

Type studies on Japanese species of *Lactarius* described by S. Imai

Xiang-Hua Wang & Pei-Gui Liu

Key Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany,
Chinese Academy of Sciences, Kunming 650204, P. R. China

Wang X. H. & Liu P. G. (2010) Type study on Japanese species of *Lactarius* described by S. Imai. – *Sydowia* 62 (2): 225–335.

Holotype material and/or authentic collections of five Japanese taxa (deposited in the herbarium SAPA), described by S. Imai in 1935 were re-examined, viz. *Lactarius akanensis*, *L. avellaneus*, *L. deliciosus* f. *laeticolor*, *L. deliciosus* f. *virescens*, and *L. flavidulus*. For *L. deliciosus* f. *laeticolor* a lectotype was designated. The neotypification of *L. deliciosus* f. *virescens* is pending because no original material is available. The morphological analysis shows that the five enumerated taxa belong to *Lactarius* subgen. *Piperites*. *Lactarius akanensis* is a member of the *L. trivialis*-complex. *Lactarius avellaneus* is characterized by an isolattice with incrustations in the pileipellis and the latex staining yellow. *Lactarius flavidulus* belongs to *Lactarius* subgen. *Piperites* sect. *Zonarii*, in which it is remarkable due to the gray-greenish discolouration of the latex and lamellae. Detailed macromorphological and micromorphological descriptions and illustrations are presented.

Key words: Japan, lectotypification, Russulaceae, Taxonomy.

In the genus *Lactarius* Pers. (*Russulaceae*, *Basidiomycota*), 22 taxa (species, varieties, and forms) are originally, validly described from Japan (Nagasawa 1998, Takahashi 2001, Wang *et al.* 2006). Among them, those described in 1935 by S. Imai (Hokkaido University, Japan), are poorly known, even in Japan (Nagasawa 1998). In Imai's paper focusing on Hokkaido's *Lactarii*, six taxa were described as new to science: *L. akanensis*, *L. avellaneus*, *L. deliciosus* f. *laeticolor* (as "*laeticolorus*"), *L. deliciosus* f. *virescens*, *L. flavidulus*, and *L. sakamotoi* (Imai 1935). All of these names are validly published according to the ICBN (Article 37.1, McNeill *et al.* 2006), though no type was explicitly designated for any of them. Later, all of these taxa were re-enumerated by Imai (1938) but nothing was supplemented to the morphological recognition. Hongo (1960) classified them in the system of Singer (1951) but no more morphological observation was made.

In our research project focusing on the taxonomy of *Lactarius* in China, several of Imai's descriptions of Japanese species prompted our attention. It is difficult to conceive the morphological circumscription

of *Lactarius* species solely relying upon the descriptions in the protologue. With the help of the Hokkaido University Museum (SAPA), Sapporo, Japan, where the majority of collections of S. Imai are preserved, the first author re-traced the type specimens and/or the original material of these species. As result, the type studies are presented in two reports. The first part, referring to *L. sakamotoi* and its occurrence in China, is already published (Wang & Liu 2009). The second part is presented here.

Materials and Methods

All specimens examined were collected by S. Imai in Hokkaido, Japan during the year of 1923–1939 and are deposited in Herb. SAPA.

All macromorphological descriptions are based on dried material. For microscopical analysis, basidiospores from gill fragments of dried basidiomata were measured in Melzer's reagent in side view, excluding ornamentation and apiculus. All other micromorphological structures were re-hydrated in 5% KOH and subsequently mounted in Congo red (aqueous reagent). Presence or absence of hyphal incrustations was checked using distilled water. All drawings, except those of the basidiospores, were made by using a drawing tube installed on a Nikon E400 microscope (oil immersion objective: $\times 100$). Colour codes are from Kernerup & Wanscher (1961).

Taxonomy

Lactarius akanensis S. Imai, Bot. Mag. (Tokyo) 49: 605. 1935. – Figs. 1–4.

Copy of protologue: "Solitarius vel gregarius. Pileo 4–10 cm. lato, primo convexo, dein depresso, demum convexo-umbilicato, viscosissimo, glabro, levi, dilute purpureo-fuliginoso, primo leniter zonato, demum azonato, margine involuto, nudo; carne alba, crassa; lacte albo, sicco flavovirescente vel viridesciente, miti, tarde subacri, copioso; lamellis subadnatis vel adnato-decurrentibus, albidis vel vix flavulis, subdistantibus, bifidis; stipite 2–5 cm. longo, 1–1.5 cm. crasso, basi leniter attenuato, albo vel albido, udo leniter viscoso, sicco nitido, solido, dein cavo; sporis in cumulo albis, late ellipsoideis vel subglobosis, echinulatis, $8\text{--}10 \times 6\text{--}8 \mu$."

The holotype material is in very poor condition and consists of a small fragment of the pileus and half of a stipe mixed with small fragments of basidioma(ta). Pileus surface smooth, shining, brown (7E6–7E7), light brown (6D6). Lamellae 3 mm wide, subcrowded, light brown (6D4–6D5). Stipe 4 mm thick, cylindrical, surface smooth, yellowish brown (5D5) to light brown (6D6). Particular odor absent.

Basidiospores (7.5) $8.0\text{--}9.5$ (10.0) \times (6.0) $6.5\text{--}8.0$ (8.5) μm ($n = 40$) [$Q = (1.14) 1.18\text{--}1.29$ (1.31), $Q = 1.24 \pm 0.04$], ellipsoid, ornamentation 0.5–0.8 (1.0) μm high, composed of ridges and warts often connected by fine lines, some more or less in a zebroid pattern, not forming closed meshes, plage rarely distinctive, amyloid. Basidia 45–55 \times 10–13 μm , clavate, 4-spored. Pleuromacrocyttidia 55–90 \times 10–13 μm , com-

mon, emergent, fusiform or subblanceolate, apex obtuse or acute, with needle-like content. Pseudocystidia 3–4 μm wide, scarce, cylindrical, not forked. Lamellar edge hard to analyzed due to poor condition. Pileipellis an ixolattice, hyphae in suprapellis 2–4 μm wide, in subpellis 4–6 μm wide, slimy layer beyond the hyphal layer up to 50 μm thick, hyphal incrustations absent. Stipitipellis an intermediate between ixolattice and ixocutis, hyphae (1) 2–4 (5) μm wide, hyphal incrustations absent. Trama of stipe and pileus with rosettes of sphaerocytes. Hymenophoral trama filamentous.

Material examined. – JAPAN, Prov. Kushiro, Akan, Lake side of Panteto, 23 Sept 1934, *leg.* S. Imai, *det.* S. Imai (SAPA, holotype).

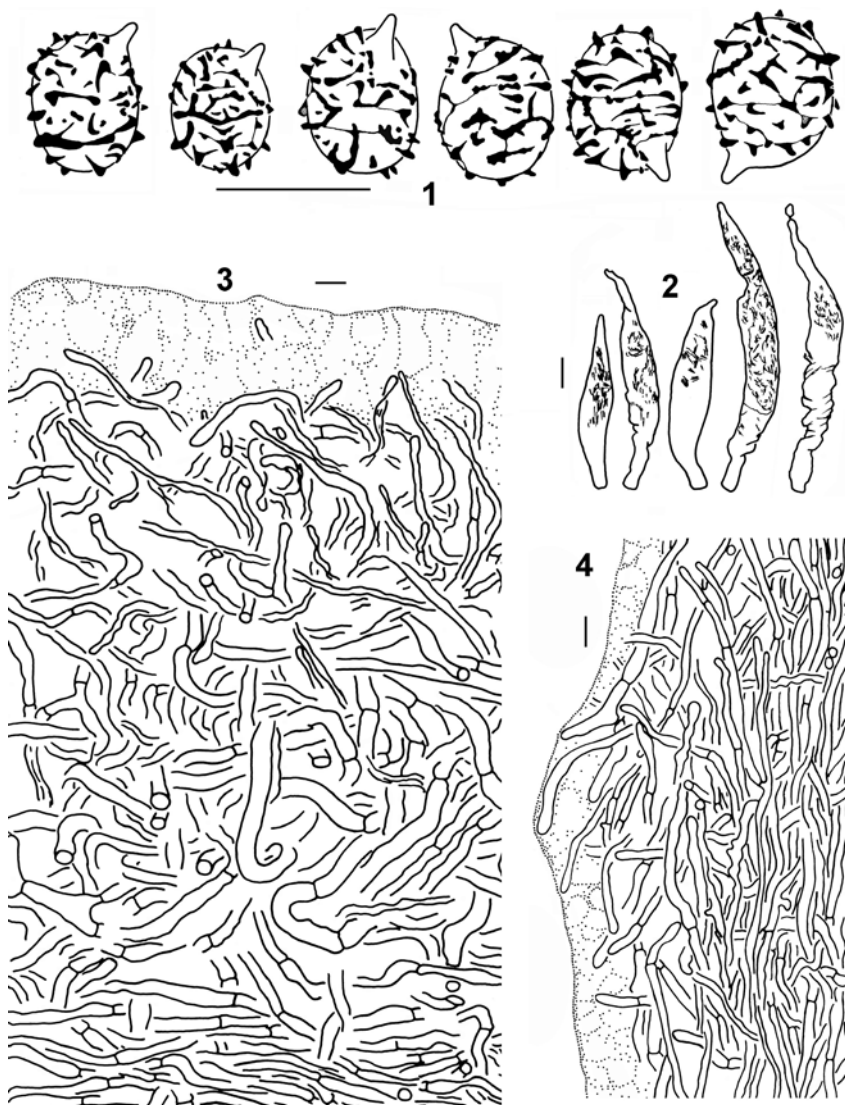
Note. – In Herb. SAPA there is only one specimen labelled as “*Lactarius akanensis*”. The handwritten annotation “Type” on the label indicates that this material actually represents the holotype (cf. also Hongo 1960).

Lactarius akanensis is a member of *Lactarius* subgen. *Piperites* subsect. *Trivialini* (Hesler & A.H. Sm.) Heilmann-Clausen & Vesterh. (Heilmann-Clausen *et al.* 1998). The colour of the pileus, the Pileipellis being an ixolattice, the presence of macrocystidia, and the basidiospores ornamented with unreticulate acute elements indicate its affinity to the European *L. trivialis* (Fr.: Fr.) Fr. Imai (1935, 1938) recognized two distinctive species which belong to the *L. trivialis*-complex viz. *L. akanensis* and *L. trivialis*, which he distinguished mainly by the colour of the pileus: “purplish-sooty” in *L. akanensis* and “livid-gray to smoky-gray or with purplish tint” in *L. trivialis*. The spore prints of the Japanese material of the two species are also different: “white” for *L. akanensis* and “subochraceous” for *L. trivialis* (Imai 1938). The close similarity of the species in the *L. trivialis*-complex is suggesting the need for further clarification.

Lactarius glutininus Takahashi (2001), a species recently described from Japan, is characterized by the dark-coloured pileus, an ixolattice as pileipellis, and the basidiospores with isolated warts. Accordingly, this taxon seems to be similar to *L. akanensis* and *L. trivialis*. However, our re-examination of the type material of *L. glutininus* shows that there are hyphal incrustations in the pileipellis and the basidiospores are ornamented with much higher warts interconnected by irregular ridges but fine connecting lines are absent.

Lactarius avellaneus S. Imai, Bot. Mag. (Tokyo) 49: 608. 1935. – Figs. 5–7

Copy of protologue: “Solitarius vel gregarius. Pileo 2–4 cm. lato, convexo, dein plano, demum depresso, levi, glabro, udo viscidulo, sicco leniter nitido, centro pallide castaneo, margine avellaneo; carne albidula vel grisea, crassiuscula; lacte albo, sicco flavidulo, acri, odore nullo; lamellis adnato-decurrentibus, albis, dein sordidis, sicco pruinosis, confertis; stipite 2–4 cm. longo, 5–7 mm. crasso, aequali vel basi leniter incrassato, flavidulo, unlevi, glabro vel pruinoso, cavo; sporis in cumulo albis, late ellipsoideis vel subglobosis, echinulatis, $8\text{--}10 \times 7.5\text{--}8 \mu$.”



Figs. 1–4: *Lactarius akanensis* (holotype): 1. Basidiospores. 2. Pleuromacrocyttidia. 3. Pileipellis. 4. Stipitipellis. Bars 10 µm.

The holotype material is in poor condition and consists of three fragments (possibly from one small-sized basidioma). Pileus applanate, thin, surface brownish, glabrous, shining, margin not crenate, transparent with striation. Lamellae 1–1.5 mm wide, subcrowded. Stipe about 2 mm thick, surface smooth, paler coloured as pileus. Particular odour absent.

Basidiospores (7.0) 7.5–9.0 (9.5) \times (5.5) 6.0–7.0 (7.5) μm ($n = 40$) [$Q = (1.14) 1.17\text{--}1.40 (1.48)$, $Q = 1.28 \pm 0.07$], rarely $10.5 \times 7.5 \mu\text{m}$, ellipsoid to elongate-ellipsoid, ornamentation 0.5–0.8 (1.0) μm high, very variable, mostly composed of ridges forming an incomplete reticulum, rarely composed of isolated ridges and warts, plage amyloid, rarely inamyloid. Basidia 45–60 \times 9–11 μm , 4-spored. Pleuromacrocystidia 50–70 \times 6–8 μm , apex sometimes moniliform, scarce. Lamellar edge not recovered due to poor condition. Pseudocystidia 2–3 μm wide, common, rarely forked. Pileipellis an ixolattice, hyphae in the suprapellis 3–5 μm wide, not inflated, hyphae in subpellis 4–7 μm wide, hyphae in whole pileipellis with incrustations. Stipitipellis an ixocutis, hyphae 3–4 μm wide, cylindrical, not inflated, not incrustated.

Material examined. – JAPAN, Prov. Ishikari, Mt. Taisetsu, 5 Sept 1934, leg. S. Imai 374, det. S. Imai (SAPA, holotype).

Note. – In Herb. SAPA, there is only one collection under the name “*L. avellaneus*” which also meets the descriptive details of the type material.

Imai (1935) classified this species in “III. *Russularia* A. Viscidi”, which followed the system of Fries (1874). When he compared his new species with *L. minuscula* and *L. subdulcis* (Imai 1935), he was more referring to a species of the modern *Lactarius* subgen. *Russularia* (Fr.) Kauffman. Hongo (1960) classified this species in *Lactarius* sect. *Russulares*, using the system of Singer (1951). The ixolattice lacking inflated hyphae and the dark-coloured slimy pileus however rather suggest that it should be accommodated in *Lactarius* subgen. *Piperites* sect. *Glutinosi* Quél. ss. Heilmann-Clausen’s *et al.* (1998). The yellowing latex of this species is a rather unique character in this group. The yellowing latex in combination with the characters of pileipellis and stipitipellis are reminiscent of the North American *Lactarius maculosus* Murrill (1916). This species, however, is characterized by mild latex and larger basidiospores, 9–10.5 \times 7.5–9 μm (Murrill 1916, Hesler & Smith 1979).

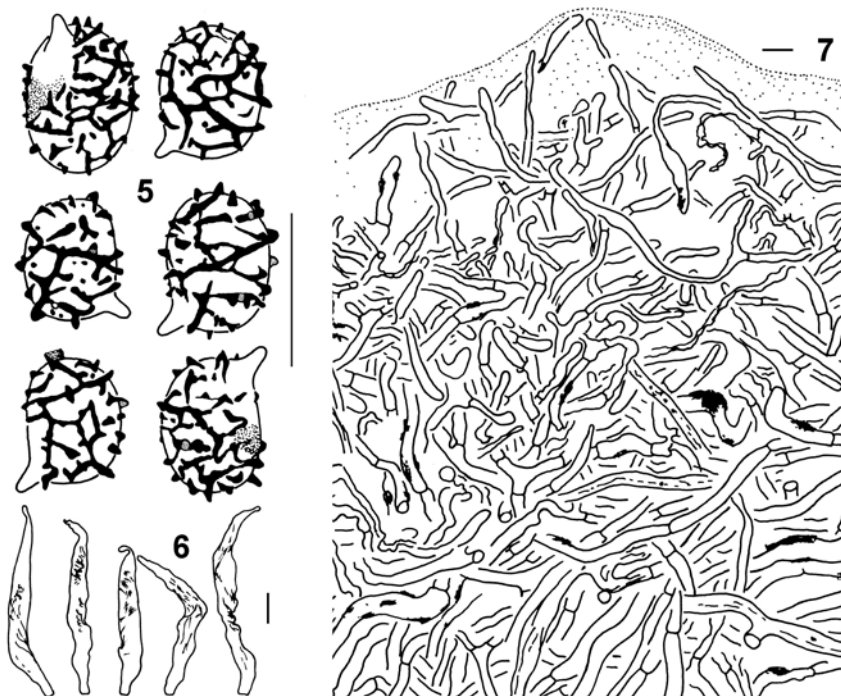
Lactarius deliciosus* f. *laeticolor S. Imai, Bot. Mag. (Tokyo) 49: 607. 1935. (as “*laeticolorus*”) – Figs. 8–9

\equiv *Lactarius laeticolor* (S. Imai) Imazeki ex Hongo, Acta Phytotax. Geobot. 18: 139. 1960. (as “*laeticolorus*”).

$=$ *Lactarius deliciosus* var. *japonicus* Kawam., The Japanese Fungi: 50. 1929.

Copy of protologue: “Vulnere non vel vix virescente.”

Basidiomata yellowish brown, in poor condition, eaten by insects. Pileus 17–85 mm diam., centre depressed, shallowly or deeply infundibuliform, surface consistency the same as that of other representatives of *Lactarius* sect. *Deliciosi*, faintly zonate or not. Lamellae 1–2 mm wide, crowded, concolourous with or darker brownish as



Figs. 5–7: *Lactarius avellaneus* (holotype): 5. Basidiospores. 6. Pleuromacrocystidia. 7. Pileipellis. Bars 10 µm.

on pileus. Stipe (incomplete) 4–20 mm thick, at least 20 mm long, equal, cylindrical, surface with obscure or distinct traces of scrobiculation, sometimes darker brownish than pileus.

Basidiospores (7.5) 8.0–9.5 × 6.5–7.5 (8.0) µm ($n = 40$) [$Q = (1.13) 1.15–1.34 (1.38)$, $Q = 1.24 \pm 0.06$], ellipsoid, ornamentation 0.6–1 µm high, composed of ridges and warts forming an incomplete reticulum, or not forming a reticulum, plage not amyloid. Macrocystidia not found. Pileipellis an ixocutis, hyphae 2–4 µm wide. Stipitipellis an ixocutis, slimy layer beyond the hyphal layer not well-developed, hyphae 2–3 µm wide. Trama with conspicuous, yellowish-brown lactiferous hyphae.

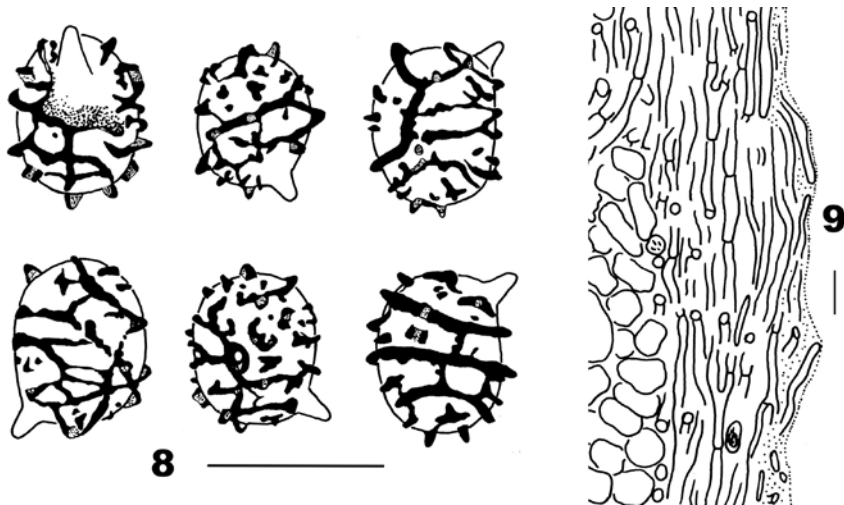
Material examined. – JAPAN, Prov. Ishikari, Maruyama, Nov 1933, *leg.* S. Imai (SAPA, **lectotype**); Prov. Ishikari, Napporo, 24 Oct 1928, *leg.* S. Imai (SAPA); Prov. Ishikari, Napporo, 18 Aug 1935, *leg.* S. Imai (SAPA).

Note. – In the protologue, Imai (1935) did not mention specific characters referring to the type material. In Herb. SAPA three authentic collections are kept under the name “*Lactarius deliciosus* (L.) Fr. f. *laeticolorus* Imai”, all identified by S. Imai. It is noteworthy, however, that the material “Aug. 18, 1935” was actually collected after the date on which Imai’s paper was accepted for publication (March 25, 1935)

and accordingly it can not represent the type material. The two other collections, gathered earlier than 1935, should be the material on which Imai's description was based and thus represent the original material (Art. 9.2 Note 2). Following Article 9.10 of the ICBN (McNeill et al. 2006) the lectotype is designated here: JAPAN, Prov. Ishikari, Maruyama, Nov. 1933, *leg.* S. Imai (SAPA, lectotypus). The description above is based upon the original material.

Morphologically, the three specimens mentioned above have identical basidiospores, which agree well with those of the collection described by Nuytinck *et al.* (2006) from Tottori, Japan. The authentic specimens are in very poor condition and accordingly several structures (hymenium, lamellar edges) can not be analyzed. This is probably also the reason why macrocystidia, an element which is regarded to be emergent in this species, were not observed. The stipitipellis being an ixocutis in the lectotype specimen suggest a viscid stipe when fresh, which corresponds to the observations and comments given by Nagasawa (1998) and Nuytinck *et al.* (2006).

Lactarius deliciosus var. *japonicus* is currently listed as a heterotypic synonym of *L. deliciosus* f. *laeticolor*, even by its author (Imai 1935, Hongo 1960, Nagasawa 1998, Nuytinck *et al.* 2006). The illustration referring to the holotype of *L. deliciosus* var. *japonicus* (Kawamura 1929), is representative for the taxon. Molecular data show that *L. deliciosus* f. *laeticolor* forms a well supported clade with the European *L. salmonicolor* R. Heim & Leclair and the North American *L. thyinos* A.H. Sm. in sect. *Deliciosi* (Nuytinck *et al.* 2007). This species is an *Abies*-associating fungus (Nagasawa 1998).



Figs. 8–9: *Lactarius deliciosus* f. *laeticolor* (lectotype): 8. Basidiospores. 9. Stipitipellis. Bars 10 μ m.

Lactarius deliciosus* f. *virescens S. Imai, Bot. Mag. (Tokyo) 49: 607. 1935.

= *Lactarius akahatsu* Tanaka, Bot. Mag. (Tokyo) 4: 394. 1890.

Copy of protologue: “vulnere virescente”.

The yellowish brown or dark brown basidiomata of the aforementioned collections are in poor condition, rigid or not. Pileus 17–25 mm diam., applanate or infundibuliform, surface consistency recalling that of *Lactarius* sect. *Deliciosi*. Lamellae 1 mm wide, subcrowded to crowded, concolourous with pileus. Stipe 10 × 3–40 × 15 mm, equal but base enlarged.

Basidiospores ellipsoid, variable in size according to different collections, e.g.: collection from Mt. Kurodake: (6.5) 7.0–8.5 × 5.5–6.5 (7.0) μm ($n = 40$) [$Q = 1.19\text{--}1.33$ (1.38), $Q = 1.24 \pm 0.05$]; collection from Aizankei: (6.5) 7.5–9.0 × (5.5) 6.0–7.0 μm ($n = 20$) [$Q = 1.18\text{--}1.29$ (1.31), $Q = 1.25 \pm 0.04$]; collection from Shikotsu: (7.5) 8.0–9.5 (10.5) × (6.0) 6.5–7.5 (8.0) μm ($n = 20$) [$Q = (1.19) 1.21\text{--}1.31$ (1.32), $Q = 1.26 \pm 0.03$]; ornamentation up to 1.0 μm high, composed of ridges connecting into an incomplete reticulum, or not forming a reticulum at all, plage amyloid. Hymenium not recovered. Pileipellis an ixocutis composed of hyphae 3–4 μm wide. Stipitipellis not recovered. Trama of lamellae and context with conspicuous, yellowish-brown lactiferous hyphae.

Material examined. – JAPAN, Prov. Ishikari, Azankei, 4 Oct 1938, *leg.* S. Imai (SAPA); Prov. Ishikari, Mt. Kurodake, 15 Sept 1939, *leg.* S. Imai (SAPA); Prov. Iburi, lake side of Shikotsu, 11 Sept 1935, *leg.* S. Imai, *det.* S. Imai (SAPA).

Note. Imai (1935) neither designated type material nor provided relevant information regarding the material used for the descriptions. In Herb. SAPA, there are three collections under the name *L. deliciosus* f. *virescens*. All specimens, however, were documented after the date at which Imai's paper was accepted and therefore they can represent neither the type nor the original material. Due to the poor condition of the three collections, no effort was made to select a neotype.

At present, *Lactarius deliciosus* f. *virescens* is treated as conspecific to *L. akahatsu* (Nagasawa 1998, Nuytinck *et al.* 2006). The conspicuous variability of the basidiomata from different localities is suggesting the need for further exploration regarding the size diversity within this taxon.

Lactarius flavidulus S. Imai, Bot. Mag. 49: 604. 1935. – Figs. 10–11
= *Lactarius tottoriensis* Matsuura, Applied Mushroom Science: 1126. 1934.

Copy of protologue: “Gregarius vel solitarius, edulis. Pileo 6–15 cm. lato, convexo, dein convexo-umbilicato, demum lato-infundibuliformi, cremicolori, avellaneo-flavidulo flavidulo, vix zonato, viscidulo, subglabro, plus minusve asperulo, margine primo pallidiori, involuto et minute villosulo, dein glabrescente; carne alba, crassa, rigida; lacte albo, aeruginescente, sapore odoreque blando; lamellis subdecurrenti-

bus vel adnato-decurrentibus, albis, dein fulvescentibus, virido-maculatis, confer-tis, utrinque attenuatis; stipite 4–6 cm. longo, 1.5–3 cm. crasso, aequali, lacteo-albo, dein cremicolori, primo leniter velutinoso, dein glabrescente, cavo; sporis in cumulo albis, subglobosis vel globosis, echinulatis, $7.5\text{--}10 \times 7\text{--}8.5 \mu$.”

The holotype material is in poor condition and consists of six mouldy fragments. The habit of the yellowish brown basidioma is stout and large-sized. Context of pileus thick, surface of pileus smooth. Stipe surface smooth, with faint traces of scrobiculation.

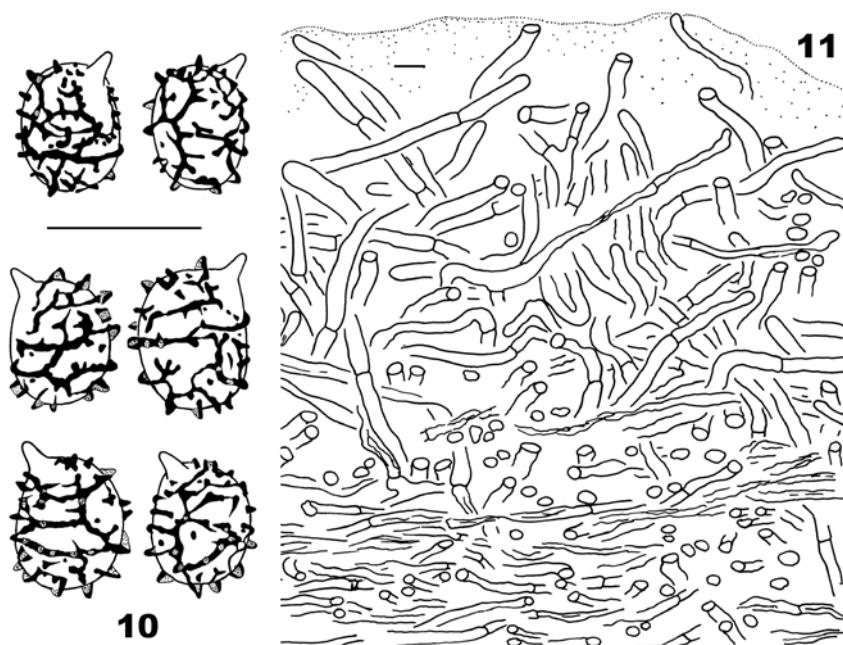
Basidiospores $7.0\text{--}9.0$ (9.5) \times (5.5) $6.0\text{--}7.0 \mu\text{m}$ ($n = 40$) [$Q = (1.17) 1.18\text{--}1.34$ (1.36), $Q = 1.26 \pm 0.05$], ellipsoid to elongate-ellipsoid, ornamentation $0.6\text{--}1.0 \mu\text{m}$ high, composed of ridges connecting to an incomplete reticulum, free ends of ridges and isolated warts frequent, plage rarely distally amyloid. Basidia $40\text{--}55 \times 11\text{--}13 \mu\text{m}$, 4-spored. Pleuromacrocyttidia not observed. Pileipellis an ixolattice, hyphae $4\text{--}5 \mu\text{m}$ wide. Pseudocystidia scarce, $2\text{--}3 \mu\text{m}$ wide, not forked. Stipitipellis a cutis, hyphae $3\text{--}5 \mu\text{m}$ wide, with conspicuous yellowish lactiferous hyphae.

Material examined. – JAPAN, Prov. Ishikari, Napporo, in forest, 24 Sept 1923; leg. S. Imai (SAPA, holotype); same locality, 1 Sept 1935, leg. S. Imai, *det.* S. Imai (SAPA); same locality, 7 Oct 1928, *leg.* S. Imai, *det.* S. Imai (SAPA); same locality, 25 Sept 1927, *leg.* S. Imai, *det.* S. Imai (SAPA).

Note. The description above refers to the type material. In contradiction to the protologue, however, the basidiospores are ellipsoid and not “globose, subglobose”.

In Herb. SAPA, four specimens are found under the name *Lactarius flavidulus*. The package of collection “24 Sept. 1923” is marked with the handwritten note “type”. The other three samples were collected in 1927, 1928, and 1935. Concerning macromorphological and micromorphological characters, these specimens are identical with the holotype. The scrobiculate surface of the stipe was also observed in the basidiomata of the three collections.

Hesler & Smith’s (1979) studied materials of this species collected by Hongo. In their description, the spores are more round ($7\text{--}8.5 \times 7\text{--}8 \mu\text{m}$) and lowly ornamented (prominences $0.3\text{--}0.4 \mu\text{m}$). They found hymenial macrocyttidia, which were not seen in this study. The structure of the pileipellis of the type material suggests this species is a member of the *Lactarius* subgen. *Piperites* (Fr.) Kauffman, as has been suggested by Hongo (1960) and Hesler & Smith (1979). In *Lactarius* subgen. *Piperites*, this species should be included within sect. *Zonarii* Quél. due to the cream-coloured basidioma, smooth pileus, and the latex lacking violet discolouration (Heilmann-Clausen *et al.* 1998). It is unique in the section because of the gray-green discoloration of latex and lamellae. In contradiction to the opinion of Imai (1935), it is not close to *L. glaucescens* Crossl. The latter belongs to *Lactarius* subgen. *Lactarius*. The name now is regarded as a synonym of *L. tottoriensis* (Nagasawa 1998).



Figs. 10–11: *Lactarius flavidulus* (holotype): **10.** Basidiospores. **11.** Pileipellis. Bars 10 μ m.

Acknowledgements

Dr. H. Takahashi and Dr. T. Kobayashi, Hokkaido University Museum (SAPA), Sapporo, Hokkaido, Japan are thanked for generously loaning the type material. Dr. E. Horak, University of Innsbruck, Innsbruck, Austria and Dr. J. Nuytinck, Ghent University, Ghent, Belgium critically reviewed and improved the manuscript. Dr. D. Hawksworth, Madrid University, Madrid, Spain gave valuable comments on related nomenclatural issues. This research project is supported by the National Natural Science Foundation of China (NSFC 30970020, 30300002), the Special Funds for Taxonomy and Conservation of CAS (KSCX2-YW-Z-0926), and the Yunnan Provincial Applied and Fundamental Funds (2009CD115).

References

- Fries E. M. (1874) *Hymenomycetes Europaei*. Upsaliae.
 Heilmann-Clausen J., Verbeken A., Vesterholt J. (1998) *Fungi of Northern Europe vol. 2. The genus Lactarius*. Svampetryk, Denmark.
 Hesler L. R., Smith A. H. (1979) *North American species of Lactarius*. University of Michigan Press, Ann Arbor.
 Hongo T. (1960) The Agricales of Japan 1–3. Russulaceae. *Acta Phytotaxonomica et Geobotanica* **18** (5–6): 129–146.

- Imai S. (1935) Studies on the Agaricaceae of Japan. II. *Lactarius* in Hokkaido. *Botanical Magazine* **49**: 603–610.
- Imai S. (1938) Studies on the Agaricaceae of Hokkaido. II. *Journal of the Faculty of Agriculture, Hokkaido Imperial University* **43** (2): 179–378.
- Kawamura S. (1929) *The Japanese Fungi*. Daichi-Shoin, Tokyo.
- Kornerup A., Wanscher J. H. (1961) *Farver i Farver*. Politikens Forlag, Copenhagen.
- McNeill J., Barrie F. R., Burdet H. M., Demoulin V., Hawksworth D. L., Marhold K., Nicolson D. H., Prado J., Silva P. C., Skog J. E., Wiersema J. H., Turland N. J. (2006) *International Code of Botanical Nomenclature (Vienna Code) adopted by the Seventeenth International Botanical Congress Vienna, Austria, July 2005*. A. R. G. Gantner Verlag, Liechtenstein.
- Murrill W. A. (1916) Illustrations of Fungi – XXIV. *Mycologia* **8** (4): 191–194.
- Nagasawa E. (1998) A preliminary checklist of the Japanese Agaricales. II. The sub-order Russulineae. *Reports of the Tottori Mycological Institute* **36**: 36–71.
- Nuytinck J., Verbeken A., Miller S. L. (2007) Worldwide phylogeny of *Lactarius* section *Deliciosi* inferred from ITS and glyceraldehyde-3-phosphate dehydrogenase gene sequences. *Mycologia* **99** (6): 820–832.
- Nuytinck J., Wang X. H., Verbeken A. (2006) Descriptions and taxonomy of the Asian representatives of *Lactarius* sect. *Deliciosi*. *Fungal Diversity* **22**: 171–203.
- Singer R. (1951) The “Agaricales” (mushrooms) in modern taxonomy. *Lilloa* **22**: 1–832.
- Takahashi H. (2001) Notes on new Agaricales of Japan 3. *Mycoscience* **42**: 355–360.
- Wang X. H., Hashiya M., Verbeken A. (2006) *Lactarius ochrogalactus*, a new species of the genus *Lactarius* (Russulaceae, Russulales) with yellowish-brown latex. *Mycoscience* **47** (4): 232–234.
- Wang X. H., Liu P. G. (2009) A type study of *Lactarius sakamotoi* and its presence in China. *Cryptogamie Mycologie* **30** (1): 45–51.

(Manuscript accepted 10 Oct 2010; Corresponding Editor: M. Kirchmair)

ZOBODAT - www.zobodat.at

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: [Sydowia](#)

Jahr/Year: 2010

Band/Volume: [062](#)

Autor(en)/Author(s): Wang Xiang-Hua, Liu Pei-Gui

Artikel/Article: [Type studys on Japanese species of Lactarius described by S. Imai. 325-335](#)