

Materials & methods

Both fresh basidiomes and herbarium specimens were studied. Colors were recorded and codified following Kornerup & Wanscher (1967), or the Online Auction Color Chart (www.onlineauctioncolorchart.com — abbreviated “OAC” herein). Microscopic features were studied using hand sections of fresh material, and of dried specimens rehydrated in water after immersion in 90% alcohol. Sections were mounted in 2% KOH and Melzer’s reagent, and viewed using an Olympus BX51 microscope. Specimens are deposited in herbaria and cited according to Thiers (2012).

DNA from each taxon was extracted from small hymenium-bearing pieces of dried basidiocarp following the methods of Lindner & Banik (2009). Protocols for ITS amplification, sequencing, sequence editing, and other related procedures followed Lorch et al. (2013) with the following modifications: denaturing for 40 s, annealing at 53 °C for 40 s, and extension for 90 s in the 30 PCR cycles. LSU sequences were obtained with the same protocols using the primers LROR (Moncalvo et al. 2000) and either LR5 or LR7 (Vilgalys & Hester 1990). Newly generated DNA sequences were deposited in GenBank and compared with available sequences via GenBank BLAST searches.

Taxonomy

Lactarius rubidus (Hesler & A.H. Sm.) Methven, **comb. & stat. nov.** PLATE 1

MYCOBANK MB803100

= *Lactarius fragilis* var. *rubidus* Hesler & A.H. Sm., N. Amer. Sp. *Lactarius*: 505. 1979.

“*Lactarius rubidus*” Methven, *Agaricales* (Gilled Fungi) of California,

10, II: 67. 1997, nom. inval. [provisional name].

PILEUS 2–8 cm broad, convex to plane, disc shallowly depressed, occasionally umbonate; margin incurved to decurved, glabrous; surface glabrous, dry to moist, rugose to rugulose, azonate, light brown (6D7-5) to brown (7D8-5), or reddish brown (8D8-6), negative with the application of 15% KOH; context up to 5 mm thick at the disc, light orange (5A4-2), unstaining on exposure; odor of maple syrup or fenugreek when dried; taste not distinctive. LAMELLAE adnate to subdecurrent, close to distant, narrow, rarely forked, light orange (5A4-2, 6A4-3), not marginate, unstaining where cut. STIPE 2–7 cm × 4–10(–15) mm, terete, equal; surface glabrous, dry, not scrobiculate, brownish orange (6C7-5) to light brown (7D7-5); white to light orange tomentum at the base; context hollow, concolorous with the pileal context, unstaining on exposure. LATEX whey-like, not copious, unstaining, unchanging, taste not distinctive.

BASIDIOSPORES white to pale yellow (4A3-2) in mass, 6–8(–8.5) × 6–7.5 μm, globose to subglobose; amyloid ornamentation a broken to partial or nearly complete reticulum 0.5–1 μm high. BASIDIA 35–55 × 7.5–12.5 μm, tetrasterigmate. CHEILOCYSTIDIA 25–35 × 6–9 μm, clavate. MACROCYSTIDIA not observed. PILEIPELLIS an epithelium composed of clavate to vesiculose cells in short chains, tangled in age, dry. PILEUS TRAMA heteromerous, sphaerocysts in rosettes, lactiferous hyphae inconspicuous. STIPITPELLIS a simple cutis with



PLATE 1: *Lactarius rubidus*, M. Kuo 01131106 (NY). Basidiocarps (top), basidiospores (middle), and pileipellis (bottom). Scale bars = 10 μ m. [For additional illustrations see Hesler & Smith (1979: Fig. 247, basidiospores) and Methven (1997: Pl. 2, basidiocarps).]

scattered projecting hyphal tips, stipe cortex heteromerous, sphaerocysts in rosettes.

ECOLOGY & DISTRIBUTION — Scattered, gregarious, or caespitose in duff, in coastal coniferous-deciduous forests in apparent association with *Quercus agrifolia*, *Notholithocarpus densiflorus*, and *Pseudotsuga menziesii*. Common. September through February. California, Oregon, and Washington.

COLLECTIONS EXAMINED — UNITED STATES. CALIFORNIA: MARIN COUNTY, 10 Dec 1982, ASM 2261 (EIU); 19 Dec 1984, ASM 3523 (EIU); 27 Dec 1984, ASM 3632

(EIU). MENDOCINO COUNTY, 30 Apr 1983, CM Bern, ASM 2456 (EIU); 13 Dec 1990, ASM 6523 (EIU). SAN MATEO COUNTY, 17 Dec 1984, ASM 3600 (EIU); 12 Jan 1985, H Saylor 2297 (EIU); 13 Jan 2005, M Kuo 01130522 (NY); 13 Jan 2011, M Kuo 01131106 (NY, GenBank ITS KC691205, LSU KC691206). SONOMA COUNTY, 02 Feb 2003, M Kuo 02200309 (NY). OREGON: POLK COUNTY, 14 Nov 1970, AH Smith 79939 (MICH 23242, paratype); 14 Nov 1970, AH Smith 79942 (MICH 11133, holotype).

COMMENTS — *Lactarius rubidus* is characterized by the reddish brown, azonate, dry to moist pileus, whey-like latex, the maple syrup or fenugreek odor when dried, and globose basidiospores with a broken to partial or nearly complete amyloid reticulum. *Lactarius fragilis* (Burl.) Hesler & A.H. Sm. var. *fragilis*, known from eastern North America, differs in having a snuff brown to burnt umber pileus, subdistant yellowish lamellae, and globose basidiospores with heavier deposits of amyloid ornamentation that form a partial to complete reticulum. *Lactarius rubidus* has frequently been misidentified as *L. camphoratus* (Bull.) Fr. However, *L. camphoratus* is a European and eastern North American species featuring a red brown pileus, close to crowded pale pinkish cinnamon lamellae, milk-white latex, and broadly ellipsoid basidiospores with amyloid ornamentation of isolated spines and nodulose ridges forming at most a broken reticulum. *Lactarius rubidus* is a popular edible commonly called the “candy cap” by collectors (Kuo 2007). Wood et al. (2012) recently determined quabalactone III to be the source of the maple syrup odor of *L. rubidus*.

ITS sequence comparisons via GenBank BLAST searches indicate *L. rubidus* is not conspecific with European and North American *L. camphoratus*. *Lactarius* cf. *rubidus* (GenBank DQ822820.1 from a basidiocarp and GU180303.1 from a *Pinus muricata* root tip; Peay et al. 2007) and unidentified samples GenBank AF323116.1 from a *Pinus muricata* root (Wurzberger et al. 2001) and DQ273391.1 from a *Notholithocarpus densiflorus* root (Bergemann & Garbelotto 2006), all from California, appear to represent *L. rubidus* at 99% sequence identity.

In Methven (1997: 67), the combination “*Lactarius rubidus* (Hesler & A.H. Sm.) Methven” appeared with a citation of its forthcoming publication as “Mycotaxon (in press). 1998” but was not validly published since it was merely proposed in anticipation of future acceptance of this taxon at the species rank (ICN Art. 36.1, McNeill et al. 2012). The subsequent Mycotaxon publication did not occur, and the combination *Lactarius rubidus* has not been validly published elsewhere since. A record for “*Lactarius rubidus* Arora 1991” appears in Index Fungorum (www.indexfungorum.org) but no further information is provided; a similar record appears in the MycoBank database (www.mycobank.org), again without any supporting publication information. David Arora’s (1991) field guide, *All That the Rain Promises and More: a Hip Pocket Guide to Western Mushrooms* is the only plausible basis we have been able to discover for these website entries. Since Arora treats the species as “*Lactarius fragilis*,” listing

“other names” as “*Lactarius fragilis* var. *rubidus*, *L. rubidus*,” without citing taxon authorities or providing full and direct references to any of the names as required for publishing a new combination, his book cannot be considered a valid publication of *Lactarius rubidus*. We validate the combination here.

STUDY OF THE HOLOTYPE — The holotype of *Lactarius fragilis* var. *rubidus* is held in the University of Michigan Herbarium (MICH 11133) and was collected by A.H. Smith (79942) on “rotten wood” in the Van Duzer Corridor, Polk County, OR; it consists of several well preserved basidiomes with a strong odor of fenugreek. BASIDIOSPORES 6.5–8.5 × 6–7.5 μm, globose to subglobose, ornamentation a partial to more or less complete reticulum 0.5–1 μm high, with scattered free ends and rare isolated elements, plage conspicuous and lacking amyloid debris. BASIDIA 35–50 × 7.5–12.5 μm, clavate, tetrasterigmate. CHEILOCYSTIDIA not clearly differentiated. MACROCYSTIDIA not observed. PILEIPELLIS an epithelium composed of vesiculose or irregularly shaped inflated cells in short chains, at times aggregated into mounds, especially in age. PILEUS TRAMA heteromerous. STIPITIPELLIS a dry, simple cutis of interwoven hyphae with scattered, projecting, pyriform to subfusiform hyphal tips 25–35 × 7.5–15 μm.

Leccinellum quercophilum M. Kuo, sp. nov.

PLATE 2

MYCOBANK MB802407

Differs from *Leccinum griseum* by its bluish green staining on the pileus and stipe, its creamy whitish tubes, its context staining gray when sliced, and its association with *Quercus* in eastern North America.

TYPE: United States, Illinois, Coles County, Charleston, under *Quercus alba* on a lawn, 12 July 2008, coll. M Kuo 07120801 (Holotype, NY; GenBank ITS KC691207, LSU KC691208).

ETYMOLOGY: from a combination of the Latin *Quercus* = oak, and the Greek φίλος = friend; “oak-loving.”

PILEUS 3–9 cm broad; convex; dry; glabrous; dull orangish brown (OAC 749) to medium yellow-brown (OAC 707, 715); rugulose-pitted when young, becoming conspicuously areolate; without an overlapping sterile margin; discoloring bluish green marginally with age; surface negative with the application of ammonia or FeSO₄, negative to yellowish with 15% KOH. HYMENOPHORE tubulose; depressed at the stipe. TUBES 1–2 cm deep, creamy whitish (contrasting with the pore surface), discoloring slowly blackish when sliced; pores 1–3 per mm at maturity, round becoming angular with maturity, whitish or medium grayish brown (OAC 736) when young, becoming yellowish brown to brownish; discoloring greenish in places with age; bruising slowly dark brown, with or without a bluish stage. STIPE 5–9 cm x 8–20 mm; equal, or tapered slightly to apex, or slightly ventricose; dry; whitish underneath fine, tiny scabers that are whitish apically and brown below; the scabers arranged in vague longitudinal