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

Abstract

The present second communication reports on some miscellaneous collections belonging to the family Boletaceae recently found in Yunnan Province (south-western China), viz. *Aureoboletus thibetanus*, *Aureoboletus cf. thibetanus*, *Neoboletus brunneissimus*, *Pulveroboletus macrosporus* and *Retiboletus kauffmanii*. A detailed macro- and micromorphological description including ecological data is provided for each species described and accompanied by colour pictures of fresh basidiomes in habitat and line drawings of the main anatomical features. Moreover, one of the collections examined includes a topotypic specimen of *R. kauffmanii*. Comparisons with closely allied phenotypically similar taxa are also elucidated and discussed.

Riassunto

In questo secondo contributo dedicato allo studio dei boleti cinesi vengono descritte e illustrate cinque specie della famiglia Boletaceae a spore lisce.

Aureoboletus thibetanus è un appariscente boleto facilmente riconoscibile sul piano morfologico per i basidiomi di taglia medio-piccola, il portamento slanciato, le superfici di cappello e gambo tipicamente vischiose, specialmente a tempo umido, la superficie pileica brunastra e vistosamente reticolato-alveolata, l'imenoforo giallo, il gambo privo di ornamentazione, le basidiospore ellittico-fusiformi, i cistidi imeniali con uno strato esterno spesso 3-9 µm contenente un pigmento giallo brillante e la pileipellis costituita da un ixotricoderma. Inoltre, la vistosa reazione metacromatica dei cistidi imeniali è un carattere microchimico degno di nota ma finora passato inosservato. Un altro elemento meritevole di attenzione è la presenza nella pileipellis del campione studiato di cellule rigonfie, vescicolose, di dimensioni fino a 75 × 52 µm, frammiste a ife filamentose; tale carattere non è mai stato riportato precedentemente in letteratura. Questa specie è rinvenibile ad altitudini elevate in associazione con membri delle Fagaceae e la sua distribuzione geografica conosciuta è attualmente circoscritta alla Cina sud-occidentale (Province di Tibet, Qinghai, Sichuan e Yunnan), all'India settentrionale (Uttarakhand) e al Buthan. *A. thibetanus* è probabilmente diffuso lungo tutta la catena dell'Himalaya.

Da un punto di vista sia morfologico che ecologico, *Aureoboletus cf. thibetanus* appare molto strettamente affine al tipico *A. thibetanus*. Differisce tuttavia da quest'ultima specie per il gambo con tinte rosate più pronunciate, le spore cianofile, i cistidi imeniali ortocromatici e privi di strato periferico contenente una sostanza giallo brillante, i cheilocistidi solitamente più larghi e perlopiù da ventricoso-fusiformi a ventricoso-lageniformi o subcapitati, l'assenza di ife cistidioidi o rigonfie nella pileipellis e la presenza di caulobasidi sulla superficie del gambo. Sfortunatamente, basandosi solo sulle descrizioni macro e microscopiche, non è possibile risolvere la questione se le due raccolte appartengano alla stessa specie oppure a entità separate. Sebbene alcuni dei caratteri differenziali menzionati sopra risultino rilevanti, saranno necessari ulteriori studi su materiale fresco e analisi filogenetico-molecolari mirate al fine di stabilire la presunta conspecificità delle raccolte esaminate e di definire i rapporti di parentela e il valore tassonomico della variabilità fenotipica in *A. thibetanus*.

I principali tratti morfologici di *Neoboletus brunneissimus* possono essere riassunti come segue: basidiomi di taglia medio-piccola, portamento slanciato, superficie pileica vellutata, cappello e pori di colore terra d'ombra o bruno-rugginoso, gambo ornato da una fitta punteggiatura da bruno-rossastra a

bruno-rugginosa su fondo giallastro, parte basale del gambo vistosamente strigosa formata da una peluria di colore giallo-dorato o bruno-giallastro, carne gialla, tessuti viranti al blu scuro alla lesione, basidiospore ellittico-fusiformi e pileipellis costituita da un tricotoderma di ife filamentose. La si rinviene associata a membri delle Fagaceae e delle Pinaceae soprattutto nella fascia tropicale e subtropicale ma è presente pure nelle regioni temperate. Questa specie sembra avere un'ampia distribuzione attraverso la Cina centrale, meridionale, occidentale e sud-occidentale, essendo stata segnalata da svariate Province quali Henan, Hunan, Guangdong, Hainan, Guizhou, Guangxi, Anhui, Sichuan, Yunnan, Qinghai, Xinjiang e Tibet ed è presente anche in ambiente subalpino in Giappone.

Tra le altre specie dello stesso genere, *Pulveroboletus macrosporus* è facilmente distinguibile sulla base della seguente combinazione di caratteri morfologici: basidiomi di taglia media, giovani esemplari interamente rivestiti da un velo universale polveroso, fioccoso, giallo brillante che si lacera presto mostrando il colore rosato-ocraceo o rosa del cappello, tubuli e pori imbluenti alla lesione, gambo giallo con un effimero anello cotonoso, carne virante all'azzurro nella zona di connessione tra cappello e gambo e spore comparativamente grandi, largamente ellissoidali (fino a 7 µm di larghezza). Riguardo alle esigenze ecologiche, sebbene possa essere rinvenuta in boschi misti, questa specie è molto probabilmente associata solo alle Pinaceae, insieme al simpatico ma morfologicamente differente *P. reticulopileus*. Geograficamente, *P. macrosporus* è stato finora segnalato solo dalla Cina sud occidentale (Provincia dello Yunnan).

I caratteri morfologici chiave per una pronta identificazione di *Retiboletus kauffmanii* includono i basidiomi di taglia da media a grande, il cappello con una tinta da bruno scuro a grigio-ocraceo o giallo-ocraceo, l'imenoforo da giallo intenso a ocraceo, la superficie del gambo da giallo intenso a ocraceo o grigio-ocraceo e interamente ornata da un vistoso reticolo da concolore a brunastro, la carne e il micelio basale giallo carico, i tessuti lentamente scurenti verso un brunastro fosco con lo sviluppo o alla manipolazione, al taglio o durante il processo di essiccazione, il sapore da amarognolo ad amaro, i cistidi con un pigmento vacuolare da giallo miele a bruno-giallastro, la pileipellis costituita da un tricotoderma con ife filamentose talvolta pesantemente incrostate, la superficie stipitale fertile e l'associazione con Fagaceae e Pinaceae. Le spore e i cistidi imeniali fortemente cianofili in Blu cotone sono una peculiarità eccezionale meritevole di considerazione tassonomica, anche se dovrebbe essere testata su un numero maggiore di campioni al fine di essere considerato un valido e costante carattere diagnostico. Sulla base delle attuali conoscenze, *R. kauffmanii* è stato finora segnalato solo dalla Cina sud-occidentale (Province di Sichuan e Yunnan) e dall'India settentrionale (Himachal Pradesh e Sikkim) ma è probabilmente diffuso su tutto l'arco dell'Himalaya.

Key words: *Basidiomycota*, *Boletaceae*, Chinese fungal diversity, mycorrhizal fungi, taxonomy, Yunnan Province.

Introduction

Bolete diversity demonstrated to be quite impressive in China. Notwithstanding the large amount of information that has come out from recent molecularly-based studies devoted to a better understanding of the boletoid fungi and their close allies from eastern and south-eastern Asia (LI ET AL., 2009, 2011, 2013, 2014a, b; ORIHARA ET AL., 2010, 2012, 2016; FENG ET AL., 2012; LEBEL ET AL., 2012; ZENG ET AL., 2012, 2013, 2014, 2015, 2016, 2017; GELARDI ET AL., 2013, 2014, 2015; HOSEN ET AL., 2013; WU ET AL., 2014, 2016a, b; ZHAO ET AL., 2014a, b, 2015; ZHU ET AL., 2014, 2015; CUI ET AL., 2016; LIANG ET AL., 2017), many species have only been sporadically encountered and their taxonomic limits with respect to related taxa currently remain unclear. As for the foregoing account (GELARDI, 2014), the aim of this second communication is to provide additional morphological and ecological data on some noteworthy bolete species from south-western China. Five ectomycorrhizal smooth-spored species in the *Boletaceae* have been investigated in detail: *Aureoboletus thibetanus* (Patouillard) Hongo & Nagasawa, *Aureoboletus* cf. *thibetanus*, *Neoboletus brunneissimus* (W.F. Chiu) Gelardi, Simonini & Vizzini, *Pulveroboletus macrosporus* G. Wu & Zhu L. Yang and *Retiboletus kauffmanii* (Lohwag) N.K. Zeng & Zhu L. Yang.

Being a continuation of the work that appeared in the same mycological journal (GELARDI, 2014), the reader is referred to the introduction to that paper for further insights. All bibliographic references will be listed in the second part (Part II) of this article.

Materials and methods

Collection sites and sampling:

In October 2011 and September 2012 fresh material was collected at several different localities in Yunnan Province, China. Herbarium acronyms follow THIERS (2017) except “MG” that refers to the author’s personal herbarium. Author citations follow the Index Fungorum-Authors of Fungal Names (www.indexfungorum.org/authorsoffungalnames.htm).

Morphological studies

Macroscopic descriptions, macro-chemical reactions (KOH) and ecological information, such as habitat notations, time of fruiting and associated plant communities were based upon detailed field notes from fresh basidiomes. Colors were recorded under daylight and described in general terms only. Macro-photographs in habitat were taken using a Nikon D3100 camera. Micro-morphologic features were observed from dried material; sections were rehydrated either in water, 5% potassium hydroxide (KOH) or in ammoniacal Congo Red. Structures and anatomical features were observed and measured by mounting preparations in ammoniacal Congo Red. Colors and pigments were described after examination in water and 5% KOH. Measurements were made at 1000× with a calibrated ocular micrometer (Nikon Eclipse E200 optical light microscope). Basidiospores were measured from hymenophores of mature basidiomes whenever possible, dimensions are given as (minimum) average ± standard deviation (maximum), Q = length/width ratio with the extreme values in parentheses, Q_m = average quotient (length/width ratio) ± standard deviation and average spore volume was approximated as a rotation ellipsoid [$V = (\pi \cdot L \cdot W^2) / 6 \pm \text{standard deviation}$]. The notation [n/m/p] indicates that measurements were made on “n” randomly selected basidiospores from “m” basidiomes of “p” collections. The width of each basidium was measured at the widest part, and the length was measured from the apex (sterigmata excluded) to the basal septum. Metachromatic, cyanophilic and iodine reactions were tested by staining the basidiospores in Brilliant Cresyl blue, Cotton blue and Melzer’s reagent, respectively. Line drawings of microstructures were traced free hand based on digital photomicrographs of rehydrated material.

TAXONOMY

Aureoboletus thibetanus (Pat.) Hongo & Nagas., *Rep. Tottori Mycol. Inst.* 18 (1): 133 (1980) s. Patouillard non s. Japanese Authors.

≡ *Aureoboletus thibetanus* (Pat.) Manfr. Binder, *Zur molekularen Systematik der Boletales: Boletineae und Sclerodermatineae subord. nov.*, Dissertation Universität Regensburg: 103 (1999) (nom. inval. and comb. superfl.)

≡ *Boletus thibetanus* Pat., *Bull. Soc. mycol. Fr.* 11 (4): 196 (1895) (basionym)

≡ *Pulveroboletus thibetanus* (Pat.) Singer, *Agaric. mod. Tax.*, Edn 4 (Koenigstein): 774 (1986)

≡ *Suillus thibetanus* (Pat.) Kuntze, *Revis. gen. pl.* (Leipzig) 3 (2): 536 (1898)

≡ *Suillus thibetanus* (Pat.) F.L. Tai, *Syll. fung. sinicorum*: 736 (1979) (comb. superfl.)

? = *Boletus flexipes* Masee, *Bull. Misc. Inf., Kew*: 208 (1909)



Fig. 1. *Aureoboletus thibetanus* in habitat (MG445).

Photo by Matteo Gelardi

Macroscopic description (Fig. 1)

Basidiomes medium-small.

Pileus 2.9 cm broad, convex-pulvinate, regularly to hardly unevenly shaped, scarcely fleshy, soft; margin steady to faintly wavy-lobed, curved downwards, with conspicuous cottony, straw yellow velar remnants hanging at the edge and extending beyond the tubes up to 6 mm; surface matt, dry but usually viscid with moist weather, finely velvety, not cracked, showily reticulate-alveolate with irregularly arranged depressions separated from each other by crests up to 2 mm high; cuticle barely separable from the pileal context beneath, evenly brownish but slightly darker in the depressions and cream-yellowish to pale brownish all along crests; unchangeable on handling or when injured; subcuticular layer straw yellow.

Tubes somewhat broad and longer than the thickness of the pileus context (up to 0.7 cm long), depressed around stipe apex and shortly decurrent with a tooth, straw yellow with an olive shade, unchangeable when cut.

Pores forming a flat surface, relatively wide (up to 1 mm in diam.), simple, roundish, concolorous with the tubes and unchangeable on bruising or when injured.

Stipe 9.9 × 1.0 cm, longer than the pileus diameter, central, solid, firm, sinuous, cylindrical but slightly tapered towards both the apex and base, ending with a short taproot at the very base; surface dry but usually viscid with moist weather, smooth to very finely longitudinally fibrillose; pale yellowish-white with a pinkish shade at the apex, pure white at the very base, faintly turning pale pinkish-brown when pressed, particularly on the lower three fourth of the stipe; basal mycelium white, rhizomorphs not observed.

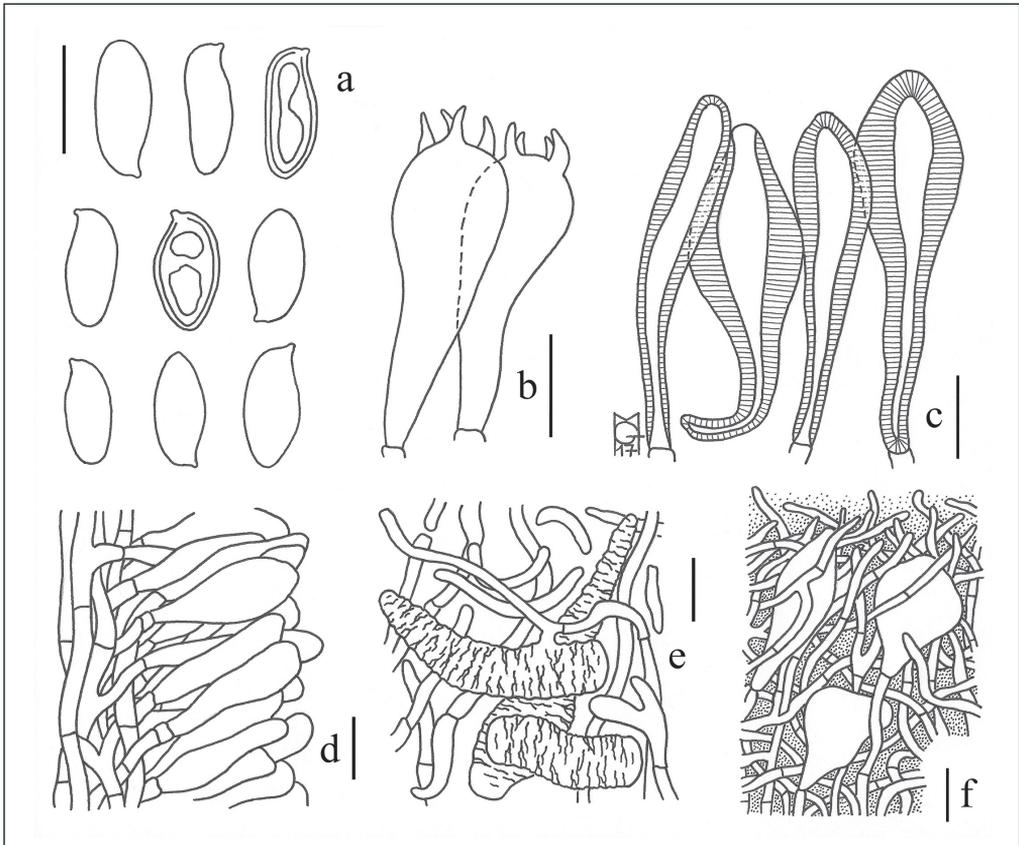


Plate 1. *Aureoboletus thibetanus*. Microscopic characters (MG445). a. Spores; b. Basidia; c. Cheilo- and pleurocystidia; d. Stipitipellis; e. Marginal veil; f. Pileipellis. Scale bars: a-c = 10 μm ; d-f = 20 μm . Drawings by Matteo Gelardi

Context soft textured in the pileus (up to 1 cm thick in the central zone), a little more fibrous in the stipe, cream yellow in the pileus but yellowish-white in the stipe and gradually paler downwards, whitish at the base, brownish-red beneath the cuticle, unchangeable when exposed to air; subhymenophoral layer straw yellow.

Odor mild, very vaguely fruity, agreeable.

Taste mild.

Spore print not obtained.

Edibility edible (LI & SONG, 2002; DAI *ET AL.*, 2010) but likely of scarce culinary interest.

Microscopic description (Plate 1)

Basidiospores [34/1/1] (10.4)12.4 \pm 0.85(14.5) \times (3.9)4.9 \pm 0.46(6.2) μm , Q = (2.08)2.16-2.79(2.86), Qm = 2.50 \pm 0.18, V = 162 \pm 40 μm^3 , inequilateral, ellipsoid-fusiform to fusiform in side view, ellipsoid to ellipsoid-fusiform in face view, smooth, with a short apiculus and a pronounced suprahilar depression, apex rounded, moderately thick-walled (0.3-0.5 μm), bright yellow colored in water, straw yellow in 5% KOH, having one, two or three large oil droplets when mature, rarely pluri-guttulate, inamyloid, acyanophilic and with an orthochromatic reaction.

Basidia (24)26-35 × 11-13 μm (n = 10), cylindrical-clavate to clavate, moderately thick-walled (0.5-0.8 μm), predominantly 4-spored but also 2-spored, usually bearing relatively short sterigmata (3-5 μm), hyaline to pale yellowish and sometimes containing straw-yellow oil guttules in water and 5% KOH, bright yellow (inamyloid) in Melzer's, without basal clamps; basidioles subcylindrical, clavate to broadly clavate, similar in size to basidia.

Cheilocystidia (25)29-56(77) × 9-16(25) μm (n = 10), very common, moderately slender, projecting straight to sometimes flexuous, broadly clavate, subclavate or sublageniform, rarely irregularly cylindrical or cylindrical-fusiform to ventricose-fusiform, with rounded to subacute tip, smooth, moderately thick-walled (0.5-0.9 μm), with a 3-9 μm thick outer layer filled by a refractive straw yellow vacuolar pigment in water, partly to completely dissolving in 5% KOH, internally colorless, outer layer nearly hyaline in Melzer's but with a persistent internal bright yellow granular content (inamyloid), decidedly and strongly metachromatic in Cresil blue, without epiparietal encrustations.

Pleurocystidia (26)42-84(88) × (7)11-18(20) μm (n = 10), decidedly frequent, on average longer than but shape, color and chemical reactions similar to cheilocystidia.

Pseudocystidia not recorded.

Pileipellis an ixotrichoderm consisting of vertically arranged, subparallel to moderately interwoven, elongated, filamentous to irregularly cylindrical, frequently branched hyphae tending to be repent in the outermost layer and embedded in gelatinous matter often intermixed with cystidioid to inflated, balloon-like, weakly metachromatic cells up to 75 × 52 μm large; terminal elements rather variable in dimensions, 21-78 × (2)3-16 μm, cylindrical to subclavate or cystidioid, tapering upwards, apex usually pointed, moderately thick-walled (up to 1 μm), ochraceous in water, straw yellow in 5% KOH, weakly dextrinoid in Melzer's, smooth; subterminal elements similar in shape, size and color to terminal elements.

Velar remnants consisting of strongly interwoven, elongated, filamentous, frequently branched, moderately thick-walled (up to 0.8 μm) gelatinous hyphae, 20-163 × 3-10 μm, often intermixed with cylindrical, cystidioid to sausage-like cells ornamented by a conspicuous zebra-like epiparietal encrustation, up to 132 × 25 μm, all hyphae hyaline to very pale yellowish in water and 5% KOH.

Stipitipellis a texture of slender, parallel to subparallel and longitudinally running, smooth walled, adpressed hyphae, 3-12 μm wide, hyaline to yellowish in water and 5% KOH; the stipe apex covered by a layer of entangled filamentous, frequently branched hyphae ending with abundant projecting cylindrical to subclavate sterile cystidioid elements, (30)36-80(83) × 4-7 μm (n = 6), having a wall up to 1 μm thick, orthochromatic in Brilliant Cresil blue; caulobasidioles not differentiated from cystidial elements; caulobasidia not observed.

Lateral stipe stratum under the caulohymenium absent.

Stipe trama composed of subparallel to moderately interwoven, densely arranged, filamentous, smooth, inamyloid hyphae, 4-19 μm broad.

Hymenophoral trama bilateral divergent of the "*Boletus*-type" with moderately to distinctly divergent, slightly recurved-arcuate and loosely arranged, gelatinous hyphae (lateral strata hyphae often branched, constricted at septa, in transversal section remaining separate and (3)4-8(11) μm apart, 2-17 μm broad), hyaline to very pale yellowish in water and 5% KOH, inamyloid in Melzer's; lateral strata (15)20-35(40) μm thick, mediostratum (10)15-30 μm thick, axially arranged, consisting of a tightly adpressed, non-gelatinous bundle of hyphae, 2-12 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 due to the presence of a universal veil.

Ecology: solitary to gregarious, in temperate to subtropical regions in montane environment, growing in mixed woods associated with *Fagaceae* (*Castanopsis*, *Lithocarpus*, *Quercus*), fairly common, summer to autumn.

Examined material: China, Yunnan Province, Kunming City, Kunming Botanical Garden, 25°08' 16"N, 102°44'50"E, 1980 m alt., a single mature specimen growing in litter in a mixed forest under *Quercus franchetii* Skan with the presence of *Pinus yunnanensis* Franch.; legit. M. Gelardi, B. Feng and Y.-J. Hao; 06 October 2011, MG445.

Other species found in the same habitat: *Chiuia virens* (W.F. Chiu) Yan C. Li & Zhu L. Yang.

Notes

Aureoboletus thibetanus is a remarkable bolete morphologically easily recognizable based on the medium-small sized basidiomes, slender stature, distinctly viscid pileus and stipe surfaces especially with moist weather, deeply reticulate-alveolate, brownish pileus, yellow hymenophore, stipe devoid of ornamentation, ellipsoid-fusiform, smooth basidiospores, hymenial cystidia with a 3-9 µm thick layer filled by a refractive yellow substance and ixotrichoderm pileipellis. Moreover, the striking metachromatic reaction of hymenial cystidia is a noteworthy micro-chemical feature that up until now went unnoticed. Another character worthy of attention is the presence in the pileipellis of our sample of inflated, balloon-like cell up to 75 × 52 µm large intermixed with filamentous hyphae; such a feature has previously never been reported in literature. This bolete is found at high altitudes in association with *Fagaceae* and its known distribution range is currently circumscribed to south-western China, including Tibet, Qinghai, Sichuan and Yunnan (LI & SONG, 2000), northern India (Uttarakhand) (SHARMA ET AL., 2005) and Buthan. *A. thibetanus* is probably widespread all over the Himalayan range.

YANG ET AL. (2003) were the first to provide a modern re-description of *A. thibetanus* corroborated by molecular phylogenetic inference. This species, however, was described by the French mycologist PATOUILLARD (1895), apparently based on a single collection, at the end of the 19th century from Sichuan and formerly placed in the genus *Boletus* Fr. as conceived in a very broad sense (see also SACCARDO & SYDOW, 1899). It was later transferred to *Suillus* Gray (KUNTZE, 1898; TAI, 1979), *Aureoboletus* Pouzar (HONGO & NAGASAWA, 1980) and *Pulveroboletus* Murrill (SINGER, 1986). Further phylogenetic evidence supporting the placement of *Boletus thibetanus* Pat. in *Aureoboletus* was later provided by BINDER & HIBBETT (2006) in their comprehensive molecular studies devoted to the systematic re-arrangement of the order *Boletales* and, more recently, by WU ET AL. (2016b).

Despite its unique features, *A. thibetanus* has only sporadically been reported in Chinese literature (CHIU, 1948, 1957; ZANG, 1986, 1996, 2006; ZANG ET AL., 1993; YING & ZANG, 1994; DING, 2002; DING & WEN, 2003; WANG, 2004; YUAN & SUN, 2007; ZHANG ET AL., 2012) and some misinterpretations are also known; as already pointed out by YANG ET AL. (2003), *A. thibetanus* described by MAO ET AL. (1993) appears to be a different species whereas the photograph provided in MAO (2000) does not represent *A. thibetanus* and is probably to be referred to a *Boletellus* species. In addition, this bolete was reported from Japan by HONGO & NAGASAWA (1980), IMAZEKI ET AL. (1988) and IMAZEKI & HONGO (1989) but according to YANG ET AL. (2003) and KLOFAC (2010), in all cases their records are not conspecific with the Chinese species and should be better ascribed to *A. novoguineensis* Hongo, an entity morphologically and geographically separate from *A. thibetanus*. Likewise, CORNER (1970) and WATLING (2001) indicated the occurrence

of *A. thibetanus* in Singapore, CORNER (1974), WATLING & HOLLAND (1990) and WATLING (2000) in Sarawak (Borneo) and THONGKLAM (2008) in Thailand, but again their collections are most likely to be regarded as misidentifications of similar taxa (YANG ET AL., 2003; KLOFAC, 2010; HORAK, 2011; Pers. Obs.). To date, the only trustable records of *A. thibetanus* from outside China and India seem to be some collections yielded in Bhutan (D. WINKLER, M. CHRISTENSEN, web sources).

DING (2002) indicated *Boletus flexipes* Masee (as “*C. Massal.*”) as a later synonym of *A. thibetanus*. Having originally been recorded in the Botanic Gardens, Singapore (MASSEE, 1909), it is quite unlikely they are conspecific. HORAK (2011) also regarded at the synonymy as doubtful. Further investigation, however, would be required to clarify its taxonomic position.

Aureoboletus thibetanus is morphologically next to a certain number of other Asian species belonging to the same genus, such as *A. tenuis* T.H. Li & Ming Zhang (?= *A. marroninus* T.H. Li & M. Zhang, according to WU ET AL., 2016b), *A. viscidipes* (Hongo) G. Wu & Zhu L. Yang and *A. quercus-spinosae* Ming Zhang & T.H. Li. All species differ, however, in the wrinkled, rugulose to radially or irregularly ridged, not distinctly reticulate-alveolate pileus surface. In addition, *A. tenuis* is also distinguished by the predominantly reddish-orange color of pileus and stipe surfaces, hymenial cystidia with a thinner (ca. 1 µm) refractive yellow outer wall and narrower pileipellis terminal cells [(3.5)4.5-8 µm broad], while *A. viscidipes* is also separated by the presence of brownish shades on the stipe, slightly smaller basidiospores [(9.5)10-12.5 × (4)4.5-5(5.5) µm, Qm = 2.30], thin-walled cystidia with a refractive yellowish substance only restricted to the apical part, shorter and narrower pileipellis terminal elements (25-44 × 5-8 µm) and the occurrence in central China (Jiangxi Province) and Japan. *A. quercus-spinosae* is also dissimilar in the slightly paler, greyish-yellow, yellowish-orange to yellowish-brown pileus color, absence of velar remnants at pileus margin, presence of reddish-brown tints in the lower part of the stipe, both internally and externally, broader and much longer basidiospores [(12)15-21 × 5-6.5 µm, Qm = 3.09] and hymenial cystidia without refractive yellow content (HONGO, 1974; ZHANG ET AL., 2014, 2015, 2017; WU ET AL., 2016b).

The reticulate pileus surface recalls *Boletus reticuloceps* (M. Zang, M.S. Yuan & M.Q. Gong) Q.B. Wang & Y.J. Yao, a porcini mushroom (*Boletus* s. str.) that was formerly described as a member of *Aureoboletus* (ZANG ET AL., 1993) but differs significantly from *A. thibetanus* because of the large sized, fleshy basidiomes, absence of a universal veil, dry pileus and stipe surfaces, white then yellowish-olive hymenophore, showily reticulate stipe, hymenial cystidia without refractive yellow pigment and distinctly larger basidiospores (ZANG ET AL., 1993; YING & ZANG, 1994; YANG ET AL., 2003; WANG, 2004; WANG ET AL., 2004; WANG & YAO, 2005; ZANG, 2006; YUAN & SUN, 2007; CUI ET AL., 2016).

When compared to *A. thibetanus*, the apparently similar *Pulveroboletus reticulopileus* M. Zang & R.H. Petersen is promptly circumscribed on account of the larger size of the specimens, scaly-squamulose pileus surface with greyish-black scales, hymenophore and context bruising light blue on exposure, pulverulent, lemon-yellow stipe with an evanescent annulus, broader basidiospores [(9.5)10-13(14) × 5-6.5(7) µm, Qm = 1.97], narrower, fusiform to subfusiform hymenial cystidia (4-10 µm broad), narrower pileipellis terminal cells (38-75 × 5-6 µm), a thricodermal stipitipellis consisting of entangled filamentous hyphae (absence of caulohymenial elements) and the occurrence under conifers, especially *Abies* and *Picea* (ZANG ET AL., 2001, 2013; 2017).

Aureoboletus cf. *thibetanus*

Macroscopic description (Fig. 2)

Basidiomes medium-small.

Pileus (1.5)4.0-5.7 cm broad, convex-pulvinate then flattened and finally slightly depressed at centre, regularly to hardly unevenly shaped, scarcely fleshy, soft; margin steady to faintly



Fig. 2. *Aureoboletus* cf. *thibetanus* in habitat (MG479).

Photo by Matteo Gelardi



Fig. 3. *Quercus pannosa* in habitat.

Photo by Matteo Gelardi

wavy-lobed, curved downwards and finally completely plane or even uplifted, devoid of velar remnants; surface matt, viscid, finely velvety, not cracked, showily reticulate-alveolate with irregularly arranged depressions separated from each other by crests up to 1 mm high; cuticle barely separable from the pileal context beneath, evenly brownish-red but slightly darker in the depressions and cream-yellowish to pale brownish all along crests; unchangeable on handling or when injured; subcuticular layer straw yellow.

Tubes somewhat broad and longer than the thickness of the pileus context (up to 0.7 cm long), depressed around stipe apex and shortly decurrent with a tooth, straw yellow with an olive shade, unchangeable when cut.

Pores forming a convex surface, relatively wide (up to 1 mm in diam.), simple, roundish, concolorous with the tubes and unchangeable on bruising or when injured.

Stipe 6.1-7.2 × 0.4-0.6 cm, longer than the pileus diameter at maturity, central, solid, firm, straight to curved, cylindrical but slightly swollen downwards, ending with a short taproot at the very base; surface viscid, smooth to very finely longitudinally fibrillose; pale yellowish-white with a pinkish shade throughout, pure white at the very base, faintly turning pale pinkish-brown when pressed, particularly on the lower three fourth; basal mycelium white, rhizomorphs not observed.

Context soft textured in the pileus (up to 0.7 cm thick in the central zone), a little more fibrous in the stipe, straw yellow in the pileus but yellowish-white in the stipe and gradually paler downwards, whitish at the base, unchangeable when exposed to air; subhymenophoral layer straw yellow.

Odor mild, very vaguely fruity, agreeable.

Taste mild.

Spore print not obtained.

Edibility unknown.

Microscopic description (Plate 2)

Basidiospores [34/2/1] (10.8)13.0 ± 1.40(16.8) × (4.3)5.1 ± 0.38(5.8) μm, Q = (2.21)2.24-2.94(2.96), Q_m = 2.54 ± 0.19, V = 181 ± 42 μm³, rather variable in dimensions, inequilateral, ellipsoid-fusiform to fusiform in side view, ellipsoid to ellipsoid-fusiform in face view, smooth, with a short apiculus and a shallow suprahilar depression, apex rounded to sometimes pointed, moderately thick-walled (0.3-0.6 μm), bright yellow colored in water, straw yellow in 5% KOH, having one, two or three large oil droplets when mature, rarely pluri-guttulate, inamyloid, strongly cyanophilic and with an orthochromatic reaction.

Basidia 26-40(44) × (8)11-13 μm (n = 10), cylindrical-clavate to clavate, moderately thick-walled (0.5-0.9 μm), predominantly 4-spored but also 2-spored, usually bearing relatively short sterigmata (3-5 μm), hyaline to very pale yellowish and sometimes containing straw-yellow oil guttules in water and 5% KOH, bright yellow (inamyloid) in Melzer's, without basal clamps; basidioles subclavate to broadly clavate, similar in size to basidia.

Cheilocystidia (35)38-53 × (14)16-21 μm (n = 10), very common, moderately slender, projecting straight to sometimes flexuous, ventricose-fusiform to ventricose-lageniform or subcapitate, with rounded to subacute tip, smooth, thick-walled (0.8-1.2 μm), hyaline to very pale yellowish in water and 5% KOH, bright yellow (inamyloid) in Melzer's, orthochromatic in Cresil blue, without epiparietal encrustations.

Pleurocystidia 57-81 × 11-14 μm (n = 6), uncommon, decidedly longer and narrower than cheilocystidia, ventricose-fusiform with a long neck, color and chemical reactions similar to cheilocystidia.

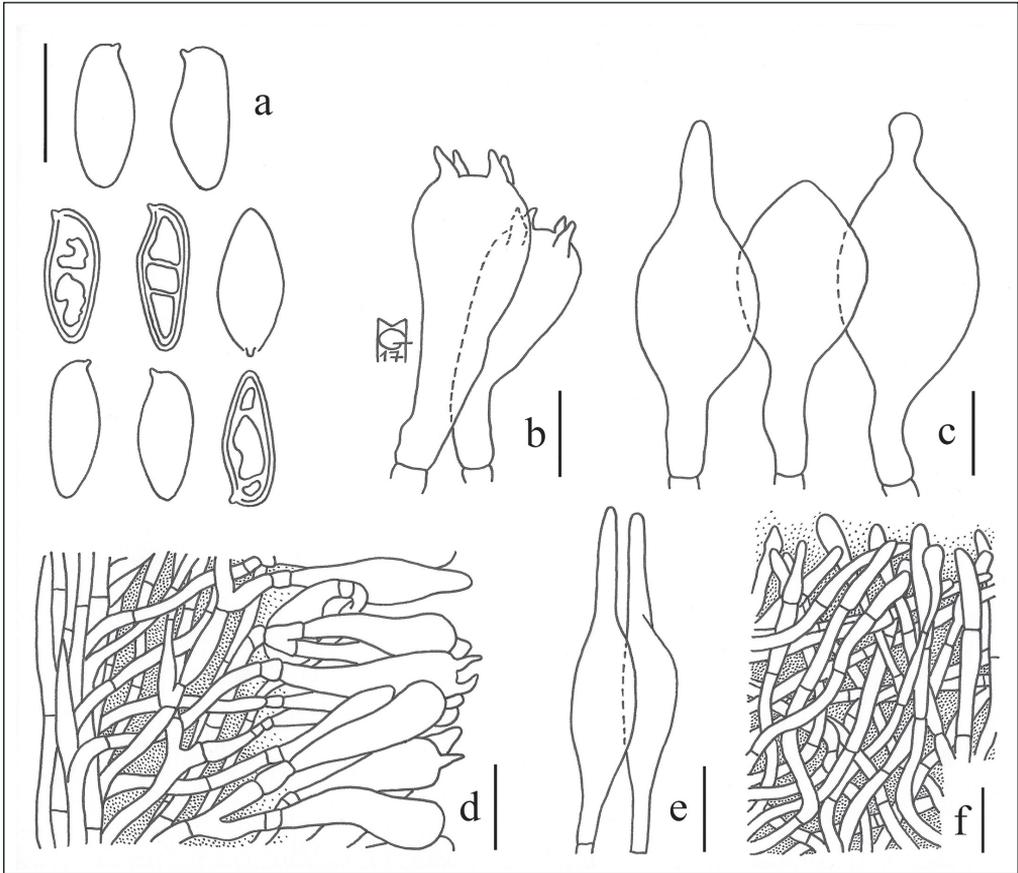


Plate 2. *Aureoboletus* cf. *thibetanus*. Microscopic characters (MG479). a. Spores; b. Basidia.; c. Cheilocystidia; d. Stipitipellis and lateral stipe stratum; e. Pleurocystidia; f. Pileipellis. Scale bars: a-c = 10 μ m; d-f = 20 μ m. Drawings by Matteo Gelardi

Pseudocystidia not recorded.

Velar remnants not present.

Pileipellis an ixotrichoderm consisting of strongly interwoven, more or less elongated, cylindrical, frequently branched hyphae tending to be repent in the outermost layer and embedded in gelatinous matter; terminal elements rather variable in dimensions, 25-89 \times 4-15 μ m, cylindrical to cystidioid or bullet-shaped to subclavate, apex usually rounded, moderately thick-walled (up to 1 μ m), ochraceous in water, straw yellow in 5% KOH, inamyloid in Melzer's, smooth; 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, 4-12 μ m wide, hyaline to yellowish in water and 5% KOH; the stipe apex covered by a well-developed caulohymenial layer consisting of entangled filamentous, frequently branched hyphae ending with very sparse, predominantly 1 or 2 -spored, fertile caulobasidia similar in shape, size and color to hymenial basidia, 29-40 \times 9-11 μ m (n = 2) and abundant projecting cylindrical, subclavate to subfusiform cystidioid elements, 23-35(83) \times 6-11 μ m (n = 8), having a wall up to 1 μ m thick, orthochromatic in Cresil blue; caulobasidioles not differentiated from cystidial elements.

Lateral stipe stratum under the caulohymenium usually absent, but in some areas of the stipe apex it may be present although not well differentiated from the stipe trama; whenever present this layer is of the “boletoid type”, (30)40-70(100) μm thick, consisting of parallel to loosely intermingled and slightly divergent, frequently branched hyphae remaining separate from each other and embedded in a gelatinous substance.

Stipe trama composed of subparallel to moderately interwoven, densely arranged, filamentous, smooth, inamyloid hyphae, 3-17 μm broad.

Hymenophoral trama bilateral divergent of the “*Boletus*-type” with moderately to distinctly divergent, slightly recurved-arcuate and loosely arranged, gelatinous hyphae (lateral strata hyphae often branched, in transversal section remaining separate and (2)4-10(12) μm apart, 3-13 μm broad), hyaline to very pale yellowish in water and 5% KOH, inamyloid in Melzer’s; lateral strata (25)30-50(60) μm thick, mediostratum (20)25-40 μm thick, axially arranged, consisting of a tightly adpressed, non-gelatinous bundle of hyphae, 3-7 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.

Ecology: solitary to gregarious, in subtropical montane environment, growing in association with *Fagaceae* (*Quercus*) 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, Yulong County, Lake Wen-Hai, 26°59' 12" N, 100°10'09" E, 3100 m alt., four mature specimens growing in litter in a mixed forest under *Quercus pannosa* Hand.-Mazz. (Fig. 3), *Pinus yunnanensis* and *P. armandii* Franch.; legit. M. Gelardi, E. Horak, A. Horak, G. Wu, K. Zhao, Q. Zhao and S.-B. Jiao; 17 September 2012, MG479.

Other species found in the same habitat: *Amanita hemibapha* (Berk. & Broome) Sacc., *Turbinellus fujisanensis* (S. Imai) Giachini.

Notes

From both morphological and ecological viewpoints, this collection appears to be very closely related to the typical *A. thibetanus* specimens. However, it differs from the latter species in having the stipe with more pronounced pinkish hues, cyanophilic spores, hymenial cystidia without a peripheral layer filled by a refractive straw yellow vacuolar pigment and orthochromatic, usually broader cheilocystidia that are mostly ventricose-fusiform to ventricose-lageniform or subcapitate, absence of cystidioid to inflated, balloon-like cells in the pileipellis and presence of caulobasidia on stipe surface. Unfortunately, based on the sole macro- and micromorphological descriptions it is not possible to solve the matter as to whether the two collections of *A. thibetanus* examined in the present contribution belong in the same species or not. Although some of the aforementioned differences appear to be remarkable, morphological observations on additional fresh material and inclusive molecular phylogenetic inference are needed in order to define the allegedly conspecificity of the collections examined and to determine the relationships and taxonomic value of phenotypic variability within *A. thibetanus*.

Aside from the typical *A. thibetanus*, the present collection exhibit morphological affinities with *A. tenuis*, *A. viscidipes* and *A. quercus-spinosae*. *Aureoboletus* cf. *thibetanus* differs from the former in the absence of velar remnants at pileus margin, longer basidiospores [(10.5)11-13.5(14) \times 4.5-5.5 μm , $Q_m = 2.42$ in *A. tenuis*], broader cheilocystidia and pileipellis terminal cells and the presence of a well-developed fertile caulohymenial layer. It is distinguished from *A. viscidipes* in the absence of

velar remnants, absence of brownish shades on the stipe, slightly smaller basidiospores, broader cheilocystidia (11-17 μm broad in *A. viscidipes*) without refractive yellow pigment, smaller pileipellis terminal cells, broader caulocystidia (4.5-6 μm broad in *A. viscidipes*) and the occurrence in south-western China (Yunnan Province). It is separated from *A. quercus-spinosae* in the darker, brownish-red pileus color, absence of reddish-brown tints in the lower part of the stipe, both inside and outside, decidedly smaller basidiospores, larger cheilocystidia (28-40 \times 10-12 μm in *A. quercus-spinosae*) and longer pleurocystidia (30-60 μm long in *A. quercus-spinosae*). Furthermore, *Aureoboletus* cf. *thibetanus* differs from all the aforementioned species in the typically reticulate-alveolate pileus surface (HONGO, 1974; ZHANG ET AL., 2014, 2017; WU ET AL., 2016b).

Neoboletus brunneissimus (W.F. Chiu) Gelardi, Simonini & Vizzini, *Index Fungorum* 192: 1 (2014)

≡ *Boletus brunneissimus* W.F. Chiu, *Mycologia* 40 (2): 228 (1948) (basionym)

≡ *Sutorius brunneissimus* (W.F. Chiu) G. Wu & Zhu L. Yang, *Fungal Diversity* 81 (1): 146 (2016)

Macroscopic description (Fig. 4)

Basidiomes medium-small.

Pileus up to 2.9 cm broad, at first hemispherical then persistently convex, regularly shaped, moderately fleshy, firm; margin steady to faintly wavy-lobed, initially involute then curved downwards, not extending beyond the tubes; surface matt, dry, velvety, not cracked; cuticle evenly rusty-brown; slowly darkening to sordid brown on handling or when injured; subcuticular layer straw-yellow.



Fig. 4. *Neoboletus brunneissimus* in habitat (MG440).

Photo by Matteo Gelardi

Tubes at first extremely thin then increasingly broader and shorter than the thickness of the pileus context (up to 0.5 cm long), adnate, bright yellow, turning blue when cut and eventually fading to drab yellowish.

Pores forming a concave to flat surface, initially very small then gradually wider, simple, roundish, at first rusty-brown then persistently reddish-brown but paler towards the margin, bruising blue when injured and finally becoming blackish.

Stipe 4.3-8.2 × 0.7-1.5 cm, slender and longer than the pileus diameter, central, solid, firm, dry, straight or faintly curved at base, cylindrical but slightly swollen at the very base, not to barely rooting; surface showing an extremely fine, brownish-red to rusty brown punctuation in the upper three fourth, completely hiding the straw-yellow ground color in the first developmental stages; the base is typically wrapped by a conspicuous golden-yellow strigosity; bruising greenish-blue then blackish throughout when pressed; basal mycelium yellowish.

Context firm and tough, straw-yellow in the pileus but gradually brighter in the stipe and golden-yellow downwards, usually with pinkish-brown to purple-brown spots at the very base; turning blue more or less evenly when exposed to air and finally fading to drab yellowish but nearly unchangeable at the extreme base; subhymenophoral layer yellowish.

Odor strong, fruity, agreeable.

Taste mild.

Spore print not obtained.

Macrochemical reactions 5% KOH: staining bright orange on stipe, pale orange on tubes and context, dark red on pileus and pores.

Edibility edible, much appreciated, largely consumed and traded in local mushroom markets, known in Yunnan with the vernacular names “cat eye mushroom” and “black goat liver”, suggesting the overall brownish color of the basidiomes (CHIU, 1948; ZANG, 1995; LI & SONG, 2002; WANG & LIU, 2002a; SITTA *ET AL.*, 2007; DAI *ET AL.*, 2010; LI *ET AL.*, 2013).

Microscopic description (Plate 3)

Basidiospores [11/2/1] (10.5)11.4 ± 0.61(12.2) × (4.2)4.9 ± 0.46(6.0) μm, Q = (2.03)2.20-2.63(2.66), Q_m = 2.31 ± 0.18, V = 149 ± 35 μm³, sparse (due to the immature specimens examined!), inequilateral, ellipsoid-fusiform to fusiform in side view, ellipsoid to ellipsoid-fusiform in face view, smooth, with a short apiculus and an indistinct to shallow suprahilar depression, apex rounded, moderately thick-walled (0.3-0.6 μm), bright yellow colored in water and 5% KOH, having one, two or three large oil droplets when mature, rarely pluri-guttulate, inamyloid and with an orthochromatic reaction.

Basidia (32)38-45(48) × 9-14 μm (n = 5), scattered, cylindrical-clavate to clavate, moderately thick-walled (0.5-0.8 μm), 4-spored, usually bearing short sterigmata (2-4 μm), hyaline to very pale yellowish and sometimes containing straw-yellow oil guttules in water and 5% KOH, bright yellow (inamyloid) in Melzer's, without basal clamps; basidioles subcylindrical to cylindrical-clavate or less frequently broadly clavate, similar in size to basidia.

Cheilocystidia (20)24-42(44) × 5-8 μm (n = 12), very common, moderately slender, projecting straight to sometimes flexuous, fusiform to sublageniform, occasionally subclavate, with rounded to subacute tip, smooth, moderately thick-walled (0.3-0.6 μm), yellowish in water and 5% KOH, bright yellow in Melzer's (inamyloid), without epiparietal encrustations.

Pleurocystidia 38-41 × 9-10 μm (n = 2), extremely rare (only two observed in several mounts!), size, shape, color and chemical reactions similar to cheilocystidia.

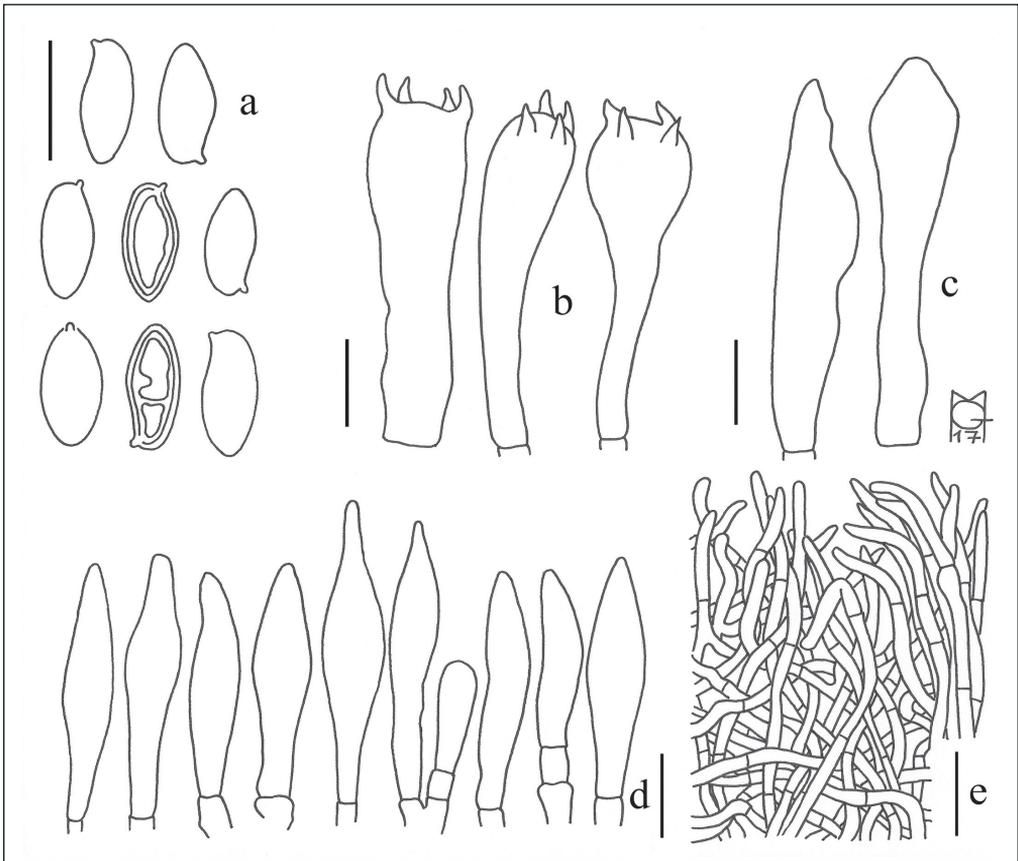


Plate 3. *Neoboletus brunneissimus*. Microscopic characters (MG440). a. Spores; b. Basidia; c. Pleurocystidia; d. Cheilocystidia; e. Pileipellis. Scale bars: a-d = 10 μ m; e = 20 μ m. Drawings by Matteo Gelardi

Pseudocystidia not recorded.

Pileipellis a trichoderm consisting of vertically arranged, subparallel to moderately interwoven, elongated, filamentous, frequently branched hyphae not embedded in gelatinous matter; terminal elements relatively short, $23\text{--}45 \times 3\text{--}6 \mu\text{m}$, cylindrical to cystidioid, tapering upwards, apex usually rounded to less frequently pointed, moderately thin-walled (up to $0.5 \mu\text{m}$), yellowish-brown in water, bright yellow (as a result of brownish pigment dissolving) in 5% KOH, inamyloid in Melzer's, smooth; 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, $3\text{--}12 \mu\text{m}$ wide, pale yellow to straw-yellow in water and 5% KOH; the stipe apex covered by a well-developed caulohymenial layer consisting of not yet differentiated caulobasidioles, caulobasidia and sterile cystidioid elements.

Lateral stipe stratum under the caulohymenium present and well differentiated from the stipe trama, of the "boletoid type", at the stipe apex a $(50)60\text{--}130(140) \mu\text{m}$ thick layer consisting of strongly divergent, inclined and running towards the external surface, loosely intermingled and branched hyphae remaining separate and embedded in a gelatinous substance.

Stipe trama composed of subparallel to moderately interwoven, densely arranged, filamentous, smooth, inamyloid hyphae, 2-13 μm broad.

Basal tomentum hairs 70-180 μm thick, consisting of tightly adpressed, parallel to subparallel, septate, filamentous, not branched, thin-walled (up to 0.3 μm) hyphae, 2-6 μm wide, pale yellow in water and 5% KOH.

Hymenophoral trama bilateral divergent of the “*Boletus*-type” with moderately to distinctly divergent, slightly recurved-arcuate and loosely arranged, gelatinous hyphae (lateral strata hyphae often branched, faintly constricted at septa, in transversal section remaining separate and (1)3-8(10) μm apart, 2-8 μm broad), hyaline to pale yellowish in water and 5% KOH, inamyloid in Melzer’s; lateral strata (20)30-50(60) μm thick, mediostratum (20)30-50 μm thick, axially arranged, consisting of a tightly adpressed, non-gelatinous bundle of hyphae, 2-5 μm broad; in Congo red the mediostratum is darker than the lateral strata.

Oleiferous hyphae present.

Clamp connections absent in all tissues.

Hyphal system monomitic.

Ontogenetic development gymnocarpic.

Ecology: solitary to gregarious, in temperate to subtropical and tropical regions, growing in association with *Fagaceae* (*Castanopsis*, *Quercus*) and *Pinaceae* (*Pinus*), summer to autumn.

Examined material: China, Yunnan Province, Kunming city, Qiongzhu Temple, 25°04' 13" N, 102°37'38" E, 2150 m alt., one middle-aged and another young basidiome fruiting within 1 meter of one another, on a slope facing north, in litter in a pure stand of *Castanopsis orthacantha* Franch. with the presence of bamboo plants; legit. M. Gelardi, B. Feng, G. Wu and Y.- J. Hao; 5 October 2011, MG440.

Other species found in the same habitat: *Boletus monilifer* B. Feng, Y.Y. Cui, J.P. Xu & Zhu L. Yang, *Chiuia virens* (W.F. Chiu) Yan C. Li & Zhu L. Yang, *Cordyceps militaris* (L.) Link, *Strobilomyces echinocephalus* Gelardi & Vizzini, *Xerocomellus communis* Xue T. Zhu & Zhu L. Yang.

Notes

The main morphological traits of *N. brunneissimus* can be summarized as follow: medium-small sized basidiomes, slender habit, velvety pileus surface, umber to rusty-brown colored pileus and pores, stipe ornamented by brown-red to rusty-brown dense punctuations on a yellowish background, lowermost part of the stipe prominently strigose with golden yellow to brownish-yellow hairs, yellow context, tissues bruising dark blue when injured, ellipsoid-fusiform basidiospores and trichodermal pileipellis consisting of filamentous hyphae. It is found associated with members of the *Fagaceae* and *Pinaceae* mainly in the subtropical and tropical belt but is present in temperate regions as well. This species seems to have a wide distribution in central, southern, south-western and western China, having been reported from a number of Provinces, such as Henan, Hunan, Guangdong, Hainan, Guizhou, Guangxi, Anhui, Sichuan, Yunnan, Qinghai, Xinjiang and Tibet (LI & SONG, 2000; SHEN ET AL., 2009) and also occurs in subalpine environment in Japan (TANEYAMA, in litt.).

Neoboletus brunneissimus was firstly described from Yunnan as a member of *Boletus* s. l. by CHIU (1948) who later provided a colored illustration (CHIU, 1957). Reports of *N. brunneissimus* can be found in a number of Chinese regional mycotas, bolete monographies, research articles, checklists and photographic atlas such as BI ET AL. (1997), ZANG (1999, 2006), MAO (2000, 2009), WANG & LIU (2002a, 2002b), WANG (2004), WANG ET AL. (2004), SHEN ET AL. (2009), etc.

Only recently the phylogenetic position of this species has been assessed (WU ET AL., 2014) with the attribution to *Neoboletus* Gelardi, Simonini & Vizzini (VIZZINI, 2014; WU ET AL., 2016a), but after a short time the same Chinese authors recombined *N. brunneissimus* in the genus *Sutorius* Halling, Nuhn & Fechner along with other allied species formerly placed in *Boletus* s. l. and *Neoboletus*, this latter being synonymized with *Sutorius* (WU ET AL., 2016b). The present author disagree with this broad circumscription of *Sutorius* since it is, judging from the original description, easily separated from *Neoboletus* based on the overall dark colors, different stipe ornamentation pattern, different spore print color, pores stuffed in early developmental stages like those of *Boletus* s. str. and *Butyriboletus* and non-bluing tissues (HALLING ET AL., 2012). Enough, in the author's personal opinion, to say they are not the same thing especially because they cluster in two different (although with a low statistical support) sister clades. Moreover, molecular studies carried out by SMITH ET AL. (2015) on boletoid fungi from north-eastern South America (Guyana) indicate the sequestrate genus *Costatisporus* T.W. Henkel & M.E. Smith as sister to *Sutorius*.

The North American *Boletus vermiculosoides* A.H. Smith & Thiers, the European *Neoboletus luridiformis* (Rostk.) Gelardi, Simonini & Vizzini (= *Boletus erythropus* Pers. s. Fr. et auct. p. p. non s. Pers.), the Chinese *B. hainanensis* T.H. Li & M. Zang and the Japanese *B. umbriniporus* Hongo are very similar to each other and to *N. brunneissimus*. The synapomorphies of the five species are the brown, velvety pileus, the yellow then olive-yellow tubes, the presence of punctuations on stipe surface, the tissues staining dark blue when exposed to air and the ellipsoid-fusiform basidiospores. In contrast to *N. brunneissimus*, basidiomes of *N. vermiculosoides* exhibit medium-sized basidiomes, pileus surface initially yellow then brown, finely pruinose stipe surface, non-strigose stipe base, narrower spores [3-3.5(4) μm broad], smaller basidia (20-26 \times 7-9 μm), pileipellis consisting of a cutis and occurrence in eastern and north-eastern North America (SMITH & THIERS, 1971; BOTH, 1993; BESSETTE ET AL., 2000, 2016). *N. luridiformis* differs significantly from *N. brunneissimus* in the large sized basidiomes (pileus up to 25-30 cm in diam.), red pores, stout, fleshy stipe (up to 15 \times 8 cm) covered by reddish punctuations, non-strigose stipe base, longer spores [(12,8)13.3-15.5(16.5) \times 4.2-5.5 μm , Qm = 2.95] and occurrence in Europe in temperate regions (PILÁT & DERMEK, 1974; ALESSIO, 1985; BREITEMBACH & KRÄNZLIN, 1991; LANNON & ESTADÈS, 2001; MUÑOZ, 2005; WATLING & HILLS, 2005; KLOFAC, 2007; KNUDSEN & TAYLOR, 2012; Pers. Obs.). *B. hainanensis* can be distinguished by the glabrous and slightly viscid pileus surface, stipe context unchanging or slowly turning light blue on exposure, longer pleurocystidia [26-70(86) μm long] and generally ixothricoderm pileipellis (BI ET AL., 1997, as "*B. erythropus* f. *hainanensis* T.H. Li nom. nud."; ZANG ET AL., 2001; WANG, 2004; ZANG, 2006; WU ET AL., 2016). *B. umbriniporus* is separated by the slightly shorter basidiospores [(10.2)10.8-11.8(12.4) \times (4.2)4.6-5(5.5) μm , Qm = 2.36 vs. (10.9)11.6-12.8(13.4) \times (4.7)4.8-5.2(5.6) μm , Qm = 2.46, based on Japanese samples of *N. brunneissimus* examined by Y. Taneyama] and possibly the occurrence at low elevations (up to 800 m alt.) (HONGO, 1969; TANEYAMA, in litt.). It must be emphasized that *B. umbriniporus* is indicated by WANG & LIU (2002a) and SITTA ET AL. (2007) as a later synonym of *N. brunneissimus* but as yet without molecular evidence. Conversely, ongoing phylogenetic investigations (TANEYAMA, unpublished data) attested that the two species are separate although with a sister relationship and confirmed the occurrence of *N. brunneissimus* in Japan. Chinese fungal material identified as *B. umbriniporus* (ZANG, 1999, 2006; MAO, 2000, 2009; ZHUANG, 2001; WANG, 2004; LI, 2011; TOLGOR ET AL., 2013; etc.) should in any case be carefully re-evaluated.

There are at least three other Asian species that could be confused with *N. brunneissimus*, viz. *Boletus obscureumbrinus* Hongo, *B. fuscopunctatus* Hongo & Nagasawa and *B. tomentulosus* M. Zang, W.P. Liu & M.R. Hu. *B. obscureumbrinus* is characterized by decidedly larger and much

fleshy basidiomes, stipe usually ventricose to bulbous at the base, yellowish-orange at apex and with concolorous dots or not punctate at all, smooth stipe base, softer, cottony context in the stipe, lighter and slower bluing of the context when cut and slightly broader pileipellis terminal elements (4.5-9 μm broad) (HONGO, 1968; MAO, 2000; WANG, 2004; WANG ET AL., 2004; ZANG, 2006; SITTA ET AL., 2007; WU ET AL., 2016). *B. fuscopunctatus* is much stouter (pileus up to 20 cm diam.), with somewhat darker pileus colors and devoid of strigosity at the stipe base (HONGO & NAGASAWA, 1976; WANG & LIU, 2002a). *B. tomentulosus* differs in the very fine, yellowish punctuations on stipe surface, shorter basidiospores [8-11(12.5) μm long], shorter cheilocystidia and pleurocystidia (18-27 μm long and 22-29 μm long, respectively) and longer pileipellis terminal cells [32-70(80) μm long] (ZANG ET AL., 1991; WANG, 2004; ZANG, 2006; WU ET AL., 2016). Molecular analysis further confirm the separation of *B. brunneissimus* from *B. tomentulosus* (WU ET AL., 2016) and, therefore, the purported synonymy of the two species as previously suggested by WANG & LIU (2002a) is to be considered wrong.

The genus *Neoboletus* has a holarctic distribution, being represented in both Eurasia and North America from temperate to tropical regions. It currently encompasses less than ten species worldwide but the real number of its members is still far from being assessed and it is likely to be expected that many more taxa will turn out to belong to that genus in the near future.

To be continued...