

## Two new species of Agaricales and a new Japanese record for *Boletellus betula* from Japan

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**Abstract** Three species of Agaricales and Boletales are fully described and illustrated from Japan: (1) *Clitopilus vernalis* sp. nov. produces collybioid basidiomata with pruinose, greyish-yellow pileus and stipe, obscurely undulate basidiospores, and has a lignicolous habit fruiting in spring on dead decorticated logs of *Pinus densiflora*; (2) *Favolaschia gelatina* sp. nov. (section *Anechinus* subsection *Rubrinae*) has pleurotoid, astipitate basidiomata with transparent, elastic, jelly-like flesh, and truly poroid hymenophore; (3) *Boletellus betula* is a new record for Japan, growing in *Quercus crispula* and *Pinus densiflora* forests.

**Keywords** *Clitopilus vernalis* · *Favolaschia gelatina* · Japanese mycobiota · Taxonomy

### Introduction

*Clitopilus* (Fr. ex Rabenh.) P. Kumm. is a genus distributed worldwide having mostly collybioid or clitocyoid basidiomata producing pink to brownish-pink basidiospores with longitudinal ribs. Co-David et al. (2009) emended the generic delimitations of *Clitopilus* to accommodate the taxa that have nodulose basidiospores, clamp connections, and hymenial pseudocystidia and had been placed into a closely related but distinct genus *Rhodocybe* Maire,

primarily based on the results of phylogenetic reconstruction and the evolutionary interpretation of spore morphology. In Japan, no extensive studies on the clitopiloid and rhodocyoid agarics have hitherto been made. According to the list of fungi recorded in Japan by Katumoto (2010), five species of *Rhodocybe*, i.e., *Rhodocybe crepidotoides* Singer, *Rhodocybe nitellina* (Fr.) Singer, *Rhodocybe gemina* (Fr.) Kuyper & Noordel. [= *Rhodocybe truncata* (Schaeff.) Singer], *Rhodocybe roseiavellanea* (Murrill) Singer, and *Rhodocybe popinalis* (Fr.) Singer [= *Rhodocybe mundula* (Lasch) Singer], and three species of *Clitopilus*, i.e., *Clitopilus caespitosus* Peck, *Clitopilus lignyotus* Hongo, and *Clitopilus prunulus* (Scop.) P. Kumm., have been known in Japan.

*Favolaschia* (Pat.) Pat. comprises about 50 species (Kirk et al. 2008) and generally distributes in tropical to subtropical areas. The genus is characterized by possessing mostly pleurotoid, strongly gelatinized basidiomata with a poroid or faveoloid hymenophore, and amyloid basidiospores and by often forming hyphidia in the hymenium. Singer (1969) excluded *Favolaschia* from the Agaricales and established the monotypic family Favolaschiaceae to accommodate the genus on the basis of the presence of a catahymenium, which was used as evidence for placing the new family in the Aphyllophorales. More recently, the genus *Favolaschia* was placed into the family Mycenaceae (Agaricales) as a result of phylogenetic analyses (Moncalvo et al. 2002). As for the Japanese flora of *Favolaschia*, very little information is available with the exception of four species reported by Kobayasi (1952), i.e., *Favolaschia fujiisanensis* Kobayasi, *Favolaschia nipponica* Kobayasi, *Favolaschia peziziformis* (Berk. & M.A. Curtis) Kuntze, and *Favolaschia phyllostachydis* Imazeki & Kobayasi.

*Boletellus betula* (Schwein.) E.-J. Gilbert was originally described from the United States and is also known from

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Mexico (Singer et al. 1992) and China (Teng 1996). Although the fruiting body of *B. betula* has outstanding macroscopic characteristics, its micromorphological features have not yet been fully described. The earliest report of this species in Japan was given by Kumamoto Kinoko Kai (1992) from Kumamoto Prefecture on the basis of only one specimen. Unfortunately, the identification is not reliable, as no microscopic information was provided and the specimen is not available.

During a survey on the mycobiota of Japan, we encountered new species of the two genera *Clitopilus* and *Favolaschia* already mentioned (*C. vernalis* and *F. gelatinosa*, respectively), and *B. betula*. They are fully described and illustrated here.

### Materials and methods

Macroscopic features are all based on fresh materials. For microscopic observations, free-hand sections of the fresh basidiomata were examined in Melzer's reagent, 5% KOH, or distilled water. Basidiospores were measured in side view in Melzer's reagent; for each collection at least 20 basidiospores were measured. Color notations in parentheses are taken from Kornerup and Wanscher (1983). Specimens cited here are deposited in the Kanagawa Prefectural Museum of Natural History, Japan (KPM).

### Taxonomic descriptions

#### 1. *Clitopilus vernalis* Har. Takah. & Degawa, sp. nov.

Figs. 1–4

MycoBank no.: MB518654

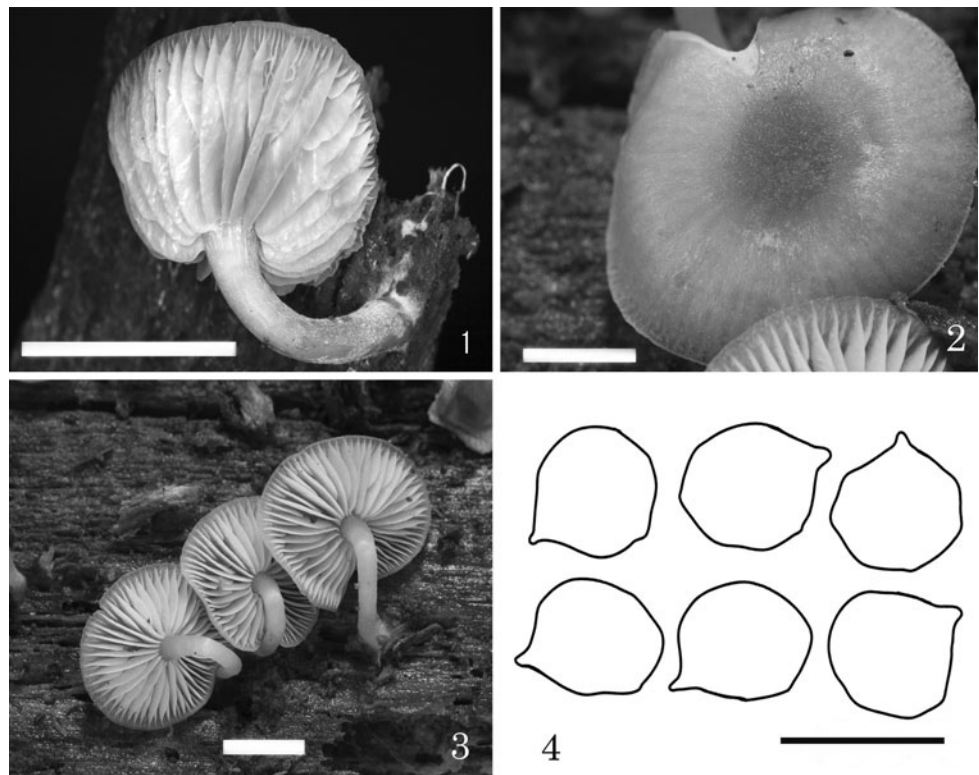
Pileo 11–30 mm lato, primo hemisphaerico, dein planoconvexo, primo pruinoso, dein glabro, hygrophano, griseo-flavido vel olivaceo-brunneo; odore saporeque nullo; stipite 10–20 × 1.5–4 mm, subaequali, cylindraco, centrali, cavo, pruinoso, griseo-flavido, mycelio basali albo affixo; lamellis adnexis vel liberis, subdistantibus, albis; basidiosporis (5–)5.5–6(–7) × (4–)5–5.5 μm, subglobosis vel ellipsoideis, obscure undulatis, levibus, hyalinis vel roseo-albis, inamyloideis; basidiis 25–30 × 7–10 μm, tetrasporis; cheilocystidiis pleurocystidiisque nullis; pileipelle ex hyphis repentibus cylindricis levibus hyalinis vel pallide aurantiacis composita; hyphis fibulatis.

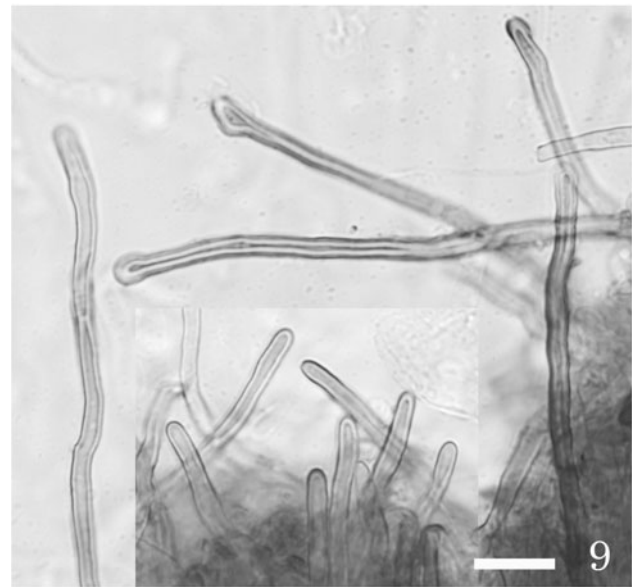
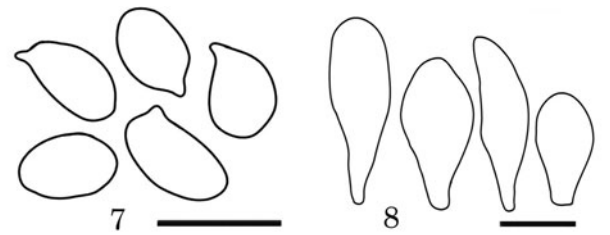
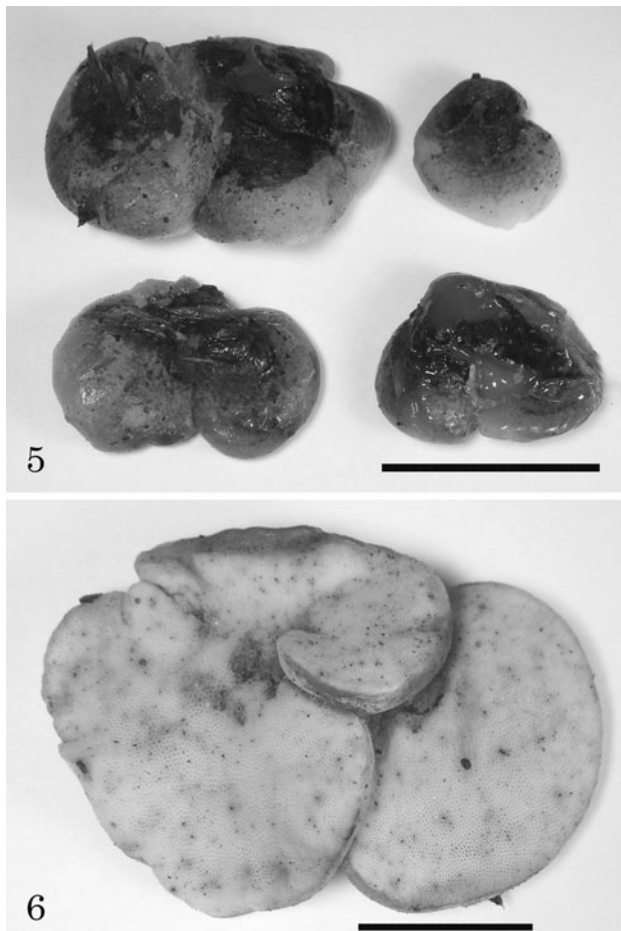
Holotypus: In arboris *Pinus densiflora* Siebold & Zucc. in silva, Iryuda, Odawara-shi, Kanagawa Pref., Japonia, 18 February 2009, Y. Degawa s.n. (KPM-NC0017291).

Etymology: from Latin, *vernal* = vernal.

Pileus (Figs. 1–3) 11–30 mm in diameter, when young hemispherical to convex with incurved margin, in age becoming broadly convex to applanate, sometimes with depressed to shallowly umbilicate center; surface moist to dry (not viscid), pruinose at first, then glabrescent, hygrophorous, pellucid-striate when moist; greyish yellow

**Figs. 1–4** *Clitopilus vernalis*. **Figs. 1–3** Basidiomata. **Fig. 4** Basidiospores (holotype). Bars **1, 3** 16 mm; **2** 8 mm. Color photos of *Clitopilus vernalis* can be seen at <http://www7a.biglobe.ne.jp/~har-takah/page135.html>





**Figs. 7–9** *Favolaschia gelatina* (holotype). **Fig. 7** Basidiospores. **Fig. 8** Cheilocystidia. **Fig. 9** Terminal elements of the pileipellis. Bars 7 5  $\mu$ m; 8 7  $\mu$ m; 9 10  $\mu$ m

**Figs. 5, 6** *Favolaschia gelatina*. **Fig. 5** Surface view of the basidiomata. **Fig. 6** Underside view of the basidiomata. Bars 5 30 mm; 6 15 mm. (Photographs by Mr. Sinya Koutoku.) Color photos of *Favolaschia gelatina* can be seen at <http://www7a.biglobe.ne.jp/~har-takah/page136.html>

(4C3–7) or olive brown (4D4–6), darker olive brown (4F3–4F6) on the disc, fading to greyish beige (4C2) to brownish grey (4D2) in age and with moisture loss. Flesh thin (up to 2 mm), greyish yellow (4C3–4). Odor and taste not distinctive. Stipe 10–20  $\times$  1.5–4 mm, central, terete, cylindrical, almost equal or slightly enlarged at the base, sometimes flexuous, hollow; entirely pruinose, glabrescent in age, dry, arising from white mycelial tomentum; greyish yellow (4B3–4 to 4C3–4), paler toward the apex. Lamellae adnexed to free, subdistant (15–24) with 1–3 series of lamellulae, broad (3–5 mm), thin, greyish brown (10E3–11E3) when young, greyish brown (10F3–11F3) to violet brown (10F4–5 to 11F4–5) in mature specimens; edges even, concolorous.

Basidiospores (Fig. 4) (5–)5.5–6(–7)  $\times$  (4–)5–5.5  $\mu$ m ( $Q$  = length/breadth: 1.1), subglobose to shortly ellipsoid, weakly angular to obscurely undulate, hyaline or pinkish white (7A2) to pale red (7A3), inamyloid, thin-walled.

Basidia 25–30  $\times$  7–10  $\mu$ m, clavate to broadly clavate, 4-spored. Pleurocystidia and cheilocystidia none. Hymenophoral trama regular; element hyphae 3–15  $\mu$ m wide, cylindrical, smooth, non-gelatinous, hyaline, thin-walled. Pileipellis a cutis of repent, cylindrical hyphae 3–11  $\mu$ m wide, smooth, hyaline at the margin of pileus, with pale brownish cytoplasmic pigment at the center of pileus, non-gelatinous, infrequently with clamped septa; terminal cells 75–150  $\times$  5–15  $\mu$ m, cylindrical-subclavate to subfusiform, smooth, hyaline or with pale brownish cytoplasmic pigment, thin-walled. Pileus trama composed of loosely interwoven hyphae 7–22  $\mu$ m wide, cylindrical to somewhat inflated, smooth, hyaline, non-gelatinous. Hypodermium undifferentiated. Stipitipellis a cutis of parallel, cylindrical hyphae, 3–7  $\mu$ m wide, smooth, hyaline or with pale brownish cytoplasmic pigment, non-gelatinous, thin-walled, occasionally with clamped septa; terminal cells 40–70  $\times$  4–8  $\mu$ m, similar to those of the pileipellis. Basal tomentum composed of loosely arranged hyphae 3–7  $\mu$ m wide, cylindrical, smooth, hyaline, non-gelatinous, thin-walled, infrequently with clamped septa, lacking differentiated terminal cells.

Habitat: Solitary or scattered, lignicolous on dead fallen decorticated log of *Pinus densiflora* Siebold & Zucc., spring (February–April).

Known distribution: Japan (Hyogo, Kanagawa).

Specimens examined: KPM-NC0017291 (holotype), Iryuda, Odawara-shi, Kanagawa Pref., on dead fallen decorticated log of *Pinus densiflora*, 66 m alt., February 18, 2009, coll. Degawa, Y.; KPM-NC0017290, same place, March 9, 2007, coll. Degawa, Y.; KPM-NC0017292, same place, March 17, 2007, coll. Degawa, Y.; KPM-NC0017293, same place, March 1, 2009, coll. Degawa, Y.; KPM-NC0017294, same place, March 5, 2009, coll. Degawa, Y.; KPM-NC0015530, same place, April 3, 2008, coll. Degawa, Y.; KPM-NC0016694, same place, March 3, 2008, coll. Oka, H.; KPM-NC0016745, same place, March 20, 2009, coll. Kabasawa, Y.; KPM-NC0017295, Kita-ku, Kobe-shi, Hyogo pref., on dead fallen log of *Pinus densiflora*, 400 m alt., March 15, 2009, coll. Koutoku, S.

Japanese name: Haruno-urabenitake.

Comments: *Clitopilus vernalis* has the characteristics of collybioid basidiomata with a pruinose, greyish-yellow pileus and stipe, subglobose, obscurely undulate basidiospores, and a basidiome formation on the dead fallen decorticated log of *Pinus densiflora* in spring.

Its non-decurrent hymenophore, the absence of pseudocystidia, and the presence of clamp connections, at least in the pileipellis and the stiptipellis, suggest that *C. vernalis* is closely related to members of the section *Rhodophana* (Kühner) Singer (Baroni 1981; Singer 1986) of the genus *Rhodocybe*.

Within the section, *Rhodocybe lignicola* Singer from Bolivia (Singer 1961) and *Clitopilus albovelutinus* (G. Stev.) Noordel. & Co-David from New Zealand (Horak 1971) have lignicolous habits and lack hymenial cystidia in common with *C. vernalis*. However, the former differs from *C. vernalis* in having a reddish-brown pileus and stipe, and the latter can be distinguished from the species by the velvety-fibrillose pileus and the eccentric to lateral stipe.

Apart from the section *Rhodophana*, *C. vernalis* seems to be also closely related to the following two taxa, if we emphasize the lignicolous habit and the lack of pseudocystidia: *Clitopilus tergipes* (Corner & E. Horak) Noordel. & Co-David from North Borneo (Horak 1978); *Rhodocybe rickii* var. *convexa* (Singer) Singer from Mexico (Singer 1961). *Clitopilus tergipes* differs from *C. vernalis* in having whitish basidiomata with decurrent lamellae and an eccentric or lateral stipe, pale brown, encrusted pigmentation in the hyphae of the pileipellis, and lacking clamp connections. *Rhodocybe rickii* var. *convexa* is distinct in forming arcuate-decurrent lamellae, solid stipe, and lacking clamp connections.

*Rhodocybe amara* T.J. Baroni & G.M. Gates from Tasmania (Baroni and Gates 2006) is somewhat similar to *C. vernalis* in appearance; however, it does not correspond to the present species for reasons of the decurrent hymenophore, presence of hymenial pseudocystidia, absence of clamp connections, and terrestrial habit. *Clitopilus vernalis* is also comparable with *Rhodocybe pruinostipitata* T.J. Baroni, Largent & Aime from Guyana (Henkel et al. 2010) in the colors of the basidiomata, the pruinose stipe, and the lignicolous habit, although it can be distinguished from *C. vernalis* by having hymenial pseudocystidia, encrusted hyphae in the outer stipe trama, and lacking clamp connections.

Recently, Co-David et al. (2009) clarified that there is no significant difference between *Clitopilus* and *Rhodocybe* at the generic rank based on analysis of the phylogenetic reconstruction and evolution of basidiospores; therefore, they transferred the nodulose-spored taxa of *Rhodocybe* to *Clitopilus*. We accept their broad concept of *Clitopilus* and relegate the present fungus to that genus.

## 2. *Favolaschia gelatina* Har. Takah. & Degawa, sp. nov. Figs. 5–9

Mycobank no.: MB518655

Fructificatio sessili, gelatina; pileo 12–35 mm lato, convexo vel unguato, subhygrophano, ruguloso, subpruinoso vel pubescenti, aurantiaco; odore saporeque nullo; tubulis gelineis, pallide aurantiacis; poris rotundatis, parvis, albis vel pallide aurantiacis; basidiosporis (3–)3.5–5 × (2.5–)3–3.5 μm, oboido-ellipsoideis, levibus, hyalinis vel roseo-albis, amyloideis; basidiis 10–15 × 3–6 μm, tetrasporis; cheilocystidiis 10–30 × 5–7 μm, claviformibus vel subfusoides, levibus, hyalinis; pleurocystidiis nullis; pileipelle ex hyphis repentibus cylindricis composita, levi, hyalina vel pallide aurantiaca; acanthophysibus nullis; hyphis fibulatis.

Holotypus: In arboris deciduis in silva, Chuou-ku, Kobe-shi, Hyogo Pref., Japonia, July 22, 2010, S. Koutoku, s.n. (KPM-NC0017518).

Etymology: from Latin, *gelatina* = jelly-like.

Basidiomata (Figs. 5, 6) pleurotoid, sessile, and dorsally attached or attached laterally, entirely consisting of elastic and jelly-like tissues. Pileus 12–35 mm in diameter by 7–11 mm tall, convex to unguate; surface moist, subhygrophanous, smooth, often rugose to rugulose in places, subpruinose, minutely pubescent near point of attachment; orange (5A6–7), dark orange (5A8) near attachment, pale orange (5A3) to light orange (5A4) toward the margin. Flesh up to 5 mm, transparent, elastic, jelly-like. Odor and taste not distinctive. Tubes up to 3.5 mm deep, jelly-like, whitish or orange white (5A2) to pale orange (5A3); pores subcircular, minute (2–4/mm), whitish or orange white

(5A2) when young, pale orange (5A3) at maturity, often spotted with orange (5A6–7) to dark orange (5A8) small stains in age.

Basidiospores (Fig. 7)  $(3-3.5-5 \times (2.5-3-3.5 \mu\text{m}))$  ( $Q = \text{length/breadth}: 1.2-1.4$ ), ovoid-ellipsoid, smooth, hyaline, amyloid, thin-walled. Basidia  $10-15 \times 3-6 \mu\text{m}$ , clavate to broadly clavate, 4-spored. Cheilocystidia (Fig. 8)  $10-30 \times 5-7 \mu\text{m}$ , clavate to subfusoid, smooth, hyaline or pale yellow (4A3) to light yellow (4A4) in  $\text{H}_2\text{O}$ , hyaline or greyish orange (6B6) to orange (6B7) in KOH, inamyloid, thin-walled. Pleurocystidia none. Hymenophoral trama with more or less parallel, cylindrical hyphae  $3-7.5 \mu\text{m}$  wide, dense, smooth, hyaline in  $\text{H}_2\text{O}$  and KOH, inamyloid, thin-walled, with numerous clamp connections. Pileipellis (Fig. 9) a loose cutis of entangled, cylindrical hyphae  $2-5 \mu\text{m}$  wide, smooth, light orange (5A4) in  $\text{H}_2\text{O}$ , orange red (8B7–8) in KOH, inamyloid, strongly gelatinized, smooth, with light orange (5A4), moderately thickened walls  $1-1.5 \mu\text{m}$  thick, with numerous clamp connections; terminal cells  $15-70 \times 2-5 \mu\text{m}$ , subcylindrical to clavate-cylindrical, at times with a somewhat capitulate apex, infrequently short-forked. Pileus trama composed of irregularly arranged, loosely interwoven hyphae  $2-5 \mu\text{m}$  wide, cylindrical, more frequently branched than the hymenophoral trama, smooth, hyaline in  $\text{H}_2\text{O}$  and KOH, inamyloid, strongly gelatinized, thin-walled, with numerous clamp connections. Acanthocysts, gloeocystidia, and diverticulate hyphae absent.

Habitat: Gregarious or scattered, lignicolous on dead fallen logs (unidentified substrata), June–October.

Known distribution: Japan (Hyogo, Kanagawa, Shizuoka, Tokyo).

Specimens examined: KPM-NC0017518 (holotype), Chuou-ku, Kobe-shi, Hyogo Pref., on dead fallen log, 410 m alt., July 22, 2010, coll. Koutoku, S.; KPM-NC0017519, same place, July 26, 2010, coll. Koutoku, S.; KPM-NC0017287, Iryuda, Odawara-shi, Kanagawa Pref., on dead fallen logs, 66 m alt., September 25, 2008, coll. Degawa, Y.; KPM-NC000017288, same place, July 6, 2008, coll. Degawa, Y.; KPM-NC0017289, same place, July 10, 2008, coll. Degawa, Y.; KPM-NC0014657, same place, July 8, 2007, coll. Nishimura, M.; KPM-NC0016890, same place, July 5, 2009, coll. Nishimura, M.; KPM-NC0014720, Minamia-sakawa-cho, Hachioji-shi, Tokyo-to, on dead fallen logs, June 24, 2007, coll. Degawa, Y.; KPM-NC0005664, KPM-NC0009570, Itoh-shi, Shizuoka Pref., on dead fallen logs, October 14, 2001, coll. Degawa, Y.; KPM-NC0010295, same place, September 30, 2002, coll. Degawa, Y.; KPM-NC0012925, Kamakura-shi, Kanagawa Pref., on dead fallen logs, June 26, 2005, coll. Degawa, Y.

Japanese name: Nikawa-rassitake.

Comments: *Favolaschia gelatina* is characterized by the astipitate, dorsally attached basidiomata with transparent,

elastic, jelly-like flesh, the truly poroid hymenophore, the ovoid-ellipsoid, amyloid basidiospores, the clavate to subfusoid, smooth cheilocystidia, the non-diverticulate pileipellis elements having moderately thickened walls, the presence of clamp connections, and the lignicolous habit. Its strongly gelatinized basidiomata with typically poroid hymenophores and the absence of acanthocysts and gloeocystidia suggest that *F. gelatina* is referable to the subsection *Rubrinae* Singer of the section *Anechinus* Singer in Singer's system (Singer 1974, 1986).

Within the subsection, *F. gelatina* seems to be closely related to *Favolaschia tonkinensis* (Fr.) Singer from Southeastern Asia and tropical Africa (Singer 1945b, 1974) because of the astipitate basidiomata and the absence of acanthocysts in the hymenium. However, the latter species clearly differs from *F. gelatina* in producing greyish basidiomata, lacking cheilocystidia, and having subglobose basidiospores.

Its distinctly jelly-like, astipitate, pleurotoid basidiomata with truly poroid hymenophores also bears a superficial resemblance to *Resupinatus porosus* M.P. Martín, Lodge & Thorn from Puerto Rico (Thorn et al. 2006). The Puerto Rican species is easily separated from *F. gelatina* in forming tubular-coralloid pileipellis elements with heavily encrusted pigments, dissepiments consisting of clavate-acanthophysoid or coralloid cells, and globose, inamyloid basidiospores.

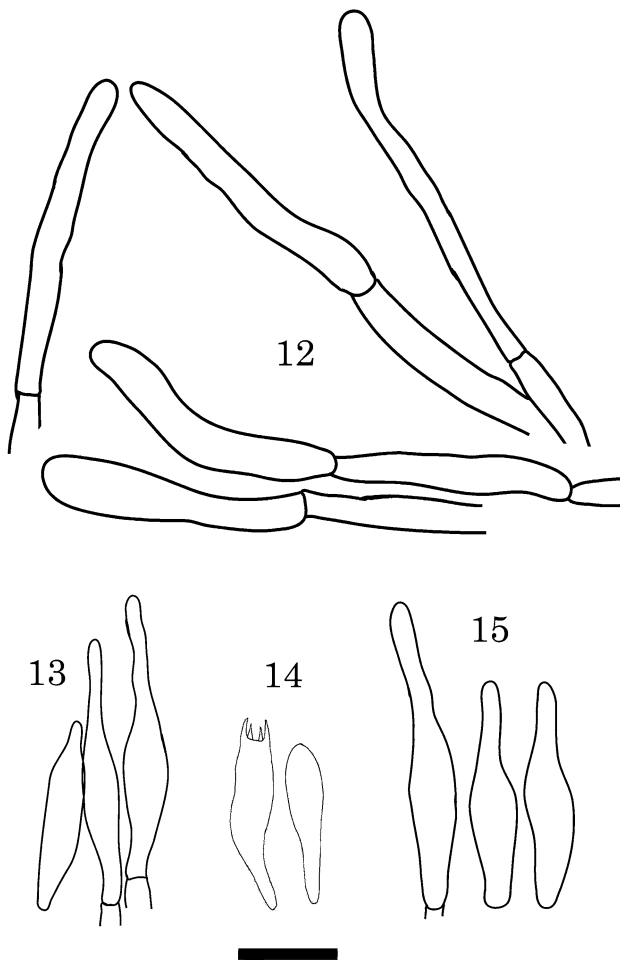
3. *Boletellus betula* (Schwein.) E.-J. Gilbert, Bolets: 108, 1931. Figs. 10–11

Basionym: *Boletus betula* Schwein., Schr. Naturf. Ges. Leipzig 1:90, 1822.

=*Austroboletus betula* (Schwein.) E. Horak, Sydowia 33:72, 1980.



**Figs. 10, 11** *Boletellus betula*. **Fig. 10** Mature basidiomata. **Fig. 11** Immature basidioma. Bars **10** 80 mm; **11** 10 mm. (Photographs by Mr. Haruo Sakamoto.) Color photos of *Boletellus betula* can be seen at <http://www.7a.biglobe.ne.jp/~har-takah/page101.html>



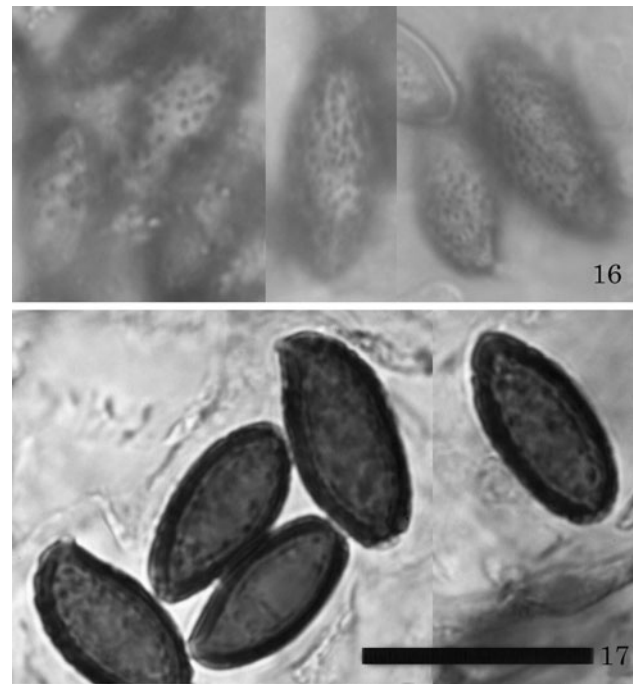
**Figs. 12–15** *Boletellus betula* (KPM-NC0007423). **Fig. 12** Terminal elements of the pileipellis. **Fig. 13** Cheilocystidia. **Fig. 14** Basidium and basidiole. **Fig. 15** Pleurocystidia. Bar 20  $\mu\text{m}$

=*Heimiella betula* (Schwein.) Watling, in Watling & Hollands, Notes R.

Bot. Gdn Edinb. 46(3):420, 1990.

=*Heimioporus betula* (Schwein.) E. Horak, Sydowia 56(2):239, 2004.

Pileus (Figs. 10, 11) 40–95 mm in diameter, at first hemispherical, expanding to broadly convex, with straight margin, not appendiculate; surface glabrous, smooth, viscid when wet, at first greyish red (8C4–5) or brownish red (8C4–5), then orange red (8A7–8 to 8B7–8), with a light yellow (3A5) to yellow (3A6) margin, at times yellow (3A6) overall. Flesh up to 10 mm thick, pale yellow (3A3) to light yellow (3A4–5), orange red (8A7–8 to 8B7–8) immediately beneath the pileus surface, whitish at the base of stipe, unchanging or sometimes changing to orange red (8A7–8 to 8B7–8) where bruised; odor and taste indistinct. Stipe 80–210  $\times$  8–20 mm, subequal or somewhat tapering toward the apex, central, terete, solid; surface dry, coarsely lacunose-reticulated overall, with longitudinally raised,



**Figs. 16, 17** Basidiospores of *Boletellus betula* (KPM-NC0007423). **Fig. 16** Mounted in  $\text{H}_2\text{O}$ . **Fig. 17** Mounted in Melzer's reagent. Bar 20  $\mu\text{m}$

yellow (3A6) reticulum, concolorous with the pileus below, yellow (3A6) above, sometimes entirely becoming orange red (8A7–8 to 8B7–8) in age; base covered with whitish mycelial tomentum. Tubes 8–22 mm deep, depressed around the stipe, yellow (3A6–7) or greyish yellow (3B6–7), unchanging when bruised; pores up to 1 mm, subcircular, concolorous with the tubes.

Basidiospores (Figs. 16, 17) 18–22  $\times$  8–11  $\mu\text{m}$  ( $Q = \text{length/breadth}: 2\text{--}2.25$ ), inequilateral with a shallow suprahilar depression in profile, oblong ellipsoid to subfusoid in face view, with a truncate and seemingly eroded apex, ornamented with crowded pits over the entire surface, greyish-yellow (4C6–7) to brownish-yellow (5C6–7), distinctly amyloid, thick-walled (0.5–1  $\mu\text{m}$ ). Basidia (Fig. 14) 22–30  $\times$  7–10  $\mu\text{m}$ , clavate, four-spored. Basidioles (Fig. 14) clavate. Cheilocystidia (Fig. 13) gregarious, 30–60  $\times$  5–10  $\mu\text{m}$ , fusoid-ventricose to ventricose-rostrate with an obtuse apex, smooth, hyaline to pale yellow, inamyloid, thin-walled. Pleurocystidia (Fig. 15) scattered, 40–75  $\times$  5–12(–17)  $\mu\text{m}$ , similar to cheilocystidia. Hymenophoral trama with parallel, cylindrical hyphae 5–15  $\mu\text{m}$  wide, smooth, hyaline or yellowish white (3A2) to pale yellow (3A3), inamyloid or weakly amyloid, thin-walled. Pileipellis (Fig. 12) of an ixotrichoderm consisting of loosely interwoven hyphae 5–10  $\mu\text{m}$  wide, cylindrical, smooth, gelatinized, colorless or with intracellular brownish red (10C7) to dark red (10C8) pigment, distinctly amyloid, thin-walled. Pileitrama of cylindrical, loosely

interwoven hyphae 10–22 µm wide, smooth, colorless or yellowish white (3A2), inamyloid, thin-walled. Stipitipellis hymeniform, consisting of caulocystidia that distribute over the entire stipe surface; caulocystidia 25–40 × 12.5–20 µm, broadly clavate, smooth, with intracellular yellowish white (3A2) to pale yellow (3A3) or brownish red (10C7) to dark red (10C8) pigment, inamyloid, thin-walled. Stipe trama composed of longitudinally running, cylindrical cells 5–12.5 µm wide, unbranched, smooth, colorless or yellowish white (3A2) to pale yellow (3A3), inamyloid, thin-walled. Clamp connections absent.

Habitat: Solitary or scattered, on ground in mixed forest dominated by *Quercus crispula* Blume and *Pinus densiflora* Siebold & Zucc. 887 m alt., July to October.

Known distribution: USA, Mexico, China, Japan.

Specimens examined: KPM-NC0007423, Hokuto-shi, Yamanashi Pref., on ground in *Quercus crispula* and *Pinus densiflora* forests, 887 m alt., August 21, 1997, coll. Sakamoto, H., Uehara, S., Yokoyama, H.; KPM-NC0017296, same place, October 5, 2007, coll. Uehara, S.

Japanese name: Kurenai-seitakaiguchi.

Comments: Except for the distinctly amyloid pileipellis elements, our material fully conforms to the descriptions given by the North American authors (Thiers 1963; Snell and Dick 1970; Smith and Thiers 1971; Bessette et al. 1997, 2000). At the collection locality in Japan (Hokuto-shi, Yamanashi Pref.), the species commonly occurs in the mixed forest of *Quercus crispula* and *Pinus densiflora* in summer to early fall.

Singer (1945a) created the new section *Allospori* Singer, in the genus *Boletellus*, to include the species with pit-like perforated basidiospores. Recently, Horak (2004) proposed the new genus name *Heimioporus* for *Heimiella* Boedijn (syn. Post.), and incorporated the *Boletellus* taxa with smooth and pit-like perforated basidiospores into *Heimioporus*. *Heimioporus*, however, seems to be a highly artificial genus because of the obvious overestimation of a single specific character, that is, the difference only in the basidiospore morphology. Furthermore, there is no closely related taxon in the other allied genera with a yellowish hymenophore such as in the genus *Boletus*. Because of its striking macromorphological resemblance to *Boletellus russellii*, except for the spore morphology, here we prefer to accommodate this species in the genus *Boletellus*.

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## References

- Baroni TJ (1981) A revision of the genus *Rhodocybe* Maire (Agaricales). Beih Nova Hedwigia 67:1–194
- Baroni TJ, Gates GM (2006) New species and records of *Rhodocybe* (Entolomataceae, Agaricales) from Tasmania. Aust Syst Bot 19:343–358
- Bessette AE, Bessette AR, Fischer DW (1997) Mushrooms of northeastern North America. Syracuse University Press, New York
- Bessette AE, Roody WC, Bessette AR (2000) North American boletes. A color guide to the fleshy pored mushrooms. Syracuse University Press, New York
- Co-David D, Langeveld D, Noordeloos ME (2009) Molecular phylogeny and spore evolution of Entolomataceae. Persoonia 23:147–176
- Henkel TW, Aime MC, Largent DL, Baroni TJ (2010) The Entolomataceae of the Pakaraima Mountains of Guyana: new species of *Rhodocybe*. Mycoscience 51:23–27
- Horak E (1971) A contribution towards the revision of the Agaricales (fungi) from New Zealand. N Z J Bot 9(3):403–462
- Horak E (1978) Notes on *Rhodocybe* Maire. Sydowia 31:58–80
- Horak E (2004) *Heimioporus* E. Horak gen. nov.—replacing *Heimiella* Boedijn (1951, syn. post., Boletales, Basidiomycota). Sydowia 56(2):237–240
- Katamoto K (2010) List of fungi recorded in Japan. The Kanto Branch of the Mycological Society of Japan, Kyoto
- Kirk PM, Cannon PF, Winter DW, Stalpers JA (2008) Dictionary of the fungi, 10th edn. CABI, UK
- Kobayasi Y (1952) On the genus *Favolaschia* and *Campanella* from Japan. J Hattori Bot Lab 8:1–4
- Kornerup A, Wanscher JH (1983) Methuen handbook of colour. Eyre Methuen, London
- Kumamoto Kinoko Kai (1992) Kumamoto no kinoko (Mushrooms of Kumamoto pref.). Kumamoto Nichinichi Shinbunsha, Kumamoto
- Moncalvo J-M, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJV, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Clémenceon H, Miller OK (2002) One hundred and seventeen clades of euagarics. Mol Phylogenet Evol 23:357–400
- Singer R (1945a) The Boletineae of Florida with notes on extralimital species I. The Strobilomycetaceae. Farlowia 2:97–141
- Singer R (1945b) The *Laschia*-complex (Basidiomycetes). Lloydia 8:170–230
- Singer R (1961) Fungorum novorum agaricalium. Sydowia 15:45–83
- Singer R (1969) Mycoflora Australis. Beih Nova Hedwigia 29:1–405
- Singer R (1974) A monograph of *Favolaschia*. Beih Nova Hedwigia 50:1–108
- Singer R (1986) Agaricales in modern taxonomy, 4th edn. Koeltz, Koenigstein
- Singer R, Garcia J, Gomez Ld (1992) The Boletineae of Mexico and Central America. Beih Nova Hedwigia 105:1–62
- Smith AH, Thiers HD (1971) The boletes of Michigan. The University of Michigan Press, Ann Arbor
- Snell WH, Dick EA (1970) The boleti of northeastern North America. J Cramer, Vaduz
- Teng SC (1996) Fungi of China (edited by Richard P. Korf). Mycotaxon, Ithaca, NY
- Thiers HD (1963) The bolete flora of the Gulf coastal plain. I. The Strobilomycetaceae. J Elisha Mitchell Sci Soc 79:32–41
- Thorn RG, Moncalvo J-M, Redhead SA, Lodge DJ, Martín MP (2006) A new poroid species of *Resupinatus* from Puerto Rico, with a reassessment of the cyphelloid genus *Stigmatolemma*. Mycologia 97(5):1140–1151