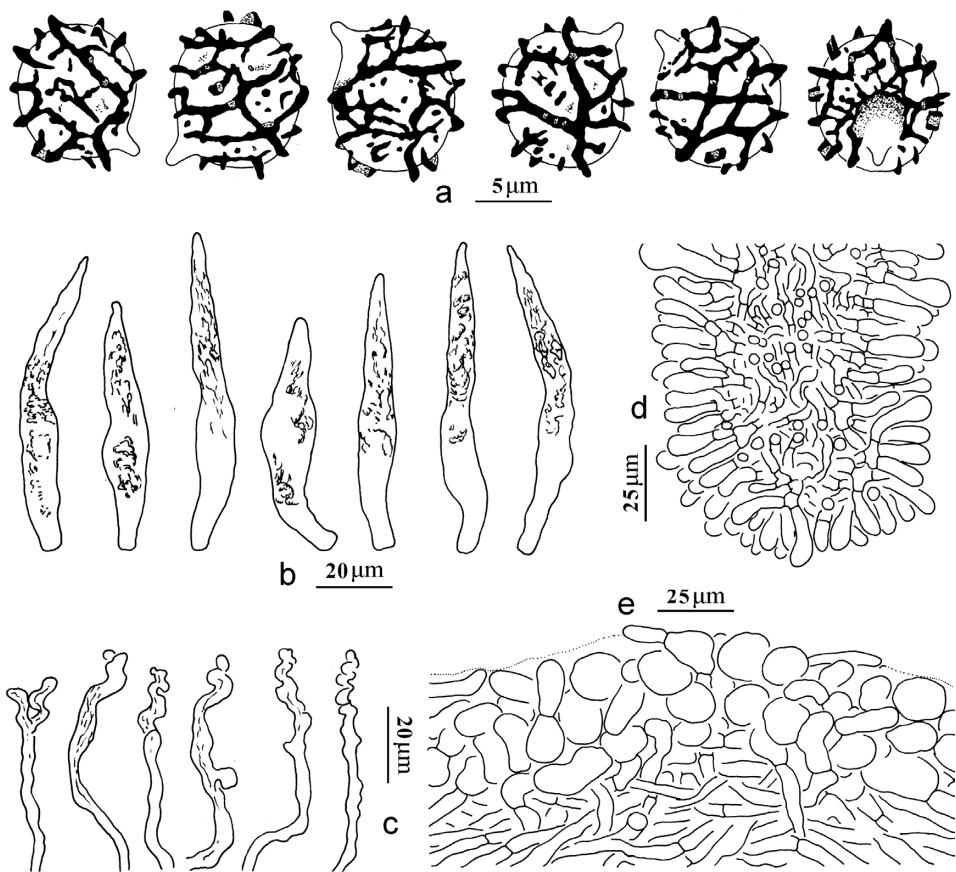


Fig. 5. *Lactarius fulvihirtipes* (HKAS 75498, holotype). a. Basidiospores. b. Pleuromacrocystidia. c. Hymenophoral pseudocystidia. d. Lamella edge. e. Pileipellis.

subtransparent dots, free ends of ridges and isolated warts common; plage distally amyloid, rarely inamyloid. *Basidia* 4-spored, 35–55 × 11–15 µm, clavate. *Pleuromacrocystidia* scattered to common, subfusiform, 50–80 × 7–10 µm, with agglomerated or granular strongly refractive contents. *Hymenophoral pseudocystidia* common, 3–5 µm broad, often tortuous and deformed at the apex, or with knob-like protrusion, with strongly refractive crystalline contents. *Lamella edge* sterile; marginal cells 8–20 × 4–8 µm, similar to basidioles in shape, clavate, cylindrical; cheilomacrocystidia absent. *Pileipellis* an (ixo-) epithelium-hyphoepithelium, locally with very thin slimy layer, 40–50 µm thick; terminal cells of suprapellis 14–50 × 3–6 µm, repent, cylindrical, filiform, when ellipsoid 12–18 × 7–9 µm; cells of subpellis 10–30 (40) µm in diam., globose, ellipsoid; hyphae beneath pileipellis 4–6 µm broad. *Stipitipellis* a cutis, of closely packed, predominantly longitudinally arranged hyphae; hyphae (3) 4–10 µm broad, often inflated to ventricose, yellowish brown, wall 0.5 µm thick. *Lactifers* scattered, colorless. *Trama of pileus* occasionally with rosettes, *stipe trama* lacking rosettes.

Habit, habitat and distribution: 1–3 individuals together, under fagaceous trees or in mixed forests of fagaceous trees and pines, associated with *Quercus* trees (GenBank accession KY684470) and *Pyrola morrisonensis* (Ericaceae, see Matsuda *et al.* 2017). Central (Shaanxi, Hubei Prov.) and southeastern (Taiwan Prov.) China.

Additional specimens examined: CHINA. **Hubei Prov.**: Fang Co., Yerengu, Xihaoping, Xiping, in mixed forest of *Pinus massoniana* and fagaceous trees, 31 July 2011, coll. X.H. Wang, no. 2935 (HKAS 73495, KUN); Shennongjia Forestry District, Muyu, Shuangyanwu, 1800 m a.s.l., under fagaceous trees, 16 July 2012, coll. X.B. Liu, no. 93 (HKAS 75705, KUN). **Shaanxi Prov.**: Langao Co., Nangong Mt., under fagaceous trees, 29 July 2011, coll. X.H. Wang, no. 2928 (HKAS 73489, KUN).

Notes: This new species looks like a yellowish form of *L. hirtipes* J.Z. Ying or *L. alpinihirtipes* X.H. Wang. The three species share slender fruiting bodies, spores with reticulate ornamentation, pileipellis a hyphoepithelium and absence of cheilomacrocytidia. The spore size of *L. fulvihirtipes* and shape are comparable with those of *L. alpinihirtipes* (Wang 2017) and bigger and more ellipsoid than those of *L. hirtipes*. The lamellae of *L. fulvihirtipes* and *L. alpinihirtipes* approach distant. These three species can be further distinguished from European *L. atlanticus* Bon, East Asian *L. subatlanticus* (described below) and Chinese *L. subhirtipes* X.H. Wang by the presence of macrocystidia (Ying 1991; Basso 1998; Wang 2007; Triantafyllou *et al.* 2015; Wang *et al.* 2018). “*Lactrius hirtipes*” found on the root tips of *Pyrola morrisonensis* in Taiwan island by Matsuda *et al.* (2017) is actually this species.

75. *Lactarius marasmoides* X.H. Wang, sp. nov.

Figs 6, 9d

Mycobank: MB 828931

GenBank: MK253494–MK253496 (ITS)

Systematic position: Basidiomycota, Agaricomycetes, Russulales, Russulaceae.

Etymology: marasmoides = *Marasmius*-like, referring to the small, thin-fleshed ochraceous brown basidiomata with a marasmoid appearance.

Diagnosis: Recognized by the small fruiting bodies, small globose spores, inconspicuous small hymenophoral macrocystidia and robust hyphae in outmost layer of the pileipellis.

Holotype: CHINA. **Yunnan Prov.**: Jinghong, Xishuangbanna nature reserve, Jinuo Mt., 9 July 2006, coll. X.H. Wang, no. 1985 (HKAS 51465, KUN!).

Basidiomata small. *Pileus* 8–15 mm in diam., at first applano-convex, often with a papilla, later applanate to concave-applanate with a distinct papilla, faintly transluscently striate towards the margin; surface dry, smooth, hygrophanous, brownish orange (5C6–5C6), grayish orange (5B5, 5B5–6B5, 5B5–5C6), center brown (6E8). *Lamellae* 1 mm broad, medium crowded to crowded, straight, adnate to short decurrent, grayish orange (5B5), brownish orange (5C6) to light brown (6D6). *Context* very thin, concolorus with lamellae. *Stipe* 6–10 × 1–1.5 mm, central to eccentric, cylindrical, equal, hollow; surface smooth, grayish orange (6B4), light brown (6D5), brown (6E7), with white mycelium at the base. *Latex* abundant, white, unchanging or turning to watery, turning into white granules when dry, hot, then slowly becoming mild.

Basidiospores (140/7/4) (5.5) 6.0–6.5–7.0 (7.5) × (5.0) 5.5–5.9–6.5 µm [Q = (1.00) 1.03–1.18 (1.22), Q = 1.10 ± 0.04] [holotype (40/2/1): (5.5) 6.0–6.4–7.0 × (5.5) 6.0–5.9–6.5 µm, Q = 1.04–1.18, Q = 1.10 ± 0.04], globose, subglobose to broadly ellipsoid, rarely ellipsoid; ornamentation 0.5–1.0 (1.2) µm high, of clear and clean ridges, connected to form an incomplete reticulum, locally aligned in a zebroid

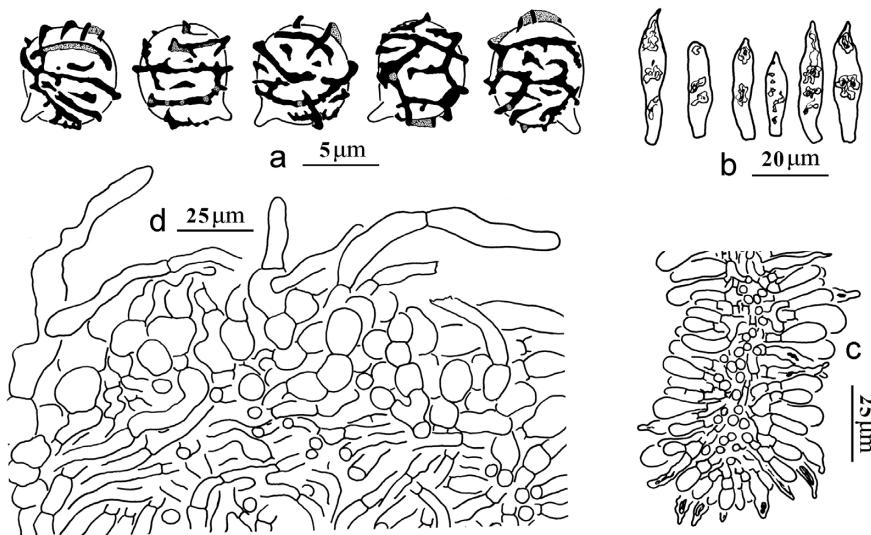


Fig. 6. *Lactarius marasmoides* (HKAS 51465, holotype). **a.** Basidiospores. **b.** Pleuromacrocystidia. **c.** Lamella edge. **d.** Pileipellis.

pattern, free ends of ridges and isolated warts common, occasionally with isolated ridges, plage inamyloid, rarely distally amyloid. *Basidia* 4-spored, $30\text{--}35 \times 9\text{--}13 \mu\text{m}$, clavate. *Pleuromacrocystidia* common, abundant near lamellar edge, embedded in basidia layer, inconspicuous, $20\text{--}35 \times 5\text{--}8 \mu\text{m}$, fusiform, subcylindrical, sublanceolate, with strongly refractive agglomerated contents, often constricted to moniliform at the apex. *Hymenophoral pseudocystidia* uncommon to common, rarely forking, $3 \mu\text{m}$ broad, sometimes enlarged at the tips, with granular contents, colorless. *Lamella edge* sterile; cheilomacrocystidia numerous, $15\text{--}30 \times 4\text{--}7 \mu\text{m}$, fusiform with an acute or moniliform apex, with strongly refractive agglomerated contents; marginal cells $6\text{--}20 \times 6\text{--}10 \mu\text{m}$, ellipsoid, clavate. *Pileipellis* a hyphoepithelium, $40\text{--}50 \mu\text{m}$ thick; hyphae of suprapellis broad, conspicuous, total length up to $150 \mu\text{m}$, terminal cells $30\text{--}70 \times (4) 5\text{--}10 (13) \mu\text{m}$, cylindrical, some fusiform, often enlarged at the apex; hyphae of subpellis globose, subglobose, $10\text{--}40 \times 10\text{--}25 \mu\text{m}$. *Stipitipellis* a cutis, of hyphae loosely interwoven, with some hyphal ends projecting outwards; terminal cells $20\text{--}70 \times 4\text{--}8 \mu\text{m}$, cylindrical, ventricose. *Lactifers* nearly colorless, fewer in lamellar trama, common in trama of pileus and stipe. *Trama of pileus and stipe* with numerous rosettes.

Habit, habitat and distribution: in group, in fagaceous forests or mixed forests of fagaceous trees and pines. Tropical zone of Yunnan, China.

Additional specimens examined: CHINA. **Yunnan Prov.:** Mengla Co., Xishuangbanna nature reserve, old road from Menglun to Mengyang, near 53 km mark, 29 October 2002, coll. X.H. Wang, no. 1460 (HKAS 41792, KUN); Puer, roadside from Puer to Ninger, 10 km to Puer, 1500 m a.s.l., in mixed forest of fagaceous trees and *P. kesiya* var. *langbianensis*, 5 July 2012, coll. X.H. Wang, no. 3445 (HKAS 76003, KUN); Puer, near Xinfang reservoir, 1300 m a.s.l., in mixed forest of fagaceous trees and *P. kesiya* var. *langbianensis*, 6 July 2012, coll. X.H. Wang, no. 3475 (HKAS 76024, KUN).

Notes: This species can be recognized by the small fruiting bodies, small globose spores and inconspicuous macrocystidia. The robust hyphae in the outmost layer of the pileipellis are very remarkable. In this respect and because of the subreticulate spores, it resembles *L. albidigalus* and *L. austrostratus*. The latter two invariably have much bigger pleuromacrocystidia, bigger and longer spores and bigger fruiting bodies (pileus 2.5–5 cm in diam.) (Wisitrassameewong *et al.* 2015; notes under *L. albidigalus*). Species with extremely small fruiting bodies include European *L. omphaliformis* Romagn. and *L. cyathuliformis* Bon and Asian *L. castanopsis* Hongo, *L. inamyloideus* Verbeken & E. Horak, *L. liliputianus* Verbeken & E. Horak, *L. crenulatulus* Wisitrassameewong & Verbeken and *L. perparvus* Wisitrassameewong & F. Hampe. These species either lack long, robust hyphae in the suprapellis of pileipellis (all but *L. liliputianus*) or have spores with totally different ornamentation (Hongo 1979; Heilmann-Clausen *et al.* 1998; Verbeken & Horak 2000; Wisitrassameewong *et al.* 2014).

76. *Lactarius neglectus* X.H. Wang, sp. nov.

Figs 7, 9e

Mycobank: MB 828932

GenBank: MK253506–MK253510 (ITS)

Systematic position: Basidiomycota, Agaricomycetes, Russulales, Russulaceae.

Etymology: referring to the small fruiting bodies, half-buried in humus, that are easily missed in the field.

Diagnosis: Recognized by the small delicate fruiting bodies, areolate-rimose pileus with striate margin, big broadly ellipsoid spores with a nearly complete reticulum, very few macrocystidia and pileipellis a cutis-epithelium with variably inflated cells.

Holotype: CHINA. Yunnan Prov.: Maguan Co., Renhe, Gesa, N 23°00'23.7" E 104°17'12.5", 1615 m a.s.l., under fagaceous trees, 13 October 2017, coll. X.H. Wang, no. 4776 (HKAS 104192, KUN!).

Basidiomata small, delicate, slender, mycenoid. Pileus 12–25 mm, at first subconvex with a conical papilla, with age becoming concave with margin irregularly waving-sinuous, transparently sulcate, margin crenate; surface dry, finely areolate-rimose, hygrophanous, light brown (5D6), brownish orange to yellowish brown (5C5–5D5), much darker at the center, paler when dry. Context very thin (< 0.5 mm), paler than lamellae. Lamellae 2 mm broad, narrowly adnate to adnate, rather distant (10–12 L/cm), cream-colored when young, pale yellow to grayish yellow (4A4–4B4) when mature, becoming orange brown when bruised. Stipe 20–35 × 1–3 mm, gradually enlarged downwards, hollow; surface dry, smooth, orange ochraceous, ochraceous brown, brown (7E7); base strigose with whitish to cream-colored hairs. *Latex* watery, neither discoloring nor staining, mild. *Spore print* white.

Basidiospores (100/5/4) 7.5–8.3–9.0 (10.0) × 6.5–7.2–7.5 (8.0) µm [Q = (1.03) 1.09–1.22 (1.28), Q = 1.16 ± 0.04] [holotype (40/1/1): 7.5–8.4–9.0 (9.5) × 6.5–7.3–7.5 (8.0) µm, Q = (1.03) 1.09–1.21 (1.28), Q = 1.15 ± 0.04], broadly ellipsoid to ellipsoid; ornamentation 0.5–1.3 (1.5) mm high, of medium acute ridges, connected to form a reticulum, isolated warts and free ends common; plage often distally amyloid, rarely inamyloid. *Basidia* 4-spored, 35–45 × 9–13 µm, clavate. *Pleuromacrocystidia* absent to rather rare, or only present at the lower side of the cap between the lamellae, emergent, projecting up to 50 µm beyond the basidia layer, 58–80 × 8–12 µm, subfusiform, subcylindrical, with sparse to strongly refractive contents. *Hymenophoral pseudocystidia* rare, embedded in basidia layer, 2–4 µm broad, filamentous, with refractive contents. *Lamella edge* sterile; marginal

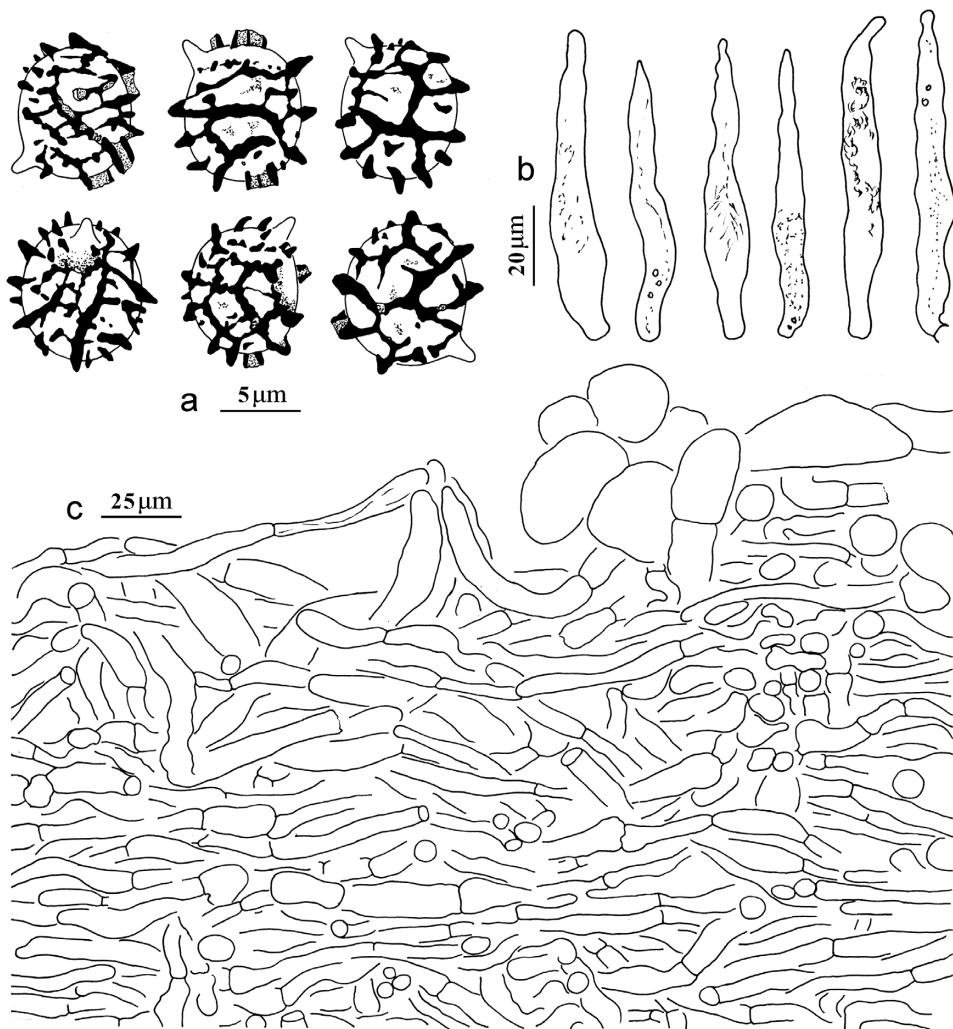


Fig. 7. *Lactarius neglectus* (HKAS 104192, holotype). a. Basidiospores. b. Pleuromacrocystidia and macrocystidia on the low side of the cap between lamellae. c. Pileipellis.

cells 7–25 (30) × 4–8 (10) μm , similar to basidioles in shape, clavate, cylindrical, occasionally capitate; cheilomacrocystidia absent. *Pileipellis* an irregular cutis, locally an epithelium with ellipsoid, subglobose and globose cells, 50–120 μm thick, yellowish brown; hyphae of the cutis 7–15 μm broad, inflated cells of the epithelium 15–50 × 15–35 μm . *Stipitipellis* a cutis, of closely packed, predominantly longitudinally arranged hyphae, yellowish brown; hyphae (3) 4–20 μm broad, often inflated to ventricose, wall 0.5–1.0 μm thick, yellowish brown. *Lactifers* pale yellowish brown, scattered. *Trama of pileus and stipe* lacking rosettes, at most with very few sphaerocysts in the inner cortex of stipe.

Habit, habitat and distribution: solitary or growing with 1–3 individuals, in fagaceous forests or mixed forests of fagaceous trees and pines. Southwestern China (Guizhou, Yunnan Prov.), Japan (see Miyamoto *et al.* 2015) and Korea.

Additional specimens examined: CHINA. **Guizhou Prov.**: Leishan Co., Leigong Mt. nature reserve, near Fairy Pool, N 26°22'21.04" E 108°11'51.08", 1566 m a.s.l., in mixed forest of fagaceous trees and *Pinus massoniana*, 23 June 2017, coll. X.H. Wang, no. 4220 (HKAS 104194, KUN). **Yunnan Prov.**: Luquan Co., Tuanjie, Xinalao, N 25°52'28.69" E 102°32'56.59", 2440 m a.s.l., 29 July 2017, coll. S.F. Shi, no. 113 (HKAS 104193, KUN); Maguan Co., Renhe, Gesa, N 23°00'22.06" E 104°17'12.07", 1595 m a.s.l., 15 October 2017, coll. X.H. Wang, no. 4799 (HKAS 104195, KUN), no. 4800 (HKAS 104196, KUN).

Notes: The small stature, the sulcate pileus with crenulate margin and rather distant lamellae of this new species are reminiscent of Thai *L. crenulatus* and *L. perparvus*. Areolate-rimose pileus cuticle is not reported for those two species (Wisitrassameewong *et al.* 2015). In addition, *L. perparvus* has more frequent macrocystidia and the pileipellis seems to have less inflated cells. The spores with a complete and dense reticulum and pileipellis a typical continuous epithelium of *L. crenulatus* are good characters to distinguish it from *L. neglectus*. For more notes, see under *L. subgracilis*.

77. *Lactarius qinlingensis* X.H. Wang, sp. nov.

Figs 8, 9f

Mycobank: MB 828945

GenBank: MK253511–MK253513 (ITS)

Systematic position: Basidiomycota, Agaricomycetes, Russulales, Russulaceae.

Etymology: *qinlingensis* refers to the area where the Chinese specimens were collected: Qinling Mts., a series of big mountains separating temperate and subtropical China.

Diagnosis: Recognized by the dull brown areolate-rimose pileus, subglobose spores with sub-transparent wings, short ridges and high warts, small pleuromacrocystidia embedded in basidia layer and absence of rosettes in pileus and stipe trama.

Holotype: CHINA. **Henan Prov.**: Luanchuan Co., Laojun Mt., Zhuimenggu trail, 1020 m a.s.l., under *Quercus* sp., 12 August 2015, coll. X.H. Wang, no. 3638 (HKAS 89912, KUN!).

Basidiomata small to medium-sized, slender. *Pileus* 15–35 mm diam., at first slightly convex to applanate, then becoming ± depressed, often with a persistent conical papilla; surface dry, strongly hygrophanous, areolate-rimose, color when young or wet blackish brown or dark brown, when dry or mature reddish brown, brown, ochraceous brown, very rarely with olivaceous tinge. *Context* 0.5–1 mm thick, cream-colored or subconcolorous with the lamellae. *Lamellae* 1–4 mm broad, medium crowded to rather distant, decurrent, sometimes forking, cream-colored when young, later light yellow (4A4), grayish yellow (4B4–4B5), pale reddish brown. *Stipe* 25–70 × 3–5 mm, equal, hollow; surface very smooth, orange brown, cinnamomeus brown, reddish brown, brown, sometimes with concolorous hairs or tomentum at the base. *Latex* watery, unchanging and not staining. *Spore print* pale ochraceous.

Spores (80/4/3) (5.5) 6.5–7.3–8.0 (8.5) × (5.5) 6.5–6.9–7.5 µm [Q = 1.00–1.13 (1.16), Q = 1.06 ± 0.04] [holotype: (6.5) 7.0–7.4–8.0 × (6.0) 6.5–7.0–7.5 µm, Q = (1.00) 1.03–1.10 (1.14), Q = 1.06 ± 0.03], subglobose, rarely broadly ellipsoid; ornamentation 1.0–1.5 mm high, composed of medium dense to dense irregular sub-

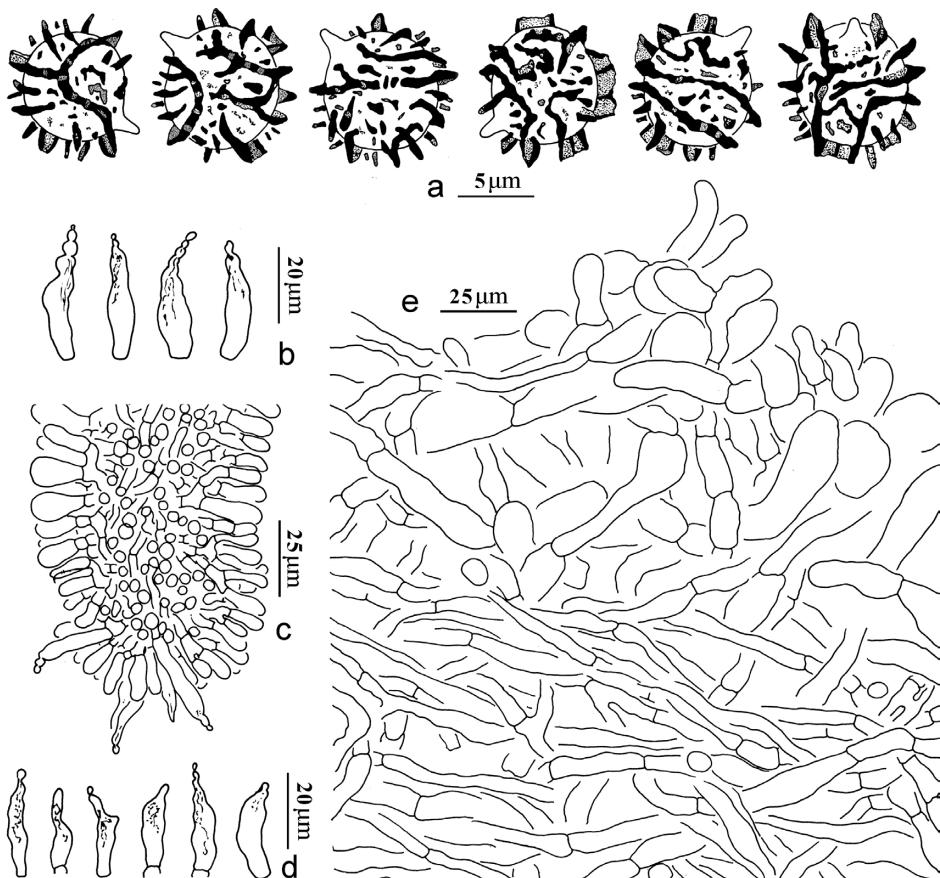


Fig. 8. *Lactarius qinlingensis* (HKAS 89912, holotype). a. Basidiospores. b. Pleuromacrocystidia. c. Lamella edge. d. Cheilomacrocystidia. e. Pileipellis.

transparent ridges variable in size, rarely branched, often arranged in a spiral or zebroid pattern, never forming closed meshes, with numerous sub-transparent dots between ridges; plage inamyloid, rarely distally amyloid. Basidia 4-spored, 33–45 × 10–13 μm , clavate. Pleuromacrocystidia rare, negligible, base originating from the same depth as basidia, often only present near lamella edge, 25–35 × 5–7 μm , subfusiform, with a moniliform apex, with very sparse contents at the apex. Hymenophoral pseudocystidia rare to common, 2–5 μm broad, filiform, equal, with refractive contents. Lamella edge sterile, composed of basidioles-like marginal cells and cheilomacrocystidia; marginal cells 8–30 × 4–11 μm , clavate, ellipsoid, cylindrical; cheilomacrocystidia numerous, 20–35 × 5–8 μm , fusiform, with a mucronate or moniliform apex, with granular contents. Pileipellis an incontinuous epithelium or hyphoepithelium, more an cutis between piles of round cells when mature, 50–120 μm thick; cells of suprapellis inflated to 25 μm , globose, ellipsoid, hyphoid, yellowish brown; repent hyphae of the cutis hyphoid, rarely ellipsoid or sausage-shape, 6–15 (20) μm broad, yellowish brown; hyphae of subpellis 5–12 μm broad, colorless. Stipitipellis a cutis; of closely packed, predominantly longitudinally



Fig. 9. Basidiomata. **a.** *Lactarius asiae-orientalis* (HKAS 104198). **b.** *L. conglutinatus* (HKAS 104200, holotype). **c.** *L. fulvihirtipes* (HKAS 73495). **d.** *L. marasmioides* (HKAS 76024). **e.** *L. neglectus* (HKAS 104193). **f.** *L. qinlingensis* (HKAS 89912, holotype).

arranged hyphae; hyphae 4–15 µm broad, yellowish brown. *Lactifers* rare, colorless or pale yellowish brown. *Trama of pileus and stipe* lacking rosettes.

Habit, habitat and distribution: 1–3 individuals together, under fagaceous trees. Qinling mountains, China (Gansu and Henan Prov.) and Korea.

Additional specimens examined: CHINA. **Gansu Prov.**: Tianshui, Maiji District, Xiaolongshan forest park, Dongcha, Taohuagou, 25 July 2011, coll. X.H. Wang, no. 2911 (HKAS 73474, KUN). **Henan Prov.**: Luanchuan Co., Laojun Mt., Tenglongyu trail, 13 August 2015, 1200–1250 m a.s.l., coll. X.H. Wang, no. 3664 (HKAS 89937, KUN).

Notes: This new species differs from *L. olivaceorimosellus* X.H. Wang *et al.*, a sister species from northeastern China, in the near-absence of olivaceous tinges, more globose spores and fewer pleuromacrocystidia (Shi *et al.* 2018). The two species can be regarded as two geographical populations of the same species complex. Species with areolate-rimose pileus together with the absence of rosettes in stipe cortex seem quite rare in the temperate zone of northern hemisphere, but very diverse in subtropical and tropical Asia. In North America only *L. thiersii* Hesler & A.H. Sm., a species with much bigger reticulate spores belongs to this group (Hesler & Smith 1979). In Asia additional representatives include at least *L. furfuraceus* X.H. Wang, *L. gracilis* Hongo, *L. neglectus*, *L. squamulosus* Z.S. Bi & T.H. Li and *L. subgracilis* described below (Wang 2007; Wang *et al.* 2018). Among these species, *L. qinlingensis* is quite distinct because of the spore ornamentation composed of wings and ridges arranged in a spiral or zebroid pattern. In Asia, such ornamentation is more often found in *L. subg. Plinthogalus* (Le *et al.* 2007; Stubbe *et al.* 2008; Stubbe & Verbeken 2012) and some species of *L. subg. Lactarius* (Heim & Perreau 1973; Verbeken & Horak 1999, 2000).

The ITS sequence KX444365 retrieved from GenBank is from a root tip sample of *Q. liaotungensis*, which confirms that *L. qinlingensis* can be associated with fagaceous trees. This sequence was tentatively named as *L. olivaceorimosellus* by Shi *et al.* (2018).

78. *Lactarius subatlanticus* X.H. Wang, *sp. nov.*

Figs 10, 13a

Mycobank: MB 828947

GenBank: MK253514–MK253518 (ITS)

Systematic position: Basidiomycota, Agaricomycetes, Russulales, Russulaceae.

Etymology: sub- = close to, -atlanticus = referring to the similarity and affinity to *L. atlanticus*.

Diagnosis: A small to medium-sized species with slender brownish orange fruiting bodies, pileipellis a typical hyphoepithelium, small globose spores with a reticulum and absence of macrocystidia. Differing from *L. atlanticus* in the smaller spores.

Holotype: CHINA. **Henan Prov.**: Luanchuan Co., Laojun Mt., Zhuimenggu trail, N 33°44'98.09" E111°38'13.38", 960 m a.s.l., under *Quercus* trees, 12 August 2015, coll. X.H. Wang, no. 3640 (HKAS 89914, KUN!).

Basidiomata small to medium-sized, slender. *Pileus* 15–40 mm, at first slightly convex, then applanate with disc depressed, often with an obtuse to conical papilla; surface dry, glossy when wet, finely rugose, hygrophanous, when young and wet reddish brown, brownish orange to light brown (6D7–6C7), when old and dry grayish orange to brownish orange, darker at the center. *Context* 0.5–1.5 mm thick, paler than or nearly concolorous with lamellae. *Lamellae* 1–3 mm broad, deeply decurrent, crowded, grayish orange, becoming reddish brown when mature. *Stipe*

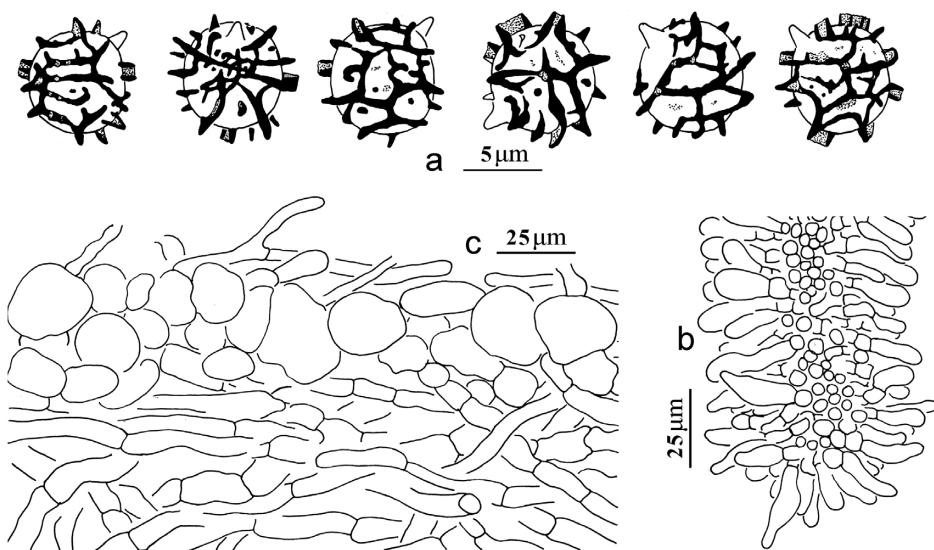


Fig. 10. *Lactarius subatlanticus* (HKAS 89914, holotype). a. Basidiospores. b. Lamella edge. c. Pileipellis.

$30\text{--}70 \times 2\text{--}4$ mm, equal, cylindrical, hollow; surface dry, smooth, reddish brown, orange brown, darker than pileus; base often strigose with long reddish brown to cream-colored hairs. Latex white or whitish watery, becoming watery, neither discoloring nor staining. Odor none. Spore print pale cream-ochraceous.

Basidiospores (100/5/4) (5.5) 6.0–**6.6**–7.0 (8.0) × (5.0) 5.5–**6.2**–6.5 (7.0) μm [$Q = 1.00\text{--}1.11$ (1.17), $Q = 1.06 \pm 0.03$] [holotype (40/2/1): (6.0) 6.5–**6.7**–7.0 (7.5) × (5.5) 6.0–**6.3**–7.0 μm , $Q = (1.00) 1.02\text{--}1.11$ (1.17), $Q = 1.07 \pm 0.03$], subglobose to globose; ornamentation 0.3–1.0 (1.3) μm high, of medium broad ridges, connected to form a nearly complete to complete reticulum, free ends of ridges and isolated warts common; plage not or distally amyloid. *Basidia* 4-spored, (25) 30–40 × 8–14 μm , clavate, cylindrical, subfusiform. *Macrocyphidia* absent. *Hymenophoral pseudocystidia* rare to common, 3–5 μm broad, slightly enlarged at the apex, with strongly refractive contents. *Lamella edge* sterile; marginal cells (6) 10–25 × 5–10 μm , similar to basidioles in shape, clavate, cylindrical, ellipsoid, rarely capitate. *Pileipellis* a hyphoepithelium, 30–60 μm thick, pale yellowish brown; terminal cells of suprapellis 20–60 × 3–6 μm , repent, cylindrical, filiform, yellowish brown; cells of subpellis 12–40 × 10–30 μm , globose, ellipsoid; hyphae beneath pileipellis 6–15 (18) μm broad, often sausage-shaped. *Stipitipellis* a cutis, of closely packed, predominantly longitudinally arranged hyphae; hyphae (3) 5–15 (20) μm broad, often more inflated in the middle part, yellowish brown, wall 0.5–1.0 μm thick. *Lactifers* colorless or yellowish brown, rare. *Trama of pileus and stipe* lacking rosettes.

Habit, habitat and distribution: often several fruiting bodies together, under fagaceous trees. Central (Henan Prov.) and southwestern (Guizhou Prov.) China, Korea.

Additional specimens examined: CHINA. **Guizhou Prov.**: Suiyang Co., Kuankuoshui nature reserve, 25 July 2010, coll. X.H. Wang, no. 2405 (HKAS 61726, KUN). **Henan Prov.**: Luanchuan Co., Laojunshan, Zhumenggu trail, 1000 m a.s.l., 12 August 2015, coll. X.H. Wang, no. 3641 (HKAS 89915, KUN); Neixiang Co., Xiaguan, Taohuayuan, 31 July 2010, coll. X.H. Wang, no. 2438 (HKAS 61750, KUN). **Hubei Prov.**: Shennongjia forestry District, Muyu, Guanmenshan, 14 August 2017, coll. Z.W. Ge, no. 4003 (HKAS 104191, KUN).

Notes: In the field this species can be mistaken for *L. hirtipes*, although the pileus is more orange and the lamellae are more crowded. Like the newly described Chinese *L. subhirtipes* X.H. Wang, *L. subatlanticus* differs from *L. hirtipes* in lacking macrocystidia and having smaller spores. Apparently *L. subhirtipes* and *L. subatlanticus* are more similar to each other and specimens of the two species were collected once in the same locality (Laojun Mt., Henan Prov.). The spores of *L. subatlanticus* are reticulate, whereas those of *L. subhirtipes* have less connected elements, rarely forming closed meshes. The globose reticulate spores together with the absence of macrocystidia suggest European *L. atlanticus*, a species with bigger spores ($6.5\text{--}9 \times 6\text{--}8.5 \mu\text{m}$, Triantafyllou *et al.* 2015). North American *L. subserifluus* is another look-alike, but it has subdistant lamellae (Hesler & Smith 1979).

79. *Lactarius subgracilis* X.H. Wang, sp. nov.

Figs 11, 13b,c

Mycobank: MB 828948

GenBank: MK253498–MK253505 (ITS)

Systematic position: Basidiomycota, Agaricomycetes, Russulales, Russulaceae.

Etymology: sub- = close to, -gracilis = *L. gracilis* referring to the similarity and affinity to *L. gracilis*.

Diagnosis: A species with small to medium-sized slender basidiomata, grayish yellow areolate-rimose pileus with very minute conical hairy protrusion at the margin, spores with an incomplete reticulum, presence of pleuromacrocystidia and absence of rosettes in the pileus and stipe trama.

Holotype: CHINA. **Yunnan Prov.**: Xinping Co., Ailao Mts. nature reserve, Jinshan virgin forest park, N $23^{\circ}56'22''$ E $101^{\circ}30'13''$, 2440 m a.s.l., 13 August 2017, coll. X.H. Wang, no. 4533 (HKAS 101921, KUN!).

Basidiomata small to medium-sized, slender. *Pileus* 15–42 mm, applanate-convex, with a distinct, persistent, conical papilla, becoming shallowly funnel-shaped in age; surface dry, finely areolate-rimose, hygrophanous, when young pale yellow, yellowish white (3A2, 4A2), olive brown (4D5–4E5), when old orange white (5A2), grayish yellow (4B4) to olive brown (4E4), paler when dry; margin ± subtransparantly sulcate, in young individuals often rugulose and forming minute conical hairy protrusion along the rim. *Context* 0.5–1 mm thick, concolorous with the pileus. *Lamellae* 1–4 mm broad, short decurrent to decurrent, crowded ($>18 \text{ L/cm}$), pale yellow (4A3) to light yellow (4A4) when young, grayish orange (5B5) to brownish orange (5C6) when mature, reddish brown when overmature. *Stipe* 20–65 × 1.5–7 mm, gradually enlarged downwards, cylindrical, hollow; surface dry, smooth, pale reddish brown, orange brown, base light brown (6D6–6D7); base strigose with nearly whitish hairs. *Latex* cream-colored, white or milky watery, not discoloring or staining, mild. *Spore print* cream-colored.

Basidiospores (220/11/10) (5.5) 6.5–7.3–8.5 (9.0) × (5.0) 6.0–**6.5**–7.0 (8.0) μm [$Q = (1.00) 1.05\text{--}1.21 (1.28)$, $Q = 1.13 \pm 0.05$] [holotype (40/2/1): 6.5–7.2–8.0 × (5.5) 6.0–**6.5**–7.0 (7.5) μm , $Q = (1.04) 1.06\text{--}1.17 (1.23)$, $Q = 1.12 \pm 0.04$], subglobose to broadly ellipsoid; ornamentation 0.8–1.0 mm high, of medium acute

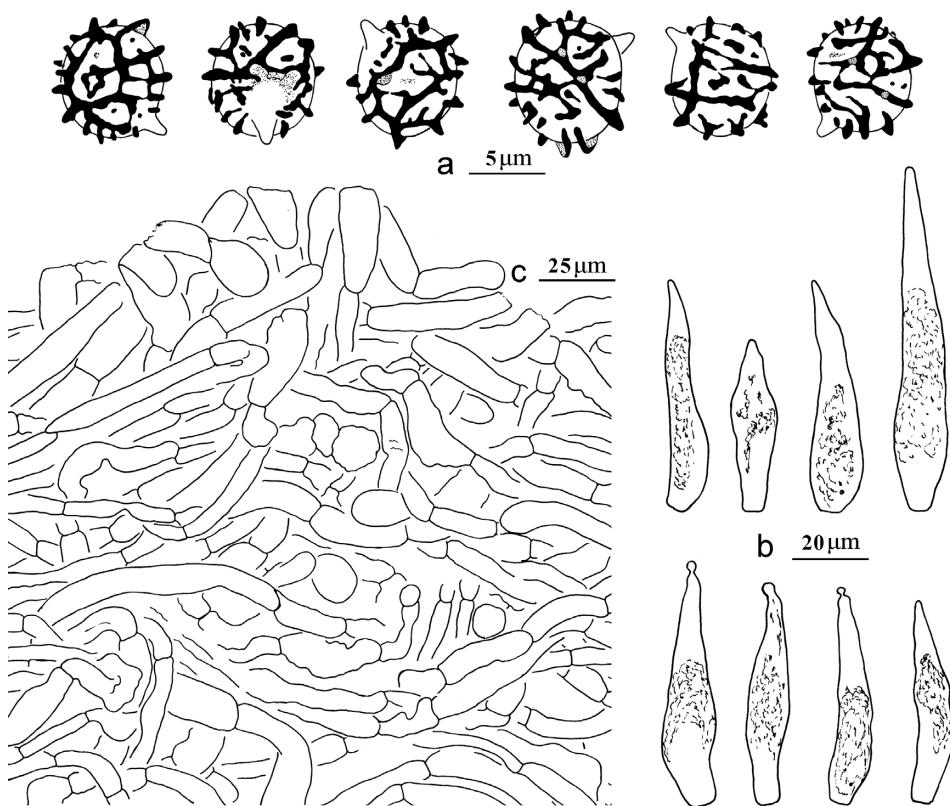


Fig. 11. *Lactarius subgracilis* (HKAS 101921, holotype). **a.** Basidiospores. **b.** Pleuromacrocytidia. **c.** Pileipellis.

ridges and irregular warts connected or connected by thinner lines, often forming closed meshes, occasionally forming a complete reticulum, isolated warts and free ends common; plage distally amyloid, rarely inamyloid. *Basidia* 4-spored, 32–40 (47) × 9–14 μm , clavate. *Pleuromacrocytidia* rare to common, emergent, projecting up to 50 mm beyond the basidia layer, (40) 50–80 (100) × (6) 8–15 μm , fusiform, sublanceolate, rarely sublageniform, some with a moniliform apex, with granular or agglomerated contents. *Hymenophoral pseudocystidia* scattered to common, embedded in hymenium, rarely projecting beyond the basidia layer, 3–5 μm broad, filamentous, rarely forking, with refractive contents. *Lamella edge* sterile; marginal cells 10–20 × 6–10 μm , similar to basidioles in shape, clavate, rarely subfusiform; cheilocyphocystidia absent. *Pileipellis* an irregular cutis, locally an epithelium with piles of ellipsoid, subglobose and globose cells; hyphae of the cutis 7–25 μm broad, cells of the epithelium 10–40 × 10–20 μm , those at the outmost layer pale yellowish brown, others colorless. *Stipitipellis* a cutis; of closely packed, predominantly longitudinally arranged hyphae; hyphae (3) 4–15 μm broad, some inflated to spindle-shaped, slightly thick-walled with wall 0.5–1.0 μm thick, yellowish brown, terminal

cells 20–60 × 4–5 (8) µm. *Lactifers* rare, colorless or pale yellowish brown. *Trama* of pileus and stipe lacking rosettes.

Habit, habitat and distribution: common, in group, in subtropical fagaceous forests. Southwestern China (Guangxi, Guizhou and Yunnan Prov.).

Additional specimens examined: CHINA: **Guangxi Prov.**: Xing'an Co., Maoer Mt. nature reserve, Lijiangyuan, 1970 m a.s.l., 24 July 2012, coll. Q. Zhao, no. 1606 (HKAS 78865, KUN); *ibid*, 24 July 2012, coll. Q. Cai, no. 872 (HKAS 75606, KUN); *ibid*, 24 July 2012, coll. X.B. Liu, no. 147 (HKAS 75759, KUN). **Guizhou Prov.**: Jiangkou Co., Fanjing Mt., coll. X.H. Wang, 12 August 2006, no. 2007 (HKAS 51730, KUN). **Yunnan Prov.**: Jingdong Co., Ailao Mts. nature reserve, Xujiaba, 1450 m a.s.l., 23 July 2000, coll. Q.B. Wang, no. 771 (HKAS 38110); *ibid*, 16 July 2007, coll. Y.C. Li, no. 854 (HKAS 52539, KUN); Lushui Co., roadside from Lushui to Pianma, near 49 km mile mark, 6 August 2011, coll. J. Qin, no. 229 (HKAS 73215, KUN); *ibid*, 6. August 2011, coll. Q. Zhao, no. 1162 (HKAS 74115, KUN); Tengchong Co., Gaoligong Mts. nature reserve, roadside to Lujiangba to Tengchong, milemark 49 km, 9 August 2011, coll. B. Feng, no. 1048 (HKAS 74528, KUN); Xinpingle Co., Ailao Mts. nature reserve, Jinshan Virgin Forest Park, N23°56'22" E101°30'13", 2440 m a.s.l, 13 August 2017, coll. X.H. Wang, no. 4532 (HKAS 101920, KUN).

Notes: This species looks like an intermediate between *L. gracilis* and *L. squamulosus* (= *L. glabrigracilis* Wissitrassameewong & Nuytinck). The minute conical hairy protrusions on the pileus margin are never as prominent as the marginal fascicules of hairs in *L. gracilis*. *Lactarius squamulosus* does not have macrocystidia (Wang 2007). *Lactarius neglectus* described above and *L. furfuraceus* X.H. Wang are another two relatives sharing areolate-rimose pileus, pileipellis a mixed cutis-epithelium and absence of rosettes in the stipe and pileus trama. These two species have relatively bigger spores (av. > 8.0 × 6.5 µm). The assemblage of these species may deserve an infrageneric taxon.

80. *Lactarius tuberculatus* X.H. Wang, sp. nov.

Figs 12, 13d

Mycobank: MB 828949

GenBank: MK253519, MK253520 (ITS)

Systematic position: Basidiomycota, Agaricomycetes, Russulales, Russulaceae.

Etymology: referring to the tuberculate spore ornamentation.

Diagnosis: A small to medium-sized species with slender fruiting bodies, brownish orange pileus, spores with pointed warts, pileipellis a hyphoepithelium, absence of pleuromacrocystidia and numerous cheilomacrocystidia.

Holotype: CHINA. **Guizhou Prov.**: Leishan Co., Leigong Mt. nature reserve, N 26°22'04" E 108°10'11", 1470 m a.s.l., in mixed forest of *Pinus massoniana* and fagaceous trees, 25 June 2017, coll. X.H. Wang, no. 4274 (HKAS 104202, KUN!).

Basidiomata small to medium-sized, slender. *Pileus* 20–40 mm, at first slightly convex, later applanate with depressed disc or concave, with a ± persistent acute papilla, margin when wet subtransparently striate; surface dry, finely rugose, hygrophanous, light brown (6D6), reddish brown (8F7), locally brown (7E6) to dark brown (8F7). *Context* 1–2 mm thick, pale yellowish brown, subconcolorous with pileus beneath the pileus cuticle. *Lamellae* 2–4 mm broad, decurrent, crowded, orange white to grayish orange (6A2–6B3) when young, then grayish orange (5B5, paler than 6C4), brownish orange (6C5), reddish brown when fully mature. *Stipe* 35–70 × 4–7 mm, central to slightly eccentric, cylindrical, equal or slightly enlarged

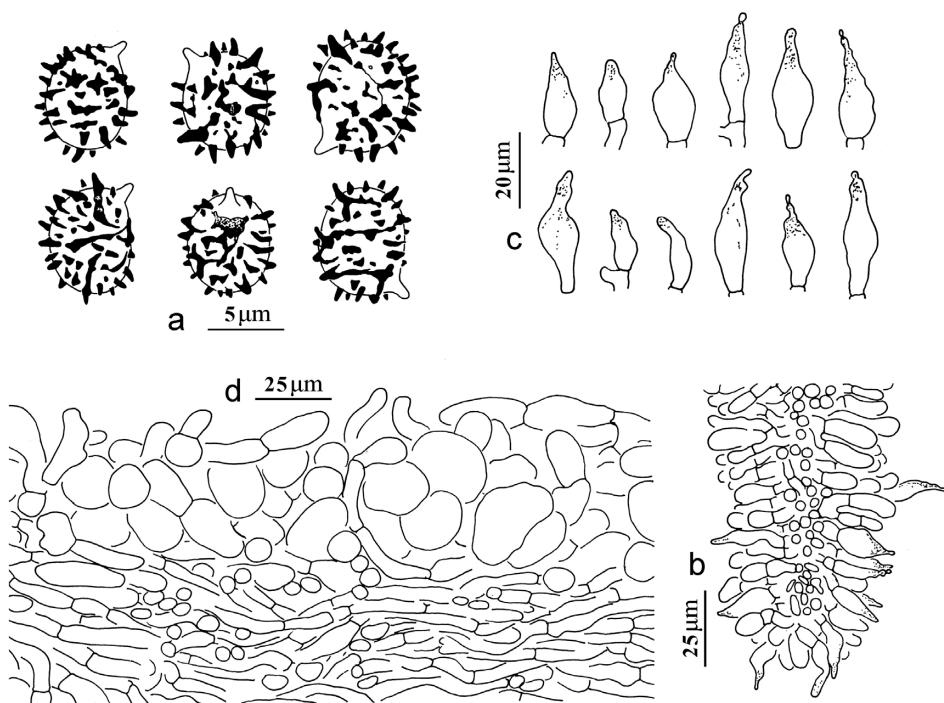


Fig. 12. *Lactarius tuberculatus* (HKAS 104202, holotype). **a.** Basidiospores. **b.** Lamella edge. **c.** Cheilomacrocytidia. **d.** Pileipellis.

or tapering downwards, hollow; surface dry, nearly smooth, when young pale red to pastel red (7A3-7B3) or concolorous with pileus, then light brown (7D5), reddish brown (8E5); base often strigose with ochraceous hairs. Latex white, cream-colored, watery, not discoloring or staining, mild. Odor sweetish, like that of *L. subzonarius*. Spore print pale cream-ochraceous.

Basidiospores (80/4/2) 5.5–**6.4**–7.0 (8.0) × 5.0–**5.4**–6.0 μm [Q = (1.08) 1.10–1.27 (1.30), **Q** = **1.18** ± 0.05] [holotype (40/2/1): 6.0–**6.6**–7.0 (8.0) × 5.0–**5.5**–6.0 μm , Q = (1.08) 1.11–1.26 (1.30), **Q** = **1.19** ± 0.05], ellipsoid, broadly ellipsoid; ornamentation 0.5–1.3 (1.5) μm high, of pointed conical warts and irregularly elongate warts, some of these aligned or connected by fine lines, never forming closed meshes, some arranged in a subzebroid pattern; plage distally amyloid, rarely inamyloid. *Basidia* 4-spored, 35–40 × 8–11 μm , clavate. *Pleuromacrocystidia* absent. *Hymenophoral pseudocystidia* common, 2–4 μm broad, slightly enlarged at the apex, often projecting beyond the basidia layer, with granular contents. *Lamella edge* sterile; marginal cells 8–20 × 5–8 μm , similar to basidioles in shape, clavate, cylindrical, some with a tapering apex; cheilomacrocytidia numerous, 15–32 × 4–11 μm , fusiform, often with a mucronate or moniliform apex, with granular contents in the upper part. *Pileipellis* a hymeno-hypoepithelium, 40–70 μm thick, pale yellowish brown; terminal cells of suprapellis 12–30 (40) × 5–11 μm , erect,



Fig. 13. Basidiomata. **a.** *L. subatlanticus* (HKAS 89914, holotype). **b.** *L. subgracilis* (HKAS 74528). **c.** *L. subgracilis* (HKAS 101921, holotype). **d.** *L. tuberculatus* (HKAS 104202, holotype).

repent, cylindrical, ellipsoid, subclavate, rarely subfusiform; cells of subpellis 10–40 × 10–25 µm, globose, ellipsoid, rarely hyphoid. *Stipitipellis a cutis*, 30–50 µm thick, of medium to closely packed hyphae, with some hyphal ends projecting outwards, pale yellowish brown; hyphae 3–5 µm broad, terminal cells 20–40 × 3–4 µm. *Lactifers* rare, colorless. *Trama pileus and stipe* with numerous rosettes.

Habit, habitat and distribution: in group, in subtropical fagaceous forests or mixed forest with fagaceous trees and pines. Southwestern China (Guizhou Prov.).

Other specimens examined: CHINA. Guizhou Prov.: Suiyang Co., Kuankuoshui nature reserve, in fagaceous forest, 24 July 2010, coll. X.H. Wang, no. 2398 (HKAS 61364, KUN).

Notes: This is apparently an Asian counterpart of the European *L. camphoratus* (Bull.: Fr.) Fr. Both species share the orange brown to reddish brown basidiomata, sweetish odor, ellipsoid spores with pointed acute warts rarely connected, absence (or very rare if present) of pleuromacrocytidia and numerous cheilomacrocytidia (Heilmann-Clausen *et al.* 1998). The only reliable difference is that *L. tuberculatus* has slightly smaller and narrower spores.

Besides *L. tuberculatus* and *L. camphoratus*, four additional Asian species of *L. subg. Russularia* have a spore ornamentation of isolated warts: *L. atrii* Van de Putte & K. Das, *L. liliputianus*, *L. minimus* var. *macrosporus* Z.S. Bi & G.Y. Zheng,

and newly published *L. verrucosporus* G.S. Wang & L.H. Qiu (Bi *et al.* 1985; Verbeken & Horak 2000; Wang 2007; Wang *et al.* 2018). Except for *L. atrii*, these species all have extremely small fruiting bodies and the warts are more isolated or (and) truncate at the apex. *Lactarius atrii* has a spores ornamentation composed of blunt warts, numerous emergent pleuromacrocystidia and pileipellis an ixocutis (Wisitrassameewong *et al.* 2016).

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