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CONTRIBUTION TO THE KNOWLEDGE OF CHINESE BOLETES. II: *AUREOBOLETUS THIBETANUS* S. L., *NEOBOLETUS BRUNNEISSIMUS*, *PULVEROBOLETUS MACROSPORUS* AND *RETIBOLETUS KAUFFMANII* (PART II)

The first part (Part I) of the present contribution has been published in the previous issue of this journal (GELARDI, 2017).

Pulveroboletus macrosporus G. Wu & Zhu L. Yang, *Fungal Diversity* 81: 112 (2016)

Macroscopic description (Fig. 5)

Basidiomes medium.

Pileus 7.0 cm broad, flattened and slightly depressed at centre, indistinctly unevenly shaped, moderately fleshy, soft; margin faintly wavy-lobed, plane, extending beyond the tubes up to 0.5 mm and appendiculate with evanescent remnants of the bright yellow marginal veil; surface matt, dry, very finely tomentose, not cracked; cuticle pinkish-ochraceous (due to the presence of an ocher tomentum on a pinkish ground color) with some scattered pure pinkish glabrous areas; unchangeable on handling or when injured; subcuticular layer pinkish.

Tubes relatively broad and shorter than the thickness of the pileus context (up to 0.5 cm long), depressed around stipe apex and shortly decurrent with a tooth, yellow-olivaceous, turning pale blue when cut.

Pores forming a flat to slightly irregular surface, somewhat wide (up to 1 mm in diam.), simple, roundish to barely angular, with dispersed small, bright yellow velar patches attached at pore mouths, concolorous with the tubes but with a suffused pinkish hue and bruising pale blue when injured.

Stipe 6.8 × 1.5 cm, as long as the pileus diameter, central, solid, firm, dry, straight, cylindrical but slightly tapering towards the base, not rooting; surface smooth, with much delicate velar remnants forming an ephemeral, inconspicuous annulus; evenly bright yellow, deeper towards the base but with pinkish hues at apex; unchangeable when pressed; basal mycelium whitish.

Context soft textured in the pileus (up to 1.3 cm thick in the central zone), a little more fibrous in the stipe, whitish in the pileus, pale yellowish in the upper part of the stipe but gradually brighter downwards; turning light blue above the tubes, in the connection zone between pileus and stipe and erratically in the upper half of the stipe when exposed to air and then fading to drab whitish, unchangeable towards the base; subhymenophoral layer whitish.

Odor indistinct.

Taste mild.

Spore print not obtained.

Macrochemical reactions 10% KOH: staining chrome yellow on pileus, pale brown on hymenophore, orange on stipe, none to pale pinkish on context.

Edibility unknown.

Microscopic description (Plate 4)

Basidiospores [34/1/1] (8.8)10.5 ± 0.75(12.0) × (4.8)5.6 ± 0.32(6.2) μm, Q = (1.66)1.67-2.00(2.03), Qm = 1.85 ± 0.09, V = 178 ± 29 μm³, inequilateral, ellipsoid, broadly ellipsoid to ovoid



Fig. 5. *Pulveroboletus macrosporus* in habitat (MG472).

Photo by Matteo Gelardi

in side view, broadly ellipsoid to ovoid in face view, smooth, with a short apiculus and without suprahilar depression, apex rounded, moderately thick-walled (0.3-0.6 μm), straw yellow in water and 5% KOH, having one, two or three large oil droplets when mature, rarely pluriguttulate, inamyloid, acyanophilic and with an orthochromatic reaction.

Basidia (27)31-43(47) \times 12-16 μm (n = 12), clavate to broadly clavate, moderately thick-walled (0.5-0.7 μm), predominantly 4-spored but also 2- or 1-spored, usually bearing relatively long sterigmata (3-9 μm), hyaline to pale yellowish and containing straw-yellow oil guttules in water and 5% KOH, bright yellow to yellowish-orange (inamyloid) in Melzer's, without basal clamps; basidioles subcylindrical to clavate, similar in size to basidia.

Cheilocystidia (20)34-97(98) \times 8-15 μm (n = 14), very common, slender, projecting straight to sometimes flexuous, subfusiform to ventricose-fusiform with a long neck or rarely lageniform, with rounded to subacute tip, smooth, moderately thick-walled (0.5-1.0 μm), pale yellowish to straw yellow in water and 5% KOH, bright yellow to yellowish-orange in Melzer's (inamyloid), without epiparietal encrustations.

Pleurocystidia (39)49-81(91) \times 11-15(17) μm (n = 6), decidedly unfrequent, size, shape, color and chemical reactions similar to cheilocystidia.

Pseudocystidia not recorded.

Pileipellis a trichoderm consisting of strongly interwoven, elongated, filamentous, frequently branched hyphae tending to be repent in the outermost layer and not embedded in gelatinous matter; terminal elements 37-120 \times (2)3-10 μm , cylindrical, tapering upwards, apex usually pointed to sometimes rounded, moderately thick-walled (up to 0.8 μm), pale yellow in water, hyaline to very pale yellowish in 5% KOH, yellowish-orange (weakly dextrinoid) in Melzer's, smooth; subterminal elements similar in shape, size and color to terminal elements.

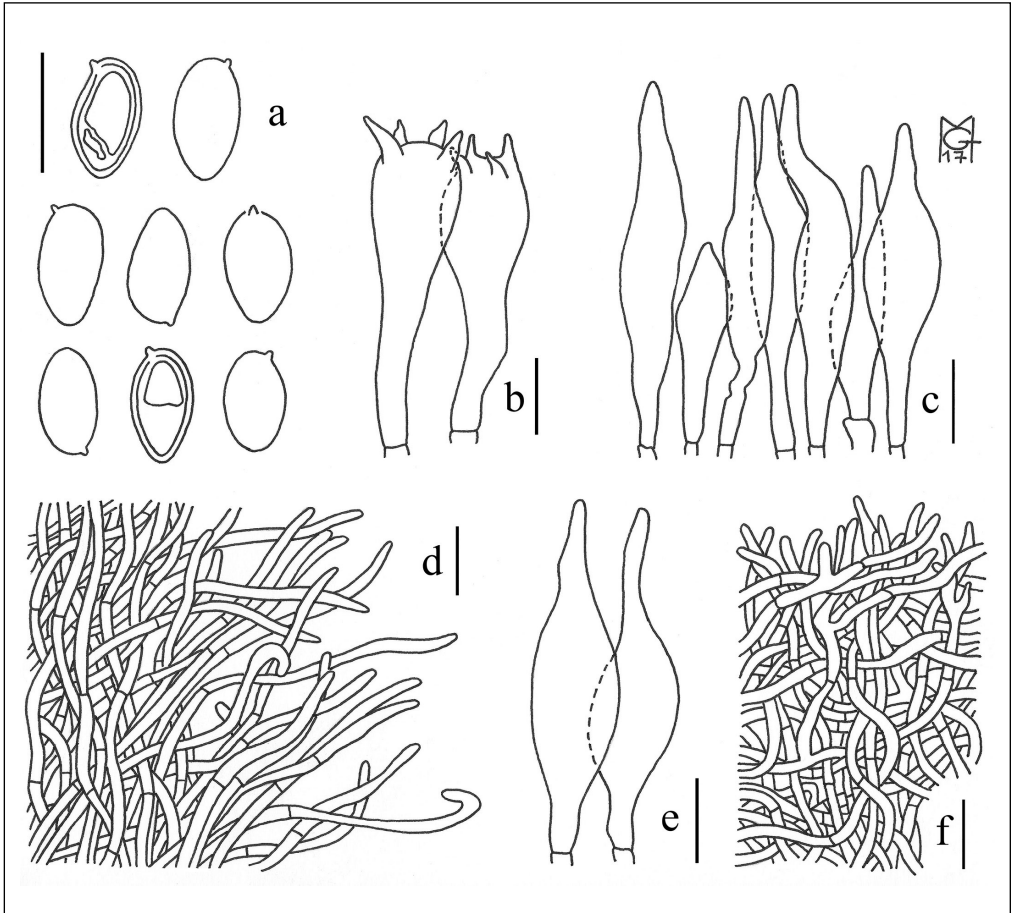


Plate 4. *Pulveroboletus macrosporus*. Microscopic characters (MG472). a. Spores; b. Basidia; c. Cheilocystidia; d. Stipitipellis; e. Pleurocystidia; f. Pileipellis. Scale bars: a-b = 10 μm ; c-f = 20 μm . Drawings by Matteo Gelardi

Velar remnants consisting of strongly interwoven, elongated, filamentous, branched, moderately thick-walled (up to 0.8 μm) hyphae, 2-10 μm wide, hyaline to pale yellowish in water and 5% KOH.

Stipitipellis a texture of slender, parallel to subparallel and longitudinally running, smooth walled, adpressed hyphae, 2-10 μm wide, hyaline to yellowish in water and 5% KOH; the stipe apex covered by a sterile layer of entangled filamentous, frequently branched hyphae 3-8 μm broad, having a wall up to 0.7 μm thick; caulohymenial elements not observed.

Lateral stipe stratum absent although the peripheral layer (40-70 μm inwards from the surface) consists of longitudinally but loosely arranged hyphae, 2-6 μm distant from each other and partially gelified.

Stipe trama composed of strongly interwoven, densely arranged, filamentous, smooth, inamyloid hyphae, 4-25 μm broad.

Hymenophoral trama bilateral divergent of the “*Boletus*-type” with moderately to distinctly divergent, recurved-arcuate and loosely arranged, gelatinous hyphae [lateral strata hyphae

sometimes branched, constricted at septa, in transversal section remaining separate and (2)3-7(10) μm apart, 2-15 μm broad], hyaline to very pale yellowish in water and 5% KOH, inamyloid in Melzer's; lateral strata (20)25-50(60) μm thick, mediostratum (20)30-40 μm thick, axially arranged, consisting of a tightly adpressed, non-gelatinous bundle of hyphae, 2-8 μm broad; in Congo red the mediostratum is darker than the lateral strata.

Oleiferous hyphae not observed.

Clamp connections absent in all tissues.

Hyphal system monomitic.

Ontogenetic development probably hemiangiocarpic or metavelangiocarpic due to the presence of a partial/universal veil.

Ecology: solitary to gregarious in subtropical montane environment, growing in association with *Pinaceae* (*Pinus* sp.) or in mixed woods with *Fagaceae* (*Quercus* sp., *Castanopsis* sp., *Lithocarpus* sp.) on acidic red soil (pH 5.9-6.5) (see LI ET AL., 2013), summer to autumn.

Examined material: China, Yunnan Province, Hengduan mountains, Lijiang, Yufeng Temple, 26°59' 39"N, 100°11'48"E, 2670 m alt., a single mature specimen, in litter in a conifer forest under *Pinus armandii* Franch. with the scattered presence of *P. yunnanensis* Franch. and *Picea likiangensis* (Franch.) E. Pritz.; legit. M. Gelardi, E. Horak, A. Horak, G. Wu, K. Zhao, Q. Zhao and S.- B. Jiao; 14 September 2012, MG472.

Other species found in the same habitat: *Amanita* cf. *aureofloccosa* Bas, *Auriscalpium vulgare* Gray, *Craterellus cornucopioides* (L.) Pers., *Rickenella fibula* (Bull.) Raithehl., *Suillus americanus* f. *sibiricus* (Singer) W. Klofac, *Suillus phylopiectus* R. Zhang, X.F. Shi, P.G. Liu & G.M. Muell., *Suillus* cf. *plorans* (Rolland) Kuntze.

Notes

The genus *Pulveroboletus* s. str. as currently circumscribed based on molecular phylogenetic studies should be restricted to the complex of *P. ravenelii* (Berk. & M.A. Curtis) Murrill (formerly assigned to *Pulveroboletus*, sect. *Flavovelati* Singer, or *Pulveroboletus*, sect. *Pulveroboletus*) (SINGER, 1947, 1986) and comprises a relatively small number of taxa sharing pulverulent and detersile, viscid with moist weather, predominantly bright yellow, universal veil, whitish-yellow context, usually bluing tissues, mild taste, brownish-olive spore print, smooth spores, trichodermal pileipellis consisting of interwoven filamentous hyphae, "Boletus-type" hymenophoral trama, sterile stipeipellis and association with *Fagaceae* and *Pinaceae* (WATLING, 2001; ŠUTARA, 2005; KLOFAC, 2010; ZENG ET AL., 2012, 2017; WU ET AL., 2016b).

Amongst the other species of the same genus, *P. macrosporus* is easily circumscribed on account of the following combination of morphological features: medium-sized basidiomes, young specimens entirely enveloped by a powdery, floccose, bright yellow veil that soon disrupts showing the pinkish-ochraceous to pink pileal color, tubes and pores staining blue on injury, yellow stipe with a delicate cottony ring, context turning light blue in the connection zone between pileus and stipe and comparatively large, broadly ellipsoid basidiospores (up to 7 μm in width!). Concerning the ecological requirements, despite the fact that it can be found in mixed forests, this species is most likely associated only with members of the *Pinaceae*, along with the sympatric but morphologically dissimilar, alpine to sub-alpine species *P. reticulopileus* M. Zang & R.H. Petersen. Geographically, *P. macrosporus* has till now been reported only from south-western China (Yunnan Province) (WU ET AL., 2016b; ZENG ET AL., 2017).

The most similar taxa to *P. macrosporus* are the eastern Asian *P. rubroscabrosus* N.K. Zeng & Zhu L. Yang and *P. subrufus* N.K. Zeng & Zhu L. Yang, both described as new to science in very recent times (ZENG ET AL., 2017). The three species share similar pileal colors,

but *P. rubroscabrosus* is distinguished by the small-sized basidiomes (pileus 2-3 cm diam. and stipe 3-4 × 0.5-0.8 cm), red pileus surface, lower part of the stipe with red to brownish-red floccose scales, context evenly bluing on exposure, narrower basidia (6-9 µm wide), smaller cheilocystidia (22-36 × 4-8 µm) and pleurocystidia (45-55 × 5-6 µm), smaller pileipellis terminal elements (10-25 × 3-5 µm), smaller, subfusiform to ellipsoid basidiospores (9-11 × 4-5 µm, Qm = 2.11), association with *Fagaceae* and occurrence in central China (Hubei Province) and Japan (ZENG ET AL., 2017). *P. subrufus* has a reddish to reddish-brown pileus, context entirely bluing on exposure, smaller basidiospores (8-10 × 4.5-5 µm, Qm = 1.89), narrower basidia (8-11 µm broad), smaller cheilocystidia (22-45 × 4-11 µm) and pleurocystidia (40-60 × 7-10 µm), smaller pileipellis terminal cells (20-46 × 3-5 µm) and an association with *Fagaceae* (ZENG ET AL., 2017).

Pulveroboletus macrosporus, together with several other Asian *Pulveroboletus* species, has long been misidentified in China with the generic type *P. ravenelii* (Berk. & M.A. Curtis) Murrill, originally described from the USA and restricted to the American continent. This latter, however, is separated by an orange-red to brownish-red or cinnamon pileus, usually more prominent and persistent annulus, smaller basidiospores [(7.5)10-11(13.5) × (4)5-5.3(6) µm in SINGER, 1947; 8.5-11.5 × 4-5.5 µm, Qm = 2.06 in PEGLER & YOUNG, 1981; 8-10.5 × 4-5 µm in SMITH & THIERS, 1971 and BESSETTE ET AL., 2000, 2016; (8)9.5-12(14) × (4.5)5-5.5(6.0) µm, Qm = 2.06 in ZENG ET AL., 2017), smaller basidia (24-36 × 10-14 µm), smaller hymenial cystidia (30-47 × 7-12 µm) and the occurrence in North and Central America (BERKELEY & CURTIS, 1853; PECK, 1889; MURRILL, 1909a; COKER & BEERS, 1943; SINGER, 1947; SMITH & THIERS, 1971; GRUND & HARRISON, 1976; BOTH, 1993; BESSETTE ET AL., 2000, 2016; HALLING & MUELLER, 2005; ORTIZ-SANTANA ET AL., 2007; ZENG ET AL., 2017).

It is presently unclear whether this species should be considered toxic or not, as it seems that gastroenteric distress have been repeatedly reported after consumption of "*P. ravenelii*" in China (DENG ET AL., 2005; CHEN ET AL., 2014).

Retiboletus kauffmanii (Lohwag) N.K. Zeng & Zhu L. Yang, *Mycologia* 108 (2): 365 (2016)
≡ *Boletus kauffmanii* Lohwag (as "*kauffmani*"), in Handel-Mazzetti, *Symb. sinica* 2: 57 (1937)
(basionym)

Macroscopic description (Fig. 6-9)

Basidiomes large.

Pileus (2.8)3.9-9.0(13.4) cm broad, at first hemispherical then persistently convex and finally broadly pulvinate-flattened or slightly depressed at centre, regularly to hardly unevenly shaped, decidedly fleshy, firm at the beginning but progressively softer with age; margin steady to distinctly wavy-lobed, initially involute but soon curved downwards and finally plane or in places even uplifted, not or only a little extending beyond the tubes (up to 1 mm); surface matt, dry, very finely velvety to tomentose, not cracked; cuticle somewhat variable in color, evenly dark brownish-olive to bay brown or slightly paler at margin in young specimens, then gradually fading with age and ranging from grayish-ochraceous to ochraceous-yellowish; unchangeable to slowly and almost imperceptibly darkening on handling or when injured; subcuticular layer initially chrome yellow and later yellowish.

Tubes at first very thin then increasingly broader and shorter than the thickness of the pileus context (up to 1.5 cm long), adnate to depressed around the stipe apex and shortly decurrent with a tooth, chrome yellow at first to bright yellow and ochraceous with olive shades at maturity, unchangeable to very slowly and faintly darkening when cut.

Pores forming a concave to flat surface, at first extremely small then gradually wider (up to 1 mm in diam.), simple, roundish to angular at maturity, concolorous with the tubes and very slowly darkening on bruising or when injured.



Fig. 6. *Retiboletus kauffmanii* in habitat (MG437).

Photo by Matteo Gelardi



Fig. 7. *Retiboletus kauffmanii*. Dried specimens (MG437).

Photo by Matteo Gelardi



Fig. 8. *Retiboletus kauffmanii* in habitat (MG473) (topotype).

Photo by Matteo Gelardi



Fig. 9. *Retiboletus kauffmanii* in habitat (MG489).

Photo by Matteo Gelardi

Stipe (5.3)6.5-12.0(12.5) × (1.0)1.3-2.1(3.0) cm, as long as the pileus diameter at maturity, central to slightly off-centre, solid, firm, dry, straight or curved, at first clavate, later cylindrical, swollen or tapered towards the base, sometimes enlarged in the middle part and narrowing towards both the apex and base, not to moderately rooting, evelate; surface showing a conspicuous and coarse reticulum developing throughout the stipe or at least on the upper three fourth, with elongated meshes particularly downwards, concolorous to the ground and slowly darkening spontaneously or when handled, becoming ochraceous to sooty brown; ground color initially chrome yellow then bright yellow and finally ochraceous to grayish-ochraceous, slowly darkening when pressed; basal mycelium chrome yellow to yellow-ochraceous.

Context firm and tough when young, later soft textured in the pileus (up to 3.1 cm thick in the central zone), a little more fibrous in the stipe, evenly lemon yellow but chrome yellow above the tubes in young specimens, later pale yellow in the pileus, sometimes with olive shades in the peripheral areas and above the tubes, yellow-ochraceous to ochraceous-olive in the stipe and progressively deeper downwards; slowly darkening when exposed to air; chrome yellow in the stipe and pale olive-brown in the pileus where eaten by slugs; subhymenophoral layer chrome yellow, yellowish to pale yellow-olive; exsiccate drab ochraceous to sordid brownish-olive.

Odor faint to pronounced, agreeable.

Taste slightly bitterish to bitter.

Spore print not obtained.

Macrochemical reactions 10% KOH: staining pale wine red to brownish on the pileus, pale pinkish on pileus context but wine red to dark reddish-brown on stipe context and hymenophore, reddish-brown to blackish-red on the stipe.

Edibility edible, appreciated and largely traded in local mushroom markets, commonly called the “yellow bolete” (LI & SONG, 2002; WANG *ET AL.*, 2004, as “*B. ornatipes*”; SITTA *ET AL.*, 2007, as “*R. ornatipes*”; DAI *ET AL.*, 2010).

Microscopic description (Plate 5)

Basidiospores [102/3/3] (7.1)10.9 ± 1.40(16.0) × (3.3)4.4 ± 0.53(7.0) μm, Q = (1.82) 1.93-3.07(3.16), Qm = 2.47 ± 0.24, V = 116 ± 49 μm³, inequilateral, cylindrical to fusiform or less frequently ellipsoid-fusiform in side view, ellipsoid-fusiform in face view, apex rounded, smooth, with a short apiculus and with an indistinct to shallow suprahilar depression, thin-walled (0.3-0.5 μm), straw yellow colored in water and 5% KOH, having one, two, three large oil droplets or more frequently pluri-guttulate when mature, inamyloid, strongly cyanophilic and with a very faint metachromatic reaction.

Basidia (25)27-43(48) × 8-10(13) μm (n = 20), subcylindrical, cylindrical-clavate to clavate, moderately thick-walled (0.5-0.9 μm), predominantly 4-spored but also 1-, 2- or 3-spored, usually bearing relatively long sterigmata (2-7 μm), pale yellowish and containing straw-yellow oil guttules in water and 5% KOH, yellowish (inamyloid) in Melzer's, without basal clamps; basidioles subcylindrical to faintly clavate, similar in size to basidia.

Cheilocystidia (38)40-61(64) × 5-10(12) μm (n = 20), very common, moderately slender, projecting straight to sometimes flexuous, irregularly cylindrical, cylindrical-fusiform to fusiform or sublageniform, rarely subclavate or ventricose-fusiform, sometimes showing a narrow and long neck, with rounded to subacute tip, smooth, moderately thick-walled (0.5-0.8 μm), with a bright honey yellow refractive vacuolar pigment in water and 5% KOH that is strongly cyanophilic, ochraceous-yellow (inamyloid) in Melzer's, without epiparietal encrustations.

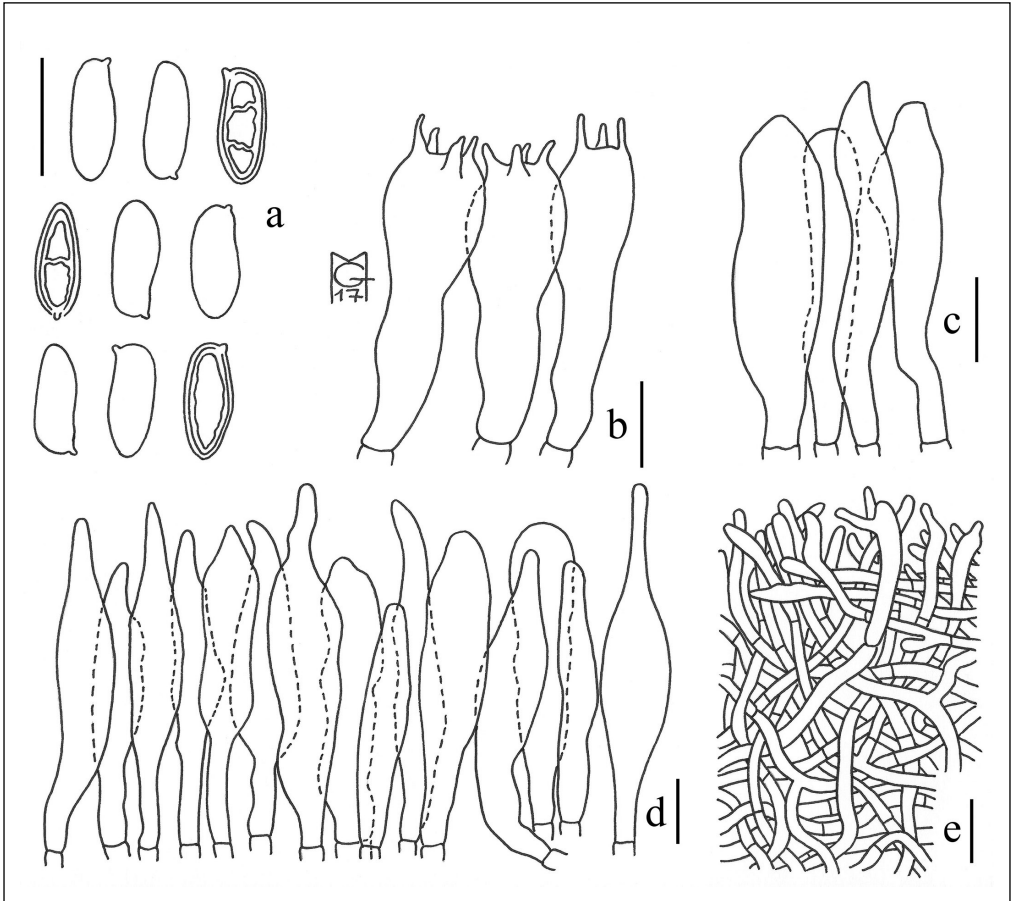


Plate 5. *Retiboletus kauffmanii*. Microscopic characters (MG437, MG473, MG489). **a.** Spores; **b.** Basidia; **c.** Caulocystidia; **d.** Cheilo- and pleurocystidia; **e.** Pileipellis. Scale bars: a-d = 10 µm; e = 20 µm. Drawings by Matteo Gelardi

Pleurocystidia 44-64(80) × 8-12 µm (n = 15), decidedly frequent, shape, size, color and chemical reactions similar to cheilocystidia.

Pseudocystidia not recorded.

Pileipellis a trichoderm consisting of strongly interwoven, elongated, filamentous and sinuous, frequently branched hyphae tending to be repent in the outermost layer and thus turning into a cutis not or only partially embedded in gelatinous matter at maturity; terminal elements 18-98 × 3-12 µm, long and slender, cylindrical to subclavate, apex rounded-obtuse to sometimes pointed, moderately thick-walled (up to 1 µm), pale yellowish, straw yellow to brownish-yellow in water and 5% KOH, inamyloid in Melzer's, smooth, occasionally with epiparietal congophilous plaques; subterminal elements similar in shape, size and color to terminal elements.

Stipitipellis a texture of slender, parallel to subparallel and longitudinally running, smooth walled, adpressed hyphae, 2-12 µm wide, hyaline to yellowish in water and 5% KOH; the stipe apex covered by a well-developed caulohymenial layer consisting of sterile

caulobasidioles, frequent, predominantly 1- or 2-spored, fertile **caulobasidia** 30-37(45) × 6-10(12) µm, sterigmata 2-7 µm, (n = 5) and abundant projecting **caulocystidia** similar in shape and color to hymenial cystidia but slightly shorter, (34)38-50(56) × 7-11 µm (n = 8), having a wall up to 0.8 µm thick.

Lateral stipe stratum under the caulohymenium in young specimens present and well differentiated from the stipe trama, of the “boletoid type”, a 25-40(50) µm thick layer consisting of divergent, inclined and running towards the external surface, loosely intermingled and branched hyphae remaining separate and embedded in a gelatinous substance; in mature specimens the lateral stipe stratum is generally absent but sometimes present in places at the stipe apex and differentiated from the stipe trama (10-30 µm thick).

Stipe trama composed of confusedly and densely arranged, strongly interwoven, filamentous, smooth, bright yellow to ochraceous yellow in water, barely dextrinoid hyphae, 2-17 µm broad.

Hymenophoral trama bilateral divergent of the “*Boletus*-type” with moderately to distinctly divergent, recurved-arcuate and loosely arranged, gelatinous hyphae [lateral strata hyphae sometimes branched, constricted at septa, in transversal section remaining separate and (3)4-9(10) µm apart, 2-9 µm broad], hyaline to very pale yellowish in water and 5% KOH, inamyloid in Melzer’s; lateral strata (10)20-50(60) µm thick, mediostratum (15)20-40(50) µm thick, axially arranged, consisting of a tightly adpressed, non-gelatinous bundle of hyphae, 2-9(12) µm broad; in Congo red the mediostratum is darker than the lateral strata.

Oleiferous hyphae very rare.

Clamp connections absent in all tissues.

Hyphal system monomitic.

Ontogenetic development gymnocarpic.

Ecology: solitary to gregarious, in subtropical regions in montane environment, growing in association with *Fagaceae* (*Castanopsis* sp., *Cyclobalanopsis* sp., *Lithocarpus* sp., *Quercus* sp.) and *Pinaceae* (*Pinus* sp., *Tsuga* sp.), summer to autumn.

Examined material: China, Yunnan Province, Kunming City, Heilongtan Park, 25°08'40"N, 102°44'29"E, 1980 m alt., three young to middle-aged specimens growing in litter in a mixed forest under *Quercus variabilis* Blume, *Pinus yunnanensis* and *Keteleeria evelyniana* Mast.; legit M. Gelardi, B. Feng and Y.- J. Hao; 04 October 2011, MG437. Yunnan Province, Hengduan mountains, Lijiang, Xuesong Village (Ngulukō), 27°01'37"N, 100°13'15"E, 2790 m alt., a single mature specimen growing at the edge of a clearing, in litter in a mixed forest under *Pinus densata* Mast. and *Quercus* sp.; legit M. Gelardi, E. Horak, A. Horak, G. Wu, K. Zhao, Q. Zhao and S.- B. Jiao; 15 September 2012, MG473 (topotype). Yunnan Province, Hengduan mountains, Dali, Binchuan County, Mount Jizu, 25°57'39"N, 100°23'24"E, 2480 m alt., a single mature specimen growing in litter in a mixed forest under *Castanopsis delavayi* Franch., *Cyclobalanopsis glaucooides* Schottky, *Keteleeria evelyniana* Mast. and *Pinus armandii* with the scattered presence of *Lithocarpus* sp.; legit M. Gelardi, E. Horak, A. Horak, G. Wu, K. Zhao, Q. Zhao and S.- B. Jiao; 21 September 2012, MG489.

Other species found in the same habitat: *Amanita hemibapha* (Berk. & Broome) Sacc., *Amanita parvipantherina* Zhu L. Yang, M. Weiss & Oberw., *Amanita rubrovolvata* S. Imai, *Caloboletus panniformis* (Taneyama & Har. Takah.) Vizzini, *Catathelasma* cf. *ventricosum* (Peck) Singer, *Clavulina* cf. *cinerea* (Bull.) J. Schröt., *Descolea flavoannulata* (Lj. N. Vassiljeva) E. Horak, *Fistulina* cf. *hepatica* (Schaeff.) With., *Gaestrum* cf. *rufescens* Pers., *Helvella* cf. *crispa* Bull., *Hypholoma fasciculare* (Huds.) P. Kumm., *Inocybe geophylla* (Bull.) P. Kumm., *Lactifluus* cf. *glaucescens* (Crossl.) Verbeken, *Lactifluus* cf. *volemus* (Fr.) Kuntze, *Lactarius* cf. *quietus* (Fr.) Fr., *Lepiota* cf.

clypeolaria (Bull.) P. Kumm., *Paxillus orientalis* Gelardi, Vizzini, E. Horak & G. Wu, *Phallus indusiatus* Venturi, *Prunulus roseolus* Murrill, *Psilocybe coprophila* (Bull.) P. Kumm., *Russula singaporensis* Singer, *Tricholoma* cf. *saponaceum* (Fr.) P. Kumm., *Turbinellus fujisanensis* (S. Imai) Giachini, *Xerula* cf. *pudens* (Pers.) Singer, *Zangia olivaceobrunnea* Yan C. Li & Zhu L. Yang, *Zangia roseola* (W.F. Chiu) Yan C. Li & Zhu L. Yang.

Notes

The morphological key features for a prompt identification of *Retiboletus kauffmanii* include the medium to large-sized basidiomes, pileus tinged dark brown to grayish-ochraceous or ochraceous-yellow, bright yellow to ochraceous hymenophore, stipe surface bright yellow to ochraceous or grayish-ochraceous and entirely ornamented by a prominent, concolorous to brownish reticulum, deep yellow context and basal mycelium, tissues very slowly darkening to dingy brownish with age or upon handling, exposure and during drying process, bitterish to bitter taste, cystidia with a honey yellow to yellowish-brown vacuolar pigment, trichodermal pileipellis with filamentous hyphae that can be sometimes showily encrusted, fertile stipe surface and association with *Fagaceae* and *Pinaceae*. The conspicuously cyanophilic spores and hymenial cystidia in Cotton blue are an outstanding feature worthy of taxonomic consideration, even though it should be tested on a more inclusive number of samples so as to be considered a constant and reliable diagnostic character. To our knowledge, *R. kauffmanii* has only been reported from south-western China (Sichuan and Yunnan Provinces) (LI & SONG, 2000; ZENG ET AL., 2016) and northern India (Himachal Pradesh, Sikkim) (LAKHANPAL, 1996, as “*Boletus ornatipes* Peck”; DAS, 2013, as “*Retiboletus ornatipes* (Peck) Manfr. Binder & Bresinsky”; CHAKRABORTY ET AL., 2017) but is likely distributed across the Himalayas.

R. kauffmanii was originally described from the village of Ngulukō, north of Lijiang, by KEISSLER & LOHWAG (1937) based on original material collected by the Austrian botanist H. Handel-Mazzetti in the second decade of the 20th Century and later deposited at the University of Vienna (WU). The holotype was later revised by HORAK (1987) and Z.L. Yang (ZENG ET AL., 2016) but poor conditions of conservation prevented adequate re-examination.

In most cases this species has been misidentified in Chinese literature with the American taxa *R. ornatipes* and *R. retipes* (Berk. & M.A. Curtis) Manfr. Binder & Bresinsky (CHIU 1948, 1957, as “*B. ornatipes*” and “*B. retipes*”, respectively; ZANG ET AL., 1996, as both “*B. ornatipes*” and “*B. retipes*”; MAO, 1998, 2000, as “*B. ornatipes*”, 2009 as “*Pulveroboletus retipes* (Berk. & M.A. Curtis) Singer”; WANG & LIU, 2002b, as “*B. ornatipes*”; WANG ET AL., 2004, as “*B. ornatipes*”; ZANG, 2006, as both “*B. ornatipes*” and “*B. retipes*”; ZANG ET AL., 2013, as “*P. retipes*”). Only few accounts have correctly been addressed to the epithet “*kauffmanii*”, but always considering this species as separate from “*B. ornatipes*” or “*B. retipes*” (ZANG, 1999, 2006; WANG, 2004); a modern and comprehensive re-description of *R. kauffmanii* has recently been provided by ZENG ET AL. (2016), who also assessed its settlement in *Retiboletus* as defined by BINDER & BRESINSKY (2002) based on phylogenetic evidence. In the same publication the Chinese authors epitypified the species with a collection (HKAS 63584) from the vicinity of the type locality.

BINDER & BRESINSKY (2002) stressed that *R. ornatipes* and *R. retipes* are morphologically nearly indistinguishable (the latter differing from the former, according to some American authors, in the smaller size, pulverulent yellowish pileus, caespitose growth and the paler colored spores), the only reliable difference being the vicariant geographical distribution (*R. ornatipes* is apparently restricted to eastern North America whereas *R. retipes* occurs in south-eastern North America and Central America). Phylogenetically these two species are separate and, in addition, molecular analysis showed that *R. retipes* is a collective species encompassing three different cryptic taxa (BINDER & BRESINSKY, 2002; ZENG ET AL., 2016). The affinity of *R. kauffmanii*

to both *R. ornatipes* and *R. retipes* s. l. is remarked by the very variable pileus color, the coarsely reticulate stipe surface, the yellow hymenophore, context and basal mycelium, the tendency of the tissue to darken on drying, the bitterish taste, the trichodermal pileipellis and the cystidia filled with a yellowish-brown substance; on the other hand, narrower basidiospores [3-4(4.5) μm broad], smaller basidia (22-30 \times 6-8 μm), slightly wider hymenial cystidia (9-15 μm broad) and the occurrence in eastern North and Central America allow easy separation from *R. kauffmanii* (BERKELEY, 1872; PECK, 1878, 1889; ATKINSON, 1903; MURRILL, 1909b, 1914; COKER & BEERS, 1943; SINGER, 1947; SMITH & THIERS, 1971; GRUND & HARRISON, 1976; PEGLER & YOUNG, 1981; BOTH, 1993; BESSETTE ET AL., 2000, 2016; ORTIZ-SANTANA ET AL., 2007). Phylogenetic inference further demonstrates the independence of *R. kauffmanii* from the American species (ZENG ET AL., 2016).

R. kauffmanii is also somewhat reminiscent of *R. flavoniger* (Halling, G.M. Mueller & L.D. Gómez) Manfr. Binder & Halling but this latter differs in the medium-small sized basidiomes (pileus up to 8.5 cm diam.), pileus somewhat darker at the beginning, black to sooty brown, lower part of the stipe blackish-brown, context and hymenophore staining orange-brown when wounded, extremely bitter taste, slightly narrower hymenial cystidia (6-8 μm broad) and distribution in Central America (Costa Rica) (HALLING & MUELLER, 1999, 2005).

The most similar Asian species is *R. sinensis* N.K. Zeng & Zhu L. Yang. It is separated by the medium-small sized basidiomes (pileus up to 8 cm diam.), context quickly turning yellowish-brown on exposure, smaller basidiospores [8-10(11) \times (3)3.5-4(4.5) μm , Qm = 2.45], smaller cheilocystidia (20-37 \times 4.5-7 μm) and pleurocystidia (31-46 \times 5-6 μm) and the occurrence in southern, south-eastern China (Hainan, Fujian, Taiwan Provinces) and Japan (ZENG ET AL., 2016).

In 2012, after 96 years from the original collection of *R. kauffmanii*, the present author was able to find a single specimen at the same locality where Handel-Mazzetti first encountered the species. Accordingly, sample MG473 can be considered topotypic.

An ITS sequence from collection MG437 has been obtained and run using the BLASTn algorithm against those available in worldwide public genomic databases. The comparison showed a 99% identity (data not shown) with other sequences of *R. kauffmanii* from Yunnan Province (voucher numbers HKAS 76418 and HKAS 68590), clearly indicating a conspecificity of the sample examined in the present work.

The presence of a particular group of secondary metabolites named retipolides (spiromacrolactones) is a common feature shared by some *Retiboletus* species (BINDER & BRESINSKY, 2002; JUSTUS ET AL., 2007; ZENG ET AL., 2016). The existence of these chemical compounds in *R. kauffmanii* is yet to be determined.

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