

The species of *Russula* subsection *Xerampelinae* described by C.H. Peck and Miss G.S. Burlingham

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Abstract – Microscopical characters of type specimens for three species in *Russula* subsect. *Xerampelinae*, *R. atropurpurea* Peck, *R. serissima* Peck and *R. fucosa* Burl., are described in detail and compared with recent collections. Taxonomic and nomenclatural aspects are discussed. Lectotypes are chosen for *R. fucosa* and *R. xerampelina* var. *semirubra*. The latter taxon is here demonstrated to be a synonym of Burlingham's species.

taxonomy / type-studies / *Russula xerampelina* var. *semirubra* / *Russula levyana* / morphology / United States

INTRODUCTION

Species of *Russula* subsect. *Xerampelinae* Singer – or “Fishy russulas” as they are commonly called in America – are typically recognized by the flesh staining rusty-brown upon handling or bruising, the development of an unpleasant, fishy smell at maturity and in particular by the bluish to dark grayish green discoloration of the flesh to iron sulfate. All species have a mild taste at maturity and produce pale yellow to cream spore-prints. *Russula* has the reputation of a difficult genus, but within the genus itself subsect. *Xerampelinae* is certainly one of the most difficult groups for species identification and delimitation because of the enormous variability of field characters for many of the species (particularly the color of the cap, a feature that is still frequently used for *Russula* identification) and the sometimes very subtle microscopical differences between them.

In their historical overview of *Xerampelinae*, Buyck & Adamčík (2011a) pointed out how the absence of precise information on the microscopic features of American type specimens has, on the one hand, led to the misapplication of many European names to probably good native American taxa and, on the other, to the misinterpretation of many early descriptions of American *Russulas* (see Adamčík & Buyck 2010, Buyck & Adamčík 2011b).

In this contribution, the authors complete their revision of validly published, North American taxa in subsect. *Xerampelinae* with the study of the few related, northeastern species described by Charles H. Peck and Miss Gertrude

S. Burlingham. At the time of the original description of these taxa, the easiest field character for the recognition of *Xerampelinae* – i.e. the unique greenish-bluish reaction of the context to iron salts – was not yet discovered (Melzer & Zvára 1927) and the only indications pointing to a close relationship with the European *R. xerampelina* (Schaeff.) Fr. were the development of a fishy smell and the brownish discoloration of the context. This concept of “fishy russulas” worked fairly well, however, and both Beardslee (1914) and Burlingham (1915) had already realized that *R. serissima* Peck and *R. atropurpurea* Peck were close relatives of the European *R. xerampelina*. Later, Burlingham (1924) added also her own *R. fucosa* to the list of eastern fishy Russulas. These early mycologists had apparently no difficulty in recognizing these few species during their life time, but with the continuous publication of more and more European *Russula* monographs that were offering often precise and well-illustrated descriptions for a growing number of species, the concepts of the native American taxa, too often still based on the older and often very succinct descriptions with insufficient microscopic detail, found a hard time to compete with those from the other side of the Atlantic ocean. As a result, one of the most recent and influential keys for *Russula* in North America (Kibby & Fatto 1990) report many European *Xerampelinae* from the eastern United States, but hardly any of the native American taxa and the latter found themselves often more easily dealt with as synonyms for some European species. In this paper, the type specimens of *R. atropurpurea* Peck (= *R. squalida* Peck), *R. serissima* Peck and *R. fucosa* Burl. are re-examined and their microscopical features illustrated and described in detail. Contrary to the general opinion, the authors will demonstrate that these species are good, native American taxa that are most probably distinct from known European species (a molecular study of the species is in preparation). Recent collections made by one of us (BB) for all of the here discussed taxa allow us now also to discuss the field characters of these ignored, American, fishy Russulas.

MATERIALS AND METHODS

Micromorphological characters were observed using an Olympus CX-41 and a Nikon Eclipse E400 microscopes under oil-immersion lenses at a magnification of 1000×. All drawings of microscopical structures, with the exception of spores, were made with a ‘camera lucida’ using a Nikon Y-IDT drawing attachment at a projection scale of 2400×. Contents of hymenial cystidia and pileocystidia in the illustrations are indicated schematically in the illustrations, with the exception of a single element where contents are indicated as observed in Congo red preparations from dried material. Spores on the lamellae were observed in Melzer’s reagent. All other microscopic observations were made in ammoniacal Congo red, after a short aqueous KOH pre-treatment to improve tissue dissociation through gelatinous matrix dissolution. All tissues were also examined for the presence of ortho- or metachromatic contents or incrustations in Cresyl blue as explained in Buyck (1989).

Spores were scanned with an Olympus Artcam camera and measured using Quick Micro Photo (version 2.1) software. Enlarged scanned pictures of spores were used for measuring with an accuracy of 0.1 µm and for drawing. Q gives length/width ratio of the spores. Measurements exclude ornamentation.

Statistics for measurements of microscopical characters are given as a mean value (underlined) plus/minus standard deviation and are based on 30 measurements. Values in parentheses give measured minimum or maximum values. An estimate for spore ornamentation density is given following Adamčík & Marhold (2000).

Names for infrageneric taxa follow the classification proposed by Sarnari (1998).

TAXONOMY

Russula atropurpurea Peck, Rep. N.Y. St. Mus. Nat. Hist. 41: 75, 1888. Figs. 1-9.

≡ *Russula squalida* (Peck) Peck, New York State Mus. Bull. 116: 80, 1907, nom. illeg.

Original description: *Pileus at first convex, then expanded or centrally depressed, glabrous, dark purple, blackish in the center, the margin even or slightly striate, flesh white, grayish or grayish-purple under the separable pellicle, taste mild, odor of the drying plant fetid, very unpleasant; lamellae nearly equal, subdistant, sometimes forked near the stem, at first white, then yellowish, becoming brownish where bruised; stem equal, glabrous, spongy within, white, brownish when bruised; spores subglobose, minutely rough, pale ochraceous with a salmon tint, .0003 to .0004 in. long. Pileus 3 to 4 in. broad, stem 2 to 3 in. long, 5 to 8 lines thick.*

In color this species resembles R. variata, but in the other respects it is very different. It is very distinct and peculiar in the color of its spores, and the brownish hue assumed by wounds.

Holotypus: UNITED STATES. **New York.** Saratoga Co., Gansevoort, open woods, July, C.H. Peck (NYSf361).

Spores (7.1)8-8.6-9.2(-9.8) × (5.7-)6.5-7-7.6(-8.1) μm, Q = (1.08-)1.16-1.23-1.29(-1.35), ornamented with relatively dispersed, amyloid, mostly conical warts [(3-)4-6(-8) warts in a 3 μm diam. circle on the spore surface], measuring 0.8-1 μm high, occasionally interconnected by fine line [0-1(-2) line connections in the circle] or fused into very short chains [0-1(-2) fusions in the circle]. Suprahilar spot amyloid. **Basidia** (34-)36.5-39.1-41.5(-44) × (11-)13-13.8-15(-15.5) μm, 4-spored, clavate-pedicellate; basidiola mostly clavate, rarely cylindrical, 4-12 μm wide. **Subhymenium** pseudoparenchymatic. **Lamellar trama** mainly composed of large sphaerocytes. **Hymenial cystidia** widely dispersed to dispersed, ca. 700/mm², measuring (39-)53-68.1-83(-120) × (10.5-)11-11.5-12(-13) μm on sides, fusiformous to clavate-pedicellate, mostly strongly narrowing towards the tip, often mucronate, thin-walled or with slightly thickened walls in the central part. **Marginal cells** ca. 23-49 × 4.5-7.5 μm, cylindrical, fusiform or clavate, often flexuous, mostly somewhat constricted or tapering at the tip. **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from the underlying sphaerocytes of the context, thick, divided in a dense, rather poorly gelatinized, 40-50 μm deep subpellis and a less dense, 100-150 μm deep suprapellis of ascending to repent hyphae. Hyphal endings of the suprapellis thin-walled, near the cap margin with narrow, attenuated or filiform-cylindrical terminal cells, 2.5-4.8-5.5 μm wide at the base but quickly narrowing down to 1.5-2.5-3 μm diam., mostly very long (> 100 μm) and often clustered together at their tips; originating from distinctly shorter and wider subapical cells, measuring ca. 11-27 × 4-7.5 μm, mostly regular and unbranched. Hyphal endings in the cap centre distinctly shorter and wider, (13-)18-25.1-32(-38.5) × (3.5-)4-4.9-6(-8) μm, attenuated towards the tip to almost subulate, subapical cells shorter and wider, ca. 11-15 × 4-7.5 μm. Primordial

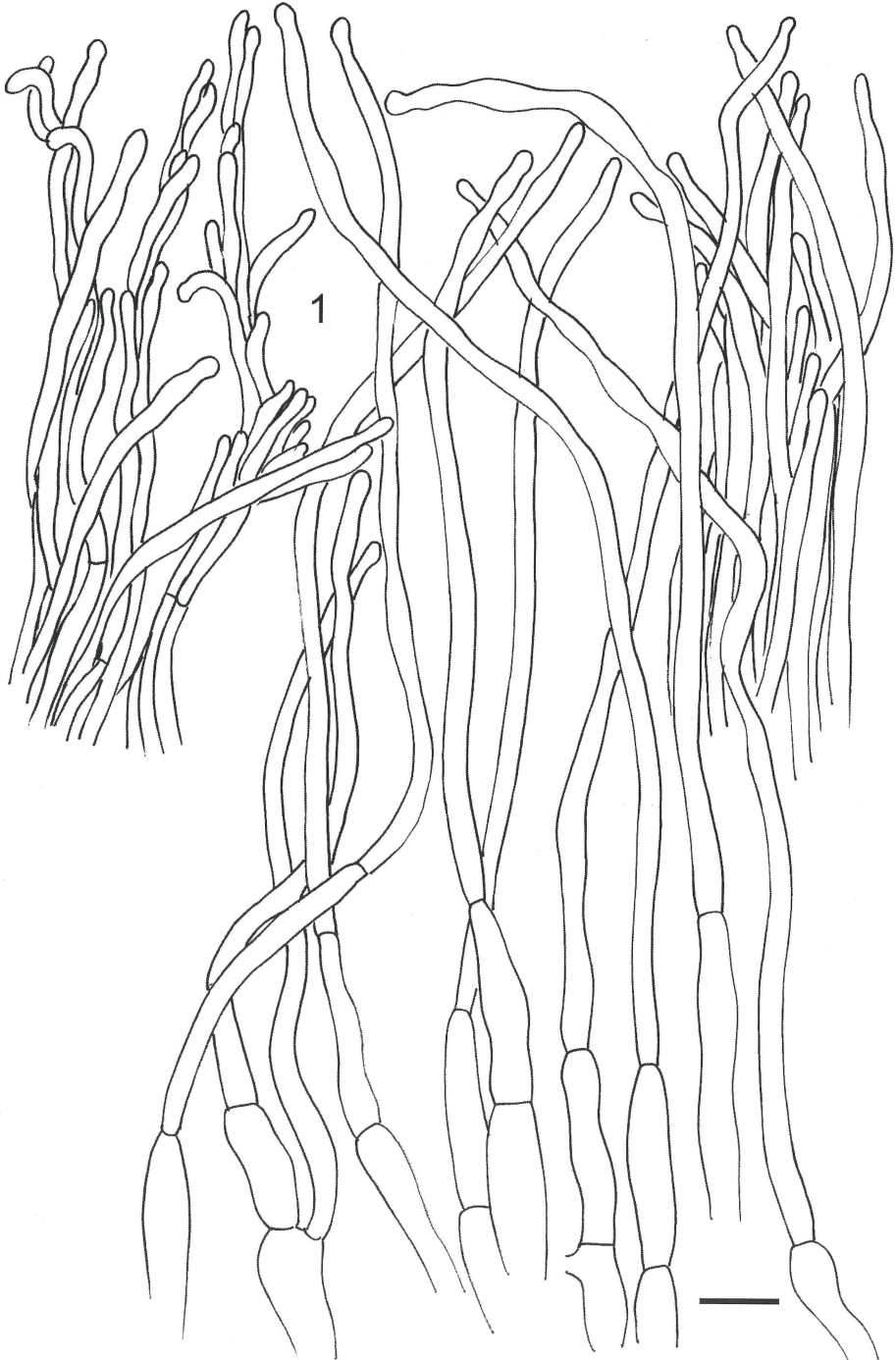
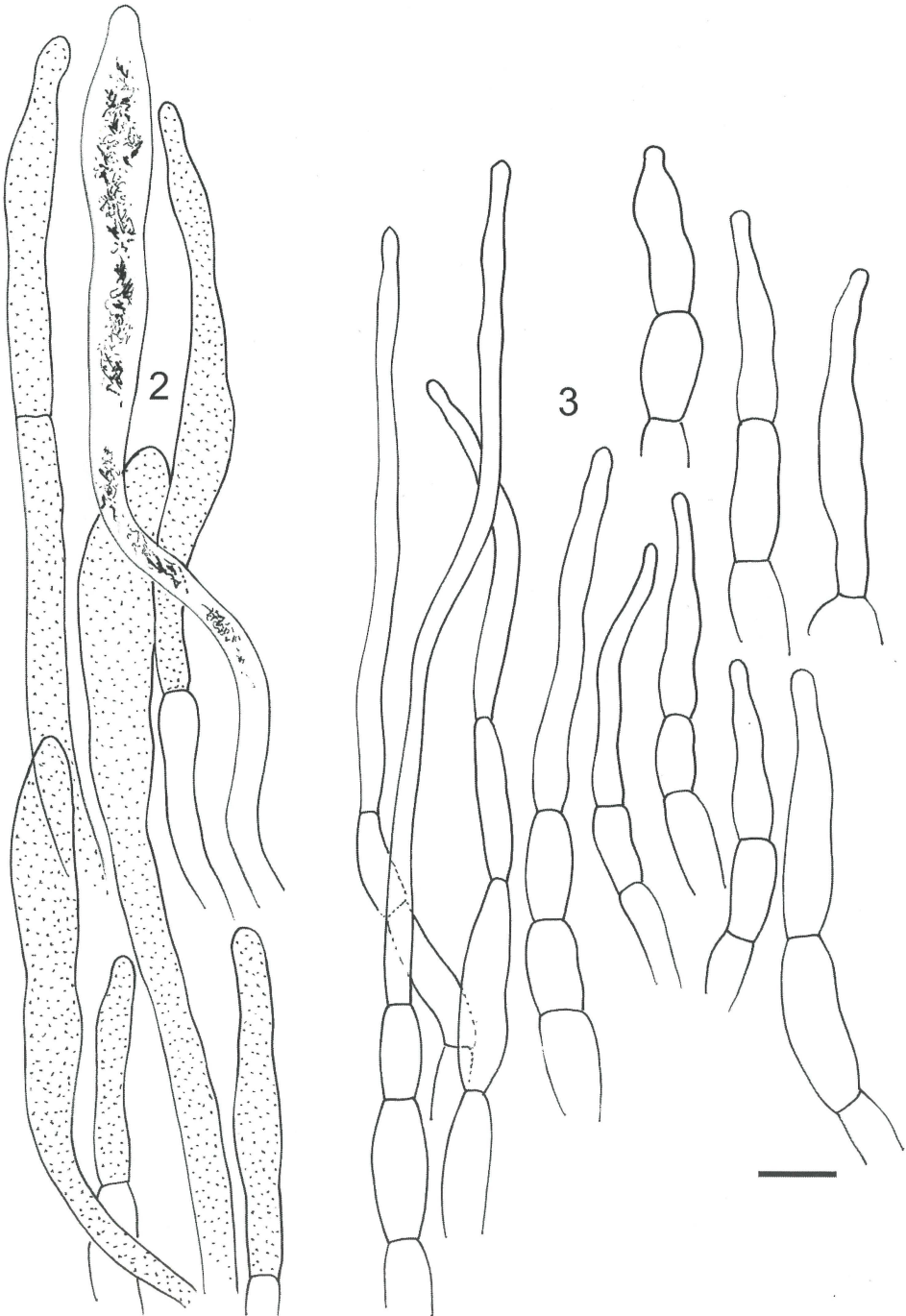
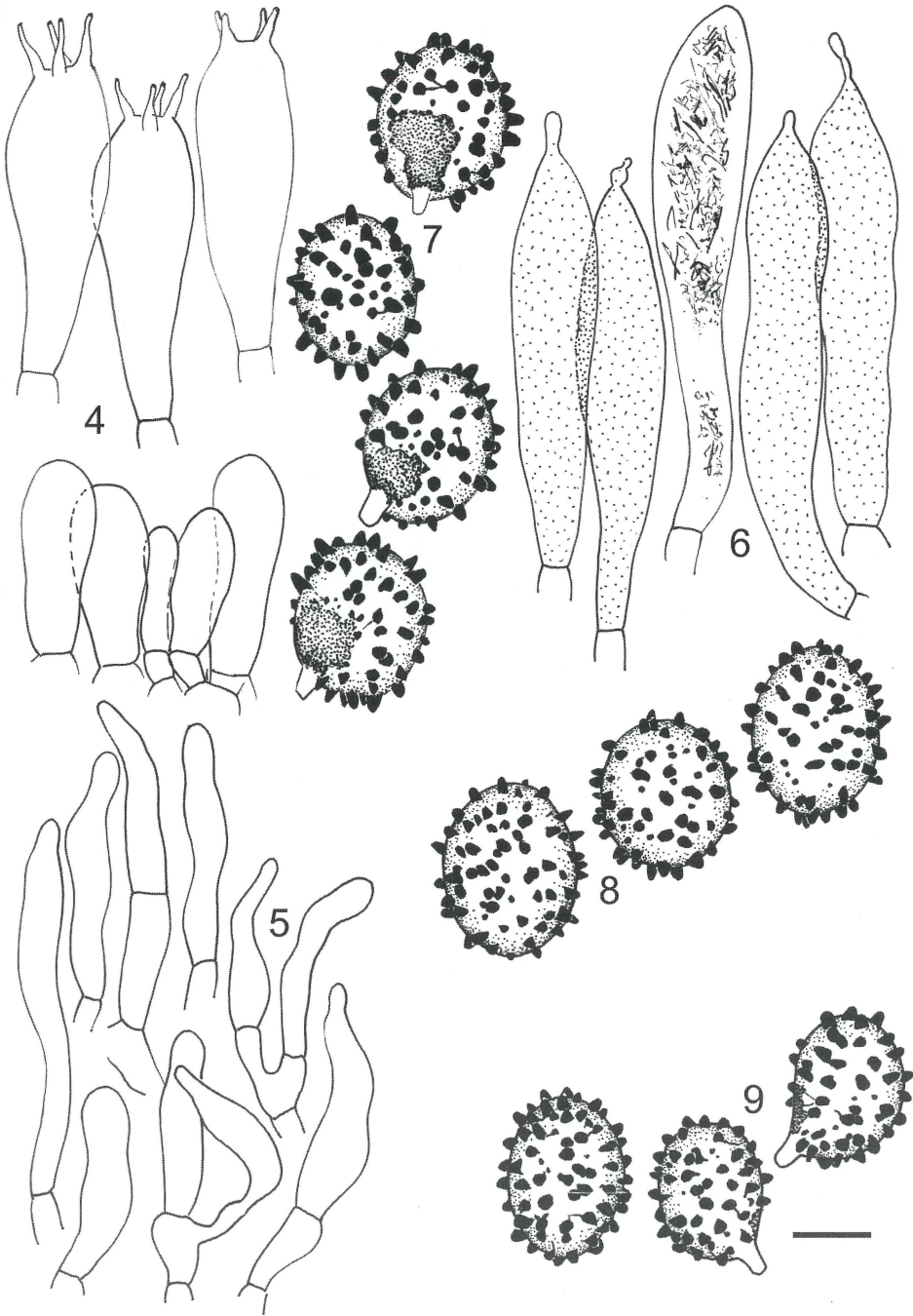


Fig. 1. *Russula atropurpurea* (holotype). Hyphal extremities near the cap margin. Scale bar equals 10 μm .



Figs. 2-3. *Russula atropurpurea* (holotype). 2. Pileocystidia. 3. Hyphal extremities in the cap center. Scale bar equals 10 μ m.



Figs. 4-9. *Russula atropurpurea* (4-7. holotype, 8. NYS Floodwood, 9. BB 06.564B). 4. Basidia and basidiola. 5. Marginal cells. 6. Pleurocystidia. 7-9. Basidiospores. Scale bar equals 10 μ m, but only 5 μ m for spores.

hyphae absent. Pileocystidia distinct but quite dispersed, often in clusters, usually submerged in the pileipellis, usually long and narrowly clavate, with terminal cells measuring (42-)50-77.9-105(-140) × (6-)6.5-8-9.5(-11) μm, obtuse or rarely with a subterminal constriction, not septate, with heteromorphous, SV- contents, continuing as cystidioid hyphae with heteromorphous content in subpellis and underlying trama of cap and gills. **Clamp connections** absent in all parts.

Other specimens examined. – UNITED STATES. **New York.** Warren Co., Bolton Landing, Aug., C.H. Peck (NYS); Albany Co., Menands, Aug. 1906, C.H. Peck (NYS, as *R. squalida*); Franklin Co., Floodwood, Round Lake & Westport, C.H. Peck (NYS, as *R. squalida*); New York. Albany Co., under *Pinus strobus* in northeastern mixed forest on limestone soil, 20 Sept. 2003, Buyck 03.125, 03.126B (PC). CANADA. **Québec.** Chute des Bull, St. Alphonse, in mixed forest with *Pinus*, 3 Sept. 2006, Buyck 06.564B (PC)

Commentary. – This species, which is clearly a member of *Xerampelinae* because of the browning context and distinctly fishy smell, was renamed *R. squalida* Peck by its author (Peck 1907) after Peck learned that the older European name *Agaricus atropurpureus* Krombh. had been recombined in the genus *Russula* by Britzelmayer (1893). Peck's species has variously been treated as a distinct species (Kauffman 1909, 1918; Burlingham 1915, 1944; Bon 1988) or as an infraspecific variant or synonym of *R. xerampelina* (Schaeff.) Fr. s.l. (Beardslee 1914, 1918; Singer 1951). It was only many years later that Shaffer (1970) correctly observed that *Russula atropurpurea* (Krombh.) Britzelm. is a later homonym of Peck's name, because the latter precedes the recombination by Britzelmayer. As a result, Shaffer (1970) abandoned the use of *R. squalida* for Peck's species and introduced the nomen novum "*R. krombholzii* Shaffer" for the European *R. atropurpurea*. This correction was initially followed in European literature (see Knudsen et al. 2008) but it may be that the absence of recent publications on American *Xerampelinae* and the constant use of *R. squalida* in older literature have contributed to the fact that *R. atropurpurea* was again – but incorrectly – applied for the European taxon (Sarnari 1998).

From our examination of the type specimen, it is clear that we are dealing with a good and native American taxon that is characterized by the very narrow and long hyphal terminations near the cap margin as already observed and illustrated by Hesler (1960). This character was never observed for European *Xerampelinae*.

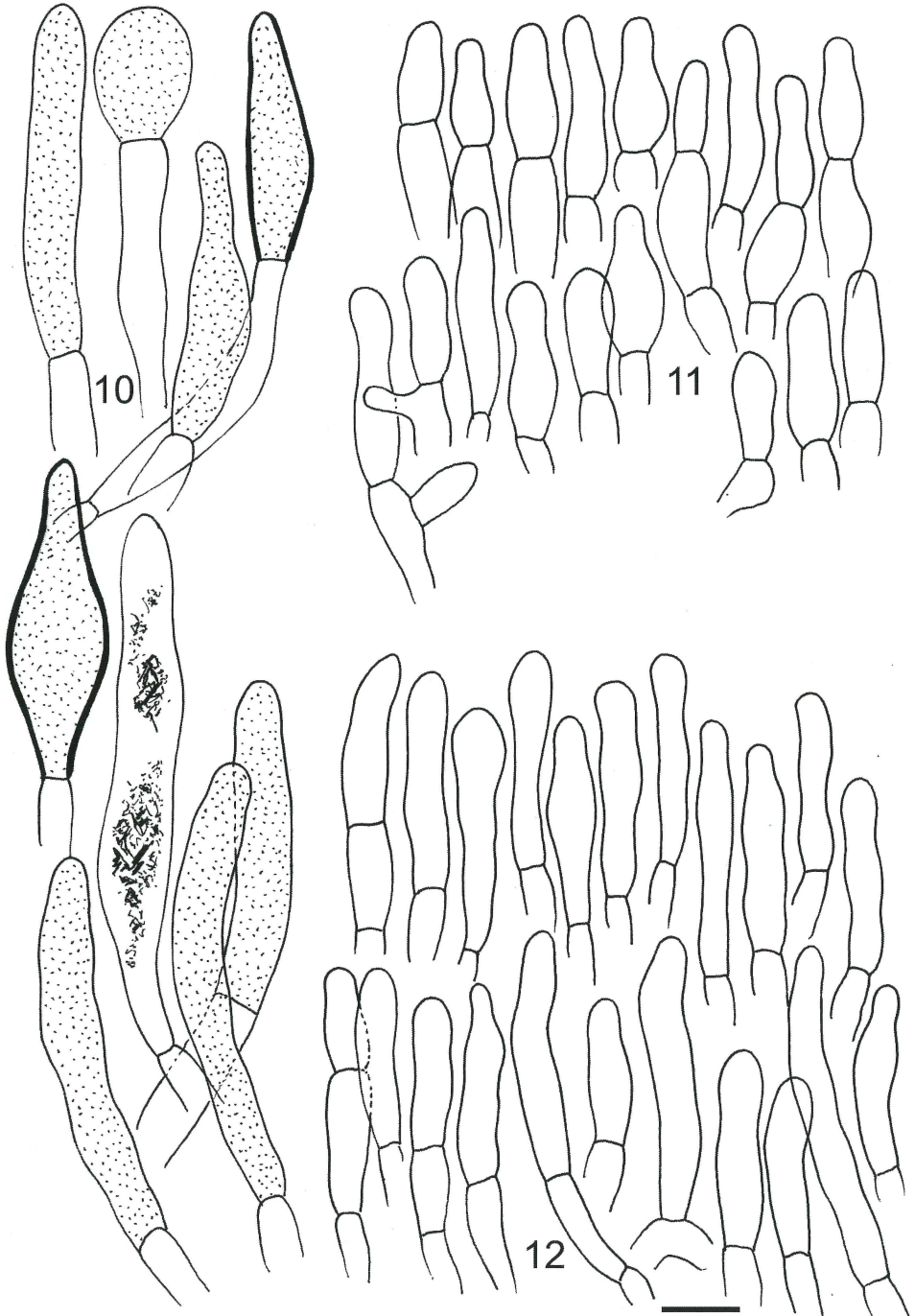
Russula serissima Peck, New York St. Mus. Ann. Rept. 139: 44. 1910. Figs. 10-19.

Original description: *Pileus* fleshy, thin, fragile, convex becoming nearly plane or centrally depressed, viscid when moist, glabrous, with the margin even or sometimes obscurely striate when old, variable in color, pale olive-green or brownish purple, sometimes spotted in the center, occasionally pruinose, flesh white or whitish, taste mild or slightly and tardily acrid, odor in the dried or drying plant strong, unpleasant, persistent; lamellae thin, close, 4-8 mm broad, narrowed behind, adnexed sometimes seceding from the stem, cream color or buff, becoming dingy or smoky in drying; stem equal or tapering upward, solid but spongy within, white, both it and the flesh assuming a somewhat smoky hue in drying; spores subglobose, buff yellow 10-12 × 8-10 μ.

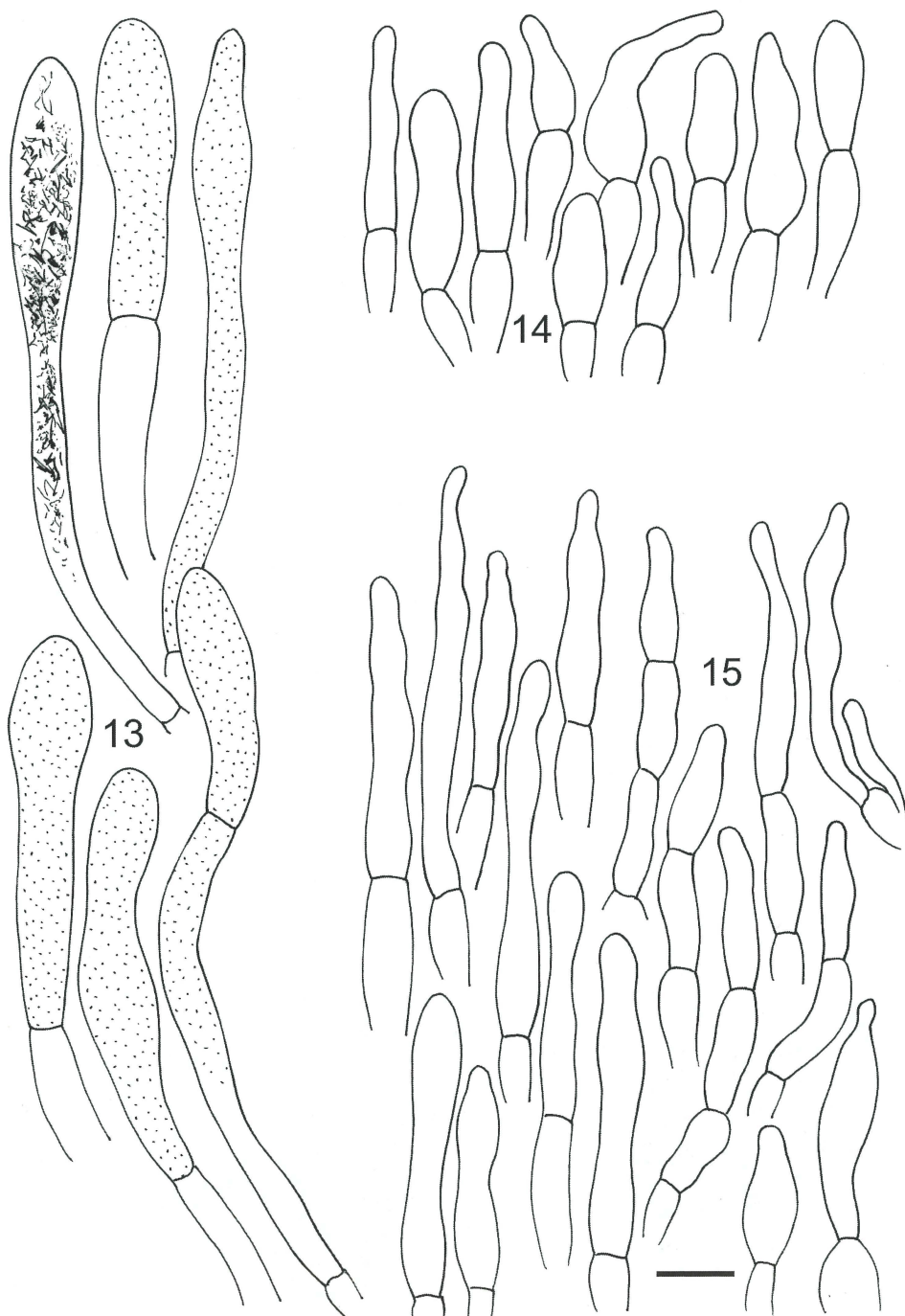
Pileus 5-7 cm broad, the stem 4-7 cm long, 8-20 mm thick.

The pileus varies in color as does the pileus of *Russula variata* Banning and *Russula squalida* Pk. It is very close to the later, from which it scarcely differs except in its viscid pileus, its late occurrence, its lamellae and flesh not changing color when wounded and specially in the color of the spore print.

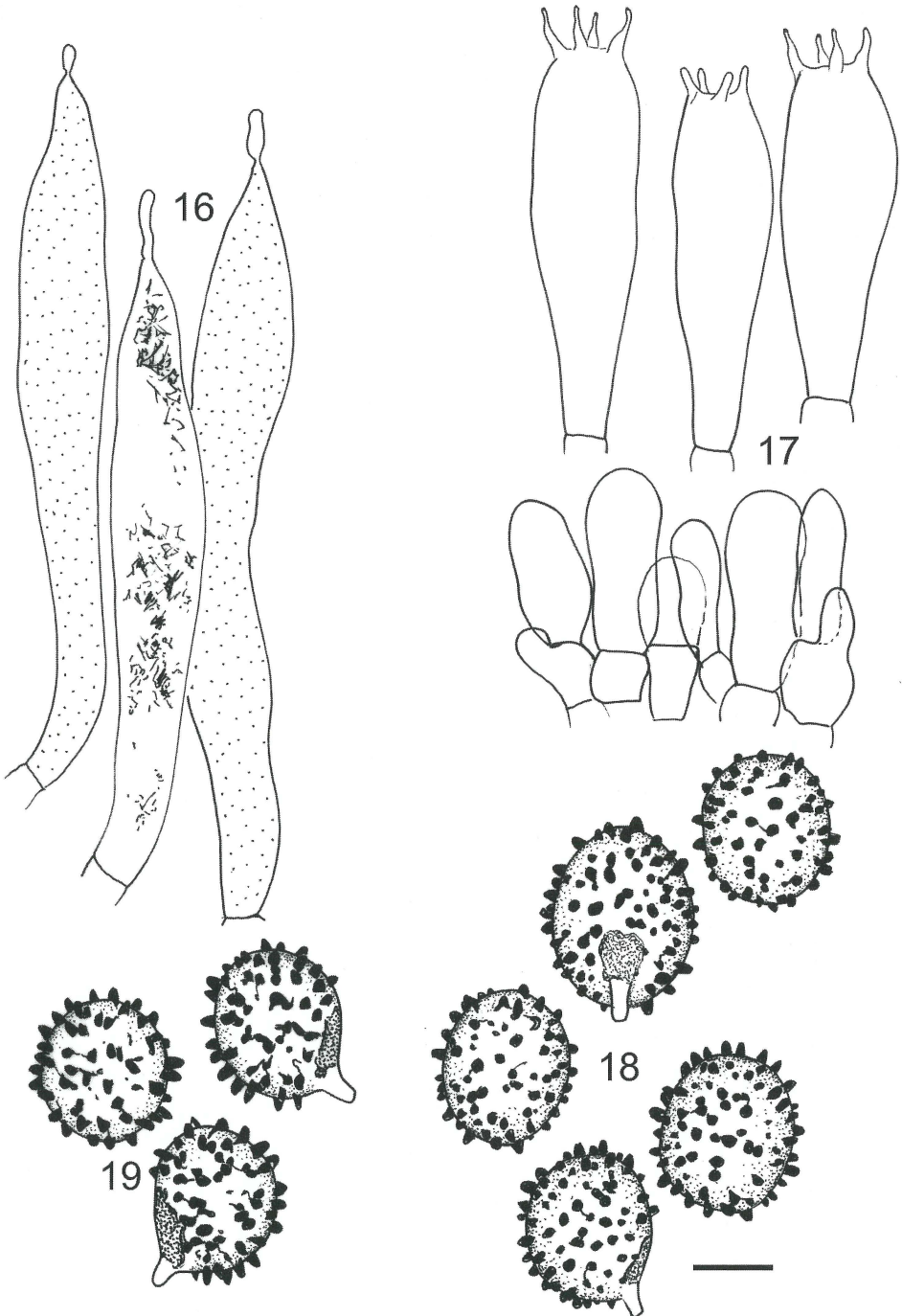
Pileus carnosus, tenuis, fragilis, convexus, deinde subplanus vel centro depressus, quum humidus viscidus, glaber, margine levis aliquando in senecture leviter striatus, olivaceus



Figs. 10-12. *Russula serissima* (holotype). **10.** Pileocystidia. **11.** Hyphal extremities in the cap center. **12.** Hyphal extremities near the cap margin. Scale bar equals 10 μ m.



Figs. 13-15. *Russula serissima* (BB "03.126B"). 13. Pileocystidia. 14. Hyphal extremities in the cap center. 15. Hyphal extremities near the cap margin. Scale bar equals 10 μ m.



Figs. 16-19. *Russula serissima* (16-18. holotype, 19. BB "03.126B"). 16. Pleurocystidia. 17. Basidia and basidiola. 18-19. Basidiospores. Scale bar equals 10 μm , but only 5 μm for spores.

vel brunneo-purpureus, aliquando centro maculatus, rare pruinosis, carne alba albidave, sapore miti vel leviter tardeque acri, odore ingratis, persistente; lamellae tenues, confertae, 4-8 mm latae, adnexae, cremeae vel luteolae, deinde fumidae; stipes aequales vel sursum attenuatus, solidus, intra spongiosus, albus, deinde fumosus; sporae subglobosae, luteo-flavae, 10-12 × 8-10 μ.

Holotype: UNITED STATES. **Massachusetts.** Suffolk Co., Ellis & West Roxbury, under fallen leaves in woods, Oct. 7. 1909, leg. Mrs. E.B. Blackford & G.E. Morris. (NYSf2763).

Spores (8.4-)9-9.5-9.9(-10.7) × (7.4-)7.6-8.0-8.3(-8.8) μm, Q = (1.08-)1.19-1.20-1.24(-1.28), ornamented with moderately distant [(3-)4-6 spines in a 3 μm diam. circle on spore surface], amyloid, mostly isolated, conical warts measuring 0.7-1.1 μm high, with rare line connections [0-2 line connections in the circle] or locally fused [0-2 fusions in the circle]. Suprahilar spot distinct and amyloid. **Basidia** (38-)42-46-50.5(-56) × (11.5-)13.5-14.7-16(-16.5) μm, 4-spored, clavate. **Subhymenium** pseudoparenchymatic. **Lamellar trama** mainly composed of large sphaerocytes. **Hymenial cystidia** dispersed (ca. 600/mm²), measuring ca. 79-102 × 11.5-14 μm on sides, fusiform-pedicellate or rarely clavate, mucronate-appendiculate up to 9 μm, thin- to slightly thick-walled. **Marginal cells** hardly differentiated. **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from the underlying spherocytes of the context, distinctly divided in a dens, rather poorly gelatinized, 80-90 μm deep subpellis of horizontally oriented, intricate hyphae (2-5 μm thick) and a less dens 50-60 μm deep suprapellis of ascending hyphae that have frequently slightly thickened walls. Primordial hyphae absent. Hyphal endings thin- or slightly thick-walled, densely intermixed, with terminal cells near the cap margin measuring (13-)21-26.7-32.5(-43) × (4-)4.5-5.2-6(-7) μm, clavate or cylindrical, obtuse or rarely subapically constricted; originating from usually shorter, narrower, eventually branching, subapical cells; hyphal endings of the cap centre shorter than those on margin, measuring (12-)13.5-18.4-23(-33.5) × 4-5.2-6(-8) μm, mostly cylindrical or subapically constricted, rarely inflated or lageniform. Pileocystidia very distinct, moderately abundant, the terminal cells measuring (15.5-)28.5-48.6-69(-96) × (4.5)6-8.3-10.5(-13) μm, one-celled or sometimes with one septum, relatively thick-walled and partly filled with yellowish-refringent, heteromorphous, SV-negative contents, descending into the subpellis but not continuing in the cap trama. **Clamp connections** absent in all parts.

Other specimens examined. – UNITED STATES. **New York.** Albany Co., in grass under isolated *Pinus strobus* in northeastern mixed forest on limestone soil, 20 Sept. 2003, Buyck 03-126A, 03-123 (PC)

Commentary – Peck's protologue mentions the typical characters for *Xerampelinae*, i.e. browning flesh and unpleasant smell, which were recognized as such by Beardslee (1914) and Burlingham (1915). Later, Burlingham (1944) underlined the importance of the larger spores and peppery taste (at least young?) of *R. serissima* as distinguishing characters from the European *R. xerampelina* and Peck's *R. atropurpurea* (as *R. squalida*).

The type collection was re-examined several times, at least by Hesler (1960) who summarized the microscopical features without any commentary or conclusions, and probably also by other mycologists such as Fatto (inserted annotation label dated Oct. 1989) who apparently did not accept it as a good species (Kibby & Fatto 1990). Perhaps the first mycologist to re-examine the type collection has been Singer (1942) although he referred to a so-called type collection deposited in FH (isotype?). Singer considered this collection a synonym of *R. xerampelina* s.l. and was herein probably followed by other mycologists, including R. Fatto.

The holotype in NYS is heavily damaged by insects, but the cuticle is well conserved and there remain fragments of gills allowing for a precise characterization and interpretation of the type. The latter is indeed characterized by large spores with mostly isolated, conical warts, and a pileipellis showing clavate or cylindrical, relatively short terminal cells of hyphal endings near the cap margin and voluminous pileocystidia. Because of these characters, this species is very similar – one could argue even identical – with *R. favrei* M. Moser (see e.g. Adamčík 2002), which would then become a later synonym of it.

***Russula fucosa* Burl.**, Mycologia 16: 20, 1924.

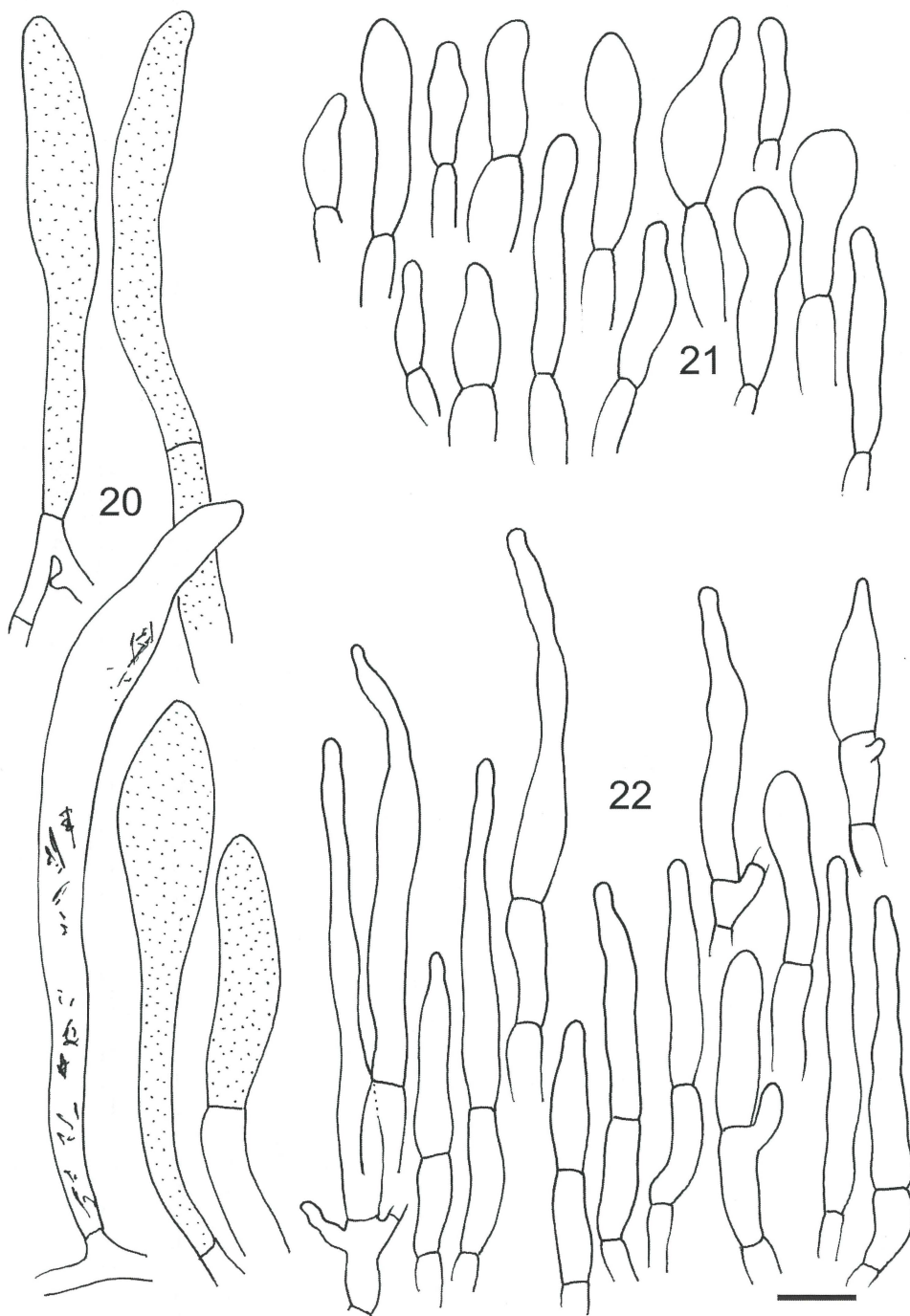
Figs. 20-31.

= *Russula xerampelina* var. *semirubra* Singer, Sydowia 11: 218. 1958, syn.nov. [**Lectotypus hic designatus**: United States. Florida. Alachua Co., Kelley's Hammock, northwest of Gainesville, under *Quercus*, *Carpinus*, *Pinus glabra*, in mesophytic hammock, July 14. 1943, Singer F 2719 (FH).]

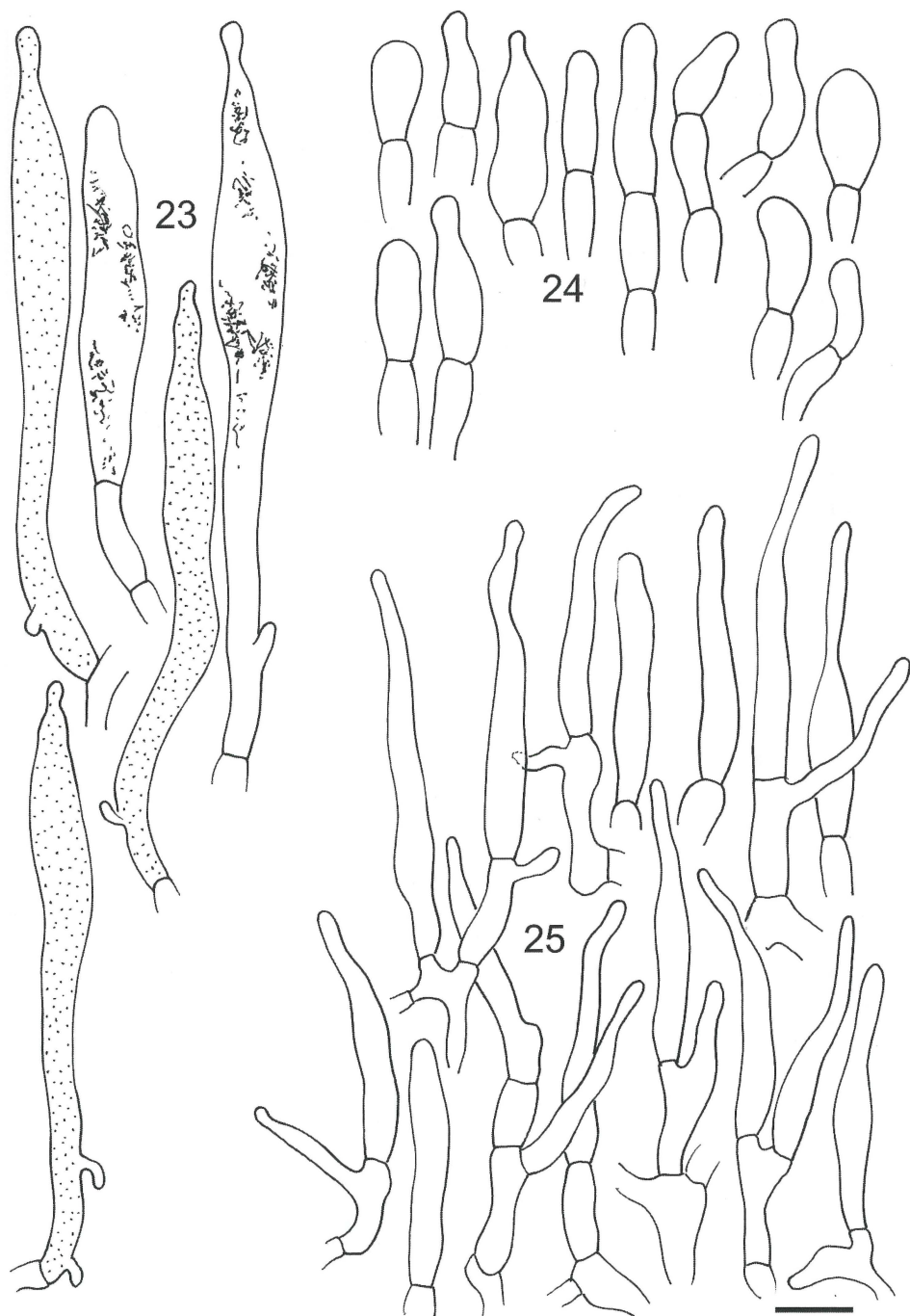
Original description: *Pileus broadly convex, becoming plane to centrally depressed, up to 5 cm. broad, surface old-blood-red (103) to coppery-red (108) or peach-red (98) to garnet-brown (164, t. 1) when mature, with some maize-yellow t. 2 in the center or elsewhere, very pruinose, viscid when wet, cuticle separable as far as the disk, margin even to faintly striate-tuberculate in places; context mild and sweet, white, staining snuff brown to putty color, developing an odor in drying slightly like that of R. atropurpurea Pk.; lamellae nearly white, equal, a few forking next the stipe, broad, narrow at the inner end, close, adnate, appearing free in age; stipe white or with a trace of pink, staining a little snuff brown where handled, glabrous, 3-4 × 1-1.5 cm.; spores flesh color (67, t. 2), nearly globose, very echinulate, 8.75 × 8.75 μ, exclusive of the apiculus which is 1.87 μ long, the spines being 1 μ long.*

Lectotypus hic designatus: UNITED STATES. **Vermont**. Windham Co., Newfane Hill, in moist woods of beech and spruce, 1922, G.S. Burlington (NY 648558).

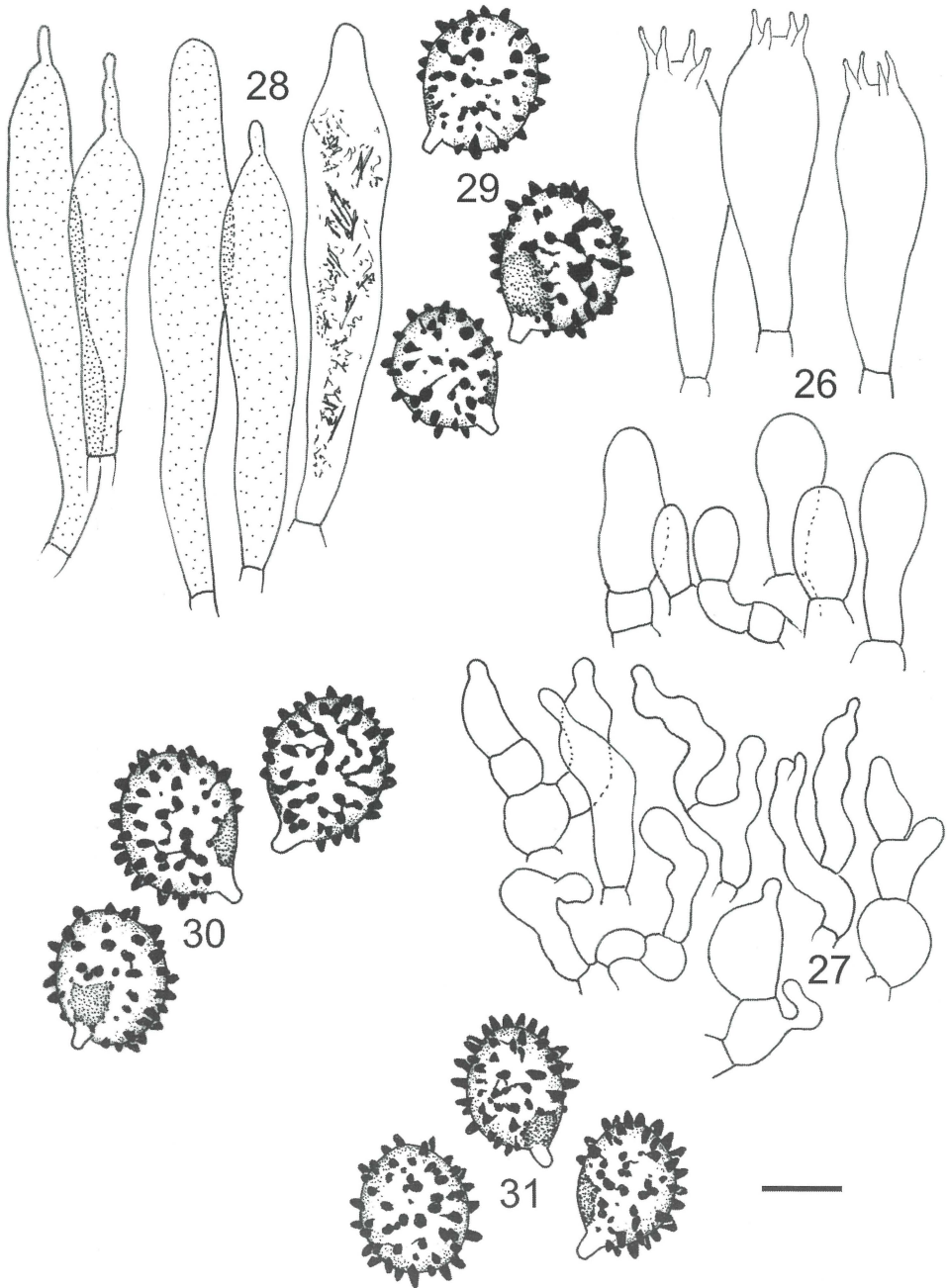
Spores (7.6-)8.1-8.6-9.1(-10) × (6.1-)6.7-7.1-7.6(-7.9) μm, Q = (1.09-)1.16-1.21-1.26(-1.31), ornamented with amyloid, quite dispersed (4-7 warts in a 3 μm diam. circle on spore surface) warts measuring 0.8-1 μm high, mostly isolated but some interconnected by some occasional fine lines [0-2(-3) line connections in the circle] or locally fused in pairs, triplets or short chains [0-2(-3) fusions in the circle]. Suprahilar spot amyloid. **Basidia** (34-)35-38.5-42(-48) × (12-)12.5-13.7-14.5(-16) μm, 4-spored, clavate-pedicellate; basidiola first cylindrical or ellipsoid, then cylindrical to clavate. **Subhymenium** pseudoparenchymatic. **Lamellar trama** mainly composed of large sphaerocytes. **Hymenial cystidia** widely dispersed ca. 350-400/mm², measuring (36-)51-64-76.5(-84) × (9-)9.5-11.9-14.5(-18) μm on sides, fusiform, obtuse to frequently mucronate, thin-walled, without septa, with heteromorphous refringent contents. **Marginal cells** ca. 10.5-17.8-27 × 3-5.5-9 μm, irregularly sinuose-nodulose, fusiform, clavate or subcylindrical, with frequent constrictions, often branched at the base, mixed with occasional cheilocystidia. **Pileipellis** orthochromatic in cresyl blue, sharply delimited from the underlying spherocytes of the context, vaguely divided in a dense, rather poorly gelatinized, ca. 40 μm deep subpellis of horizontal, ca. 2-3 μm thick hyphae and a less dense, ca. 70 μm deep suprapellis of ascending hyphae, composed of distinct pileocystidia and endings of generative hyphae. Primordial hyphae absent. Hyphal endings near cap margin with terminal cells measuring (18-)25-31-47(-42.5) × (3.5-)4-4.6-5(-5.5) μm, subulate, cylindrical or rarely clavate, often subapically constricted, thin-walled; subapical cells of equal width but shorter, sometimes branched; hyphal endings in the cap centre (11.5-)13.5-17-20.5(-25.5) × (3.5-)4-6.1-8.5(-16) μm, more voluminous compared to those near the margin, cylindrical, lageniformous, ellipsoid or fusiform. Pileocystidia large and distinct, moderately dispersed, ca. 22.5-81 × 4.5-8 μm, subcylindrical or fusiform, mostly obtuse-rounded, with



Figs. 20-22. *Russula fucosa* (lectotype). 20. Pileocystidia. 21. Hyphal extremities in the cap center. 22. Hyphal extremities near the cap margin. Scale bar equals 10 μ m.



Figs. 23-25. *Russula fucosa* (lectotype of *R. xerampelina* var. *semirubra*). **23.** Pileocystidia. **24.** Hyphal extremities in the cap center. **25.** Hyphal extremities near the cap margin. Scale bar equals 10 μ m.



Figs. 26-31. *Russula fucosa* (26-29. holotype, 30. lectotype of *R. xerampelina* var. *semirubra*, 31. BB 06.622). 26. Basidia and basidiola. 27. Marginal cells. 28. Pleurocystidia. 29-31. Basidiospores. Scale bar equals 10 μ m, but only 5 μ m for spores.

heteromorphous, refringent, SV- contents, not septate, cystidioid hyphae in subpellis and trama absent. **Clamp connections** absent in all parts.

Other specimens examined – UNITED STATES. **New York. Orange Co.**, Rutgers Creek Wildlife Conservancy, Greenville, Sept. 14, 2006, Gene Yetter leg., Buyck 06.622 (PC).

Commentary – Burlingham (1924) described her species as related to *R. atropurpurea* Peck from which it differs mainly by the paler spore print and weaker brownish discoloration of the flesh as well as by the weaker fishy smell which seems to develop particularly on drying. However, the most important difference is the beautiful intense orange-red to carmine red color of the cap, which is reminiscent of species in the *emetica*-group or as Burlingham indicated of her *R. pulchra*. Burlingham (1944) later discussed its delimitation from *R. serissima* and *R. xerampelina* and she indicated again the paler spore print color as well as the red cap color and constantly mild taste as the main diagnostic features of her species. We were able to take spore prints of the above-cited recent collection, and can confirm the pale cream (IIa in Romagnesi's chart) spore color.

The type collection is a box bearing indications and labels for 3 different dates from the same site and very likely may contain specimens from different collections. We therefore selected one specimen as a lectotype (which is marked as such in its herbarium box). Hesler (1961) studied the type, but without any discussion and his line drawings of the pileipellis show only clusters of long filiform hyphae very much like in *R. atropurpurea* Peck while his description states that pileocystidia are absent. Although the hyphal endings of *R. fucosa* are indeed clustering, the terminal cells are much shorter than the illustration by Hesler suggests, and they are usually mixed with pileocystidia which are quite distinct. Our examination of the type confirms that this is a good species of *Xerampelinae*, microscopically similar to the European *R. clavipes* Velen. because of the terminal cells which are attenuated-subulate near the cap margin, but inflated in the cap centre. *R. fucosa* is probably not very common. Burlingham notes that she recollected it every year, but always at the same locality in Vermont. We ourselves have seen her species only once in the fresh condition.

The real problems with *R. fucosa* start only later, when Singer (1958) describes a red-capped variety '*semirubra*' in *R. xerampelina* (Schaeff.) Fr. from the southeastern United States as "*Pileo rubro; stipite albo; in quercetis et silvis mixtis.*" – a diagnosis which is perfectly applicable to *R. fucosa*. Singer, however, does not discuss Burlingham's species at all and only indicates the relation between his new variety and several of Murrill's red-capped *Russula*, namely *R. floridana*, *R. levyana* and *R. praerubriceps*, all of which he considers to be synonyms. Singer's strange viewpoint was adopted without criticism in nearly all later publications dealing with American russulas (involving sometimes the use of the illegitimate name "*R. semirubra*", e.g. Thiers 1997, Roberts 2008). However, as already demonstrated by Adamčík & Buyck (2010), none of Murrill's above-cited species are synonyms and in some cases not even closely related to *Xerampelinae*. The situation gets even more complicated as the Farlow herbarium does not contain a specimen that exactly mentions the date, locality or collectors reported by Singer for the holotype. It is therefore necessary to select a lectotype from among the collections cited in the protologue of *R. xerampelina* var. *semirubra*. As evident from our illustrations (Figs. 23-25, 30), the features of this lectotype are not unexpectedly identical to those of Burlingham's *R. fucosa* and we can therefore conclude that Singer's variety is a later synonym of the latter. We refer to Table 1 for the distinguishing features between *R. fucosa* and *R. levyana*, which

Table 1. Comparison of selected microscopic characters observed on studied material of *R. atropurpurea*, *R. serissima*, *R. fucosa* and *R. levyana*. All shown values are average values based on 30 measurements. TC = terminal cells of hyphae in pileipellis. In shaded boxes the overall average values for all individual specimens measured. The distinguishing characters between *R. serissima* and *R. atropurpurea* and between *R. levyana* and *R. fucosa* are outlined in bold.

	Spores					TC cap margin					TC cap centre			Pileocystidia		
	length	width	Q	warts in 3 μ m circle	lines in 3 μ m circle	length	width	constricted ratio	attenuated ratio	cylindrical ratio	length	width	> 6 μ m diam. ratio	length	width	
<i>atropurpurea</i>	<i>atropurpurea</i> type	8,6	7	1.23	5.2	0.7	> 100	4.7	0.95	0.95	0.05	25.1	4.9	0.2	77.9	7.9
	BB 03.125	9	7.5	1.2	5.2	0.7	56.5	3	1	0.38	0.63	32.4	4.9	0	58.7	6.2
	BB 06.564B	8.8	7	1.25	5.6	1.3	75.4	4.1	1	0.75	0.13	55.7	3.4	0	51.5	4.9
	NYS Mennands	8.7	7.1	1.22	5.3	1.03	89	4.3	1	0.71	0.29	28.4	4.2	0.07	96.3	8.1
	NYS Floodwood	8.3	6.6	1.27	6.3	1	48.1	3.5	0.87	0.4	0,6	16.8	4.7	0.1	50.5	6.8
	average <i>atropurpurea</i>	8.7	7	1.23	5.5	0.95	67.3	3.9	0.96	0.64	0.34	31.7	4.4	0.07	67	6.8
<i>serissima</i>	<i>serissima</i> type	9.5	8	1.19	4.8	0.5	26.7	5.2	0.1	0	0.53	18.4	5.2	0.1	48.6	8.3
	BB 03.123	9.8	8.1	1.2	7.1	0.73	33.4	4.3	0.37	0.13	0.57	23.5	5.3	0.2	63.4	9.2
	BB 03.126	9.4	7.8	1.2	5.9	0.83	30.2	4.7	0.77	0.53	0.3	25.3	6.2	0.37	55.7	8.5
	average <i>serissima</i>	9.6	8	1.2	5.9	0.69	30.1	4.7	0.41	0.22	0.47	22.4	5.6	0.22	55.9	8.7
<i>fucosa</i>	<i>fucosa</i> type	8.6	7.1	1.21	5.4	1.2	31	4.6	0.87	0.6	0.3	17	6.1	0.28	50.7	6
	BB 06.622	8.5	6.7	1.25	6	1,3	51.4	5.6	0.93	0.9	0.03	36.9	6	0.41	43.3	7.8
	<i>semirubra</i> (lectotype)	8.7	7	1.25	6.5	1.7	38.1	4.9	0.87	0.67	0.23	20.6	5.5	0.23	67.4	8.7
	average <i>fucosa</i>	8.6	6.9	1.24	6	1.4	40.2	5	0.89	0.72	0.19	24.8	5.9	0.31	53.8	7.5
<i>levyana</i>	<i>levyana</i> type	8.7	7.2	1.21	5	1.1	27	4.4	0.07	0.2	0.8	21.5	3.7	0	39.5	8.1
	BB 09.956	9.2	7.4	1.25	6.5	2	27	4.5	0.27	0.2	0.67	29.7	3.7	0	65.9	8.8
	BB 09.955	9.2	7.5	1.23	6	1.8	38.7	4.1	0.73	0.17	0.57	38.9	3.4	0	57.5	5.4
	BB 09.955B	9.1	7.2	1.27	5.7	1.7	26.1	4.5	0.23	0.1	0.77	20.7	3.4	0	51.1	7.2
	BB 09.958	8.7	7.2	1.21	5.9	2	26.1	4.6	0.17	0.33	0.57	23.4	3.7	0	65.9	8.4
	average <i>levyana</i>	8.8	7.1	1.24	6.2	1.6	27.1	4.4	0.31	0.25	0.72	24.7	3.53	0	51.3	7.1

is for the moment the only other red-capped (but quickly discoloring) fishy *Russula* along the east-coast and around the Gulf of Mexico.

DISCUSSION

During these past years, the second author was able to collect near the collecting grounds of Peck and Burlingham and see fresh collections of all of the above taxa.

R. serissima is very similar to *R. atropurpurea* Peck with respect to macro-morphological characters, but Peck was apparently able to distinguish between both his species in the field since our examination of all his collections at NYS demonstrated that these are correctly labeled. Both *R. atropurpurea* and *R. serissima* are very variable in color of cap and they come in almost any combination of wine to purple-red, pale to dark brown and greenish tints. Both are probably common and abundant species that are very likely associated with *Pinus* (we collected them growing together in mixed woods as well as under isolated *Pinus strobus*). Burlingham (1944) assigned collections of fishy russulas with a pink stipe to the European *R. xerampelina* (Schaeff.) Fr. and she (as well as her contemporary colleagues) considered therefore both Peck's species never to have a pink stipe. Whether or not this is the case will require more collecting, but at least for *R. serissima* we have seen collections with a pink stipe. According to Peck's notes, *R. serissima* should also be occurring later in the season and possess "unchanging" gills. Peck (1888) also noted as typical character of his *R. atropurpurea* a salmon tint of the spore print that we were not able to confirm on our recent collections. Between both Peck's species and *R. fucosa* we can confirm now that there is a distinct difference in spore print color: IIIa for the former, IIa for the latter.

As stated in the commentaries above, these three American fishy Russulas are clearly reminiscent of some European species: *R. clavipes* in the case of *R. fucosa*, and very strongly of *R. favrei* in the case of *R. serissima*. These resemblances are in line with the spore print colors of these species on both sides of the Atlantic Ocean. Our unpublished, still too limited sequence data indicate that this is indeed a reality and our data also suggest that *R. serissima* and *R. atropurpurea* Peck are extremely close species. Whether the American taxa (at least those from the United States) occur also in Europe (or vice versa) is possible, but probably not very likely as suggested by our recent molecular work on *Cantharellus*, another ectomycorrhizal genus where presumed conspecificity on both sides of the Atlantic Ocean appears unwarranted (Buyck & Hofstetter, 2011, Buyck et al., 2010, 2011).

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