

Russula ochrifloridana* sp. nov., a new yellowish fishy *Russula* from Florida and its comparison with *R. grundii

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Abstract – *R. ochrifloridana* sp. nov. is described as a new, yellow-capped species in section *Xerampelinae* from Florida which is closely related to *R. levyana*, a species that has mostly a red-colored cap. It is compared with *R. grundii*, another yellowish, fishy *Russula* that is still only known from the type collection and that was described from California. Both *R. grundii* and the new species are here described and illustrated in detail.

Xerampelinae / taxonomy / Russulaceae / United States

INTRODUCTION

This paper is part of a series of contributions on *Russula* sect. *Xerampelinae* (Singer) Jul. Schaeff. in the southeastern United States (Buyck 2007, Buyck *et al.* 2008, Adamčík *et al.* 2010, Adamčík & Buyck 2011). The species of this section are well defined by their fishy smell, the grey-green discoloration of their flesh in contact with iron sulphate (FeSO_4) and the brown discoloration of the context upon handling or with age, particularly on the lower half of the stipe. Many members of the section are very variable in color whereas the microscopic differences are often quite subtle. In the southern part of the United States, the members of this section are very rare and often occur with few or even a single individual at a time. In this contribution, we describe a pale yellowish species from Florida and we compare its features with the only two other known members of this section in North America that may exhibit more or less similar colors, i.e. *R. grundii* Thiers, described from California (Thiers 1997), and *R. levyana* Murrill, a normally red-capped, but sometimes strongly discoloring species that was recently rediscovered in Texas and reinstated as good member of section *Xerampelinae* (Adamčík *et al.* 2010).

MATERIALS AND METHODS

Micromorphological characters were observed using Olympus CX-41 and Nikon Eclipse E400 microscopes under oil-immersion lenses at a magnification of 1000x. 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 2400x. 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 and Marhold (2000).

Names for infrageneric taxa follow the classification proposed by Romagnesi (1967, 1987).

TAXONOMY

Russula ochrifloridana sp. nov.

Fig. 1-8

Latin diagnosis: A *R. levyana* differt sporarum ornamentatione minus alta, extremitatibus prope pilei marginem magis septatis ac pilei colore haud rubra sed centrum versus distincte flava.

Holotypus: UNITED STATES. Florida. Gulf Co., St. Joseph Preserve on Cape San Blas, in *Quercus myrtifolia*, *Q. geminata*, *Pinus elliottii* woodland, 30 Jan. 2005, Donna Mitchell legit sub nr FL05-11 (in herbario PC conservatur).

Pileus 5.6 cm diam., off white with areas of light brown, staining yellowish brown, smooth, tacky, obscurely striate for ca. 3 mm near the margin. **Lamellae** cream with lemon tones, free, not forked, equal, 8 mm at mid-radius, not staining. **Stipe** 45 mm long, tapering upwards, white but quickly yellowing to ochre where handled, pruinose at apex, soft spongy inside with the cortex staining lemon yellow; stipe surface turning quickly deep blue green on contact with FeSO₄. **Context** cream to off-white, slowly browning, a thin line bordering lamellae lemon yellow, ca. 4 mm thick at mid-radius. **Odor** of shellfish. **Taste** mild. Spore print F (Kibby & Fatto 1990, equals IVa in Romagnesi 1967).

Spores ellipsoid, (8.7)-9.2-9.7-10.2(-10.7) \times (6.5)-7-7.3-7.7(-7.9) μm , Q=(1.22)-1.26-1.33-1.4(-1.5); ornamentation subreticulate, composed of amyloid warts, 0.3-0.5 μm high, dense to very dense (6-11 warts in a 3 μm diam. circle on the spore surface), mostly fused in short to sometimes longer chains or interconnected by fine lines; suprahilar spot distinct and amyloid. **Basidia** (40)-42-45.6-49(-54) \times (11)-11.5-12.5-13.5(-14) μm , 4-spored, clavate-pedicellate basidiola first cylindrical, then clavate. **Subhymenium** pseudoparenchymatic. **Lamellar trama** mainly composed of large sphaerocytes. **Hymenial cystidia** dispersed, ca 500-700/mm², measuring (48)-54.5-64.7-74.5(-81) \times (7.5)-8-9.1-10(-11.5) μm on gill sides, fusiform to clavate, pedicellate, obtuse-rounded near the tip, sometimes

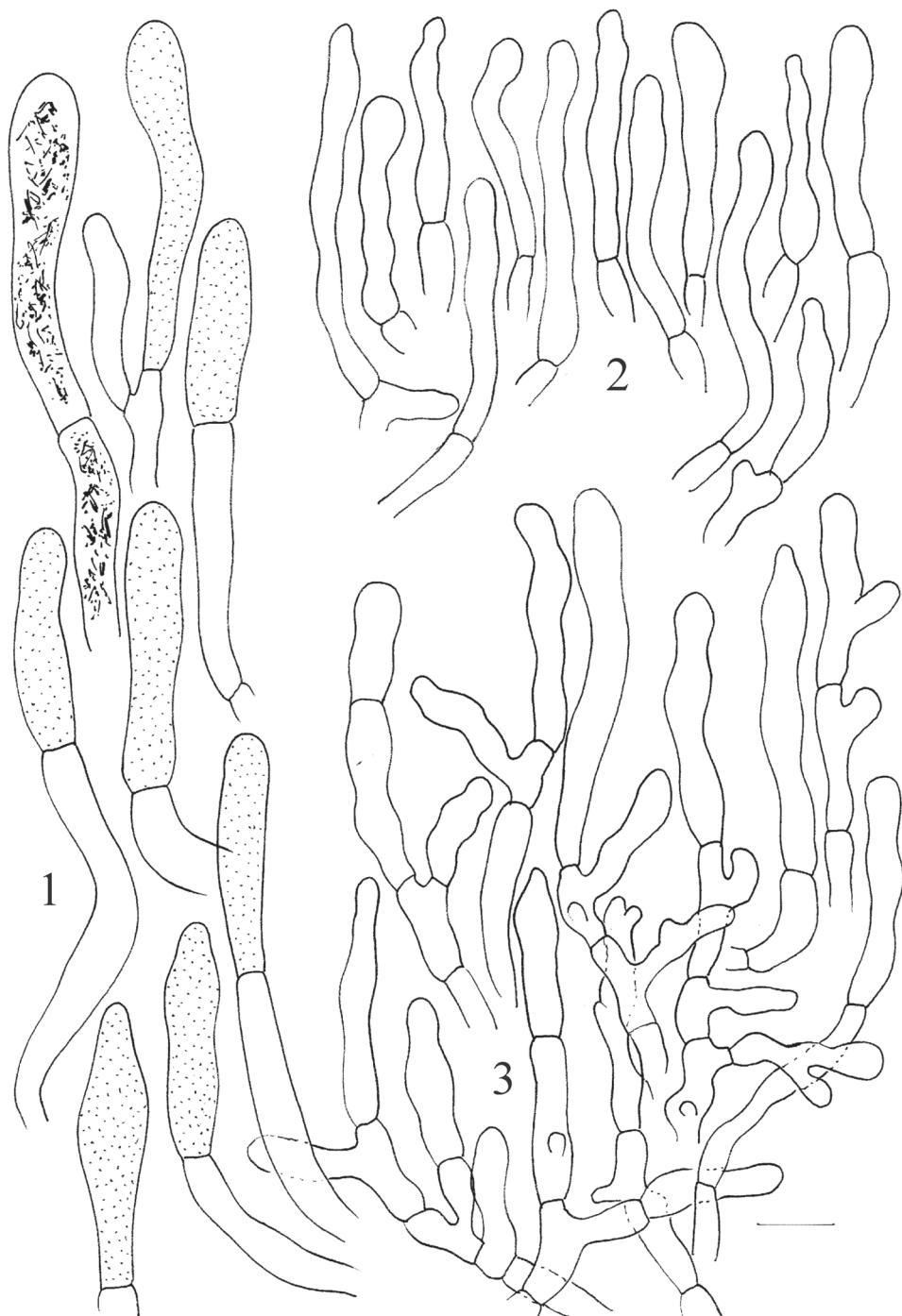


Fig. 1-3. *Russula ochrifloridana* (holotype). **1.** Pileocystidia. **2.** Hyphal extremities in the cap center. **3.** Hyphal extremities near the cap margin. Scale bar equals 10 μm .

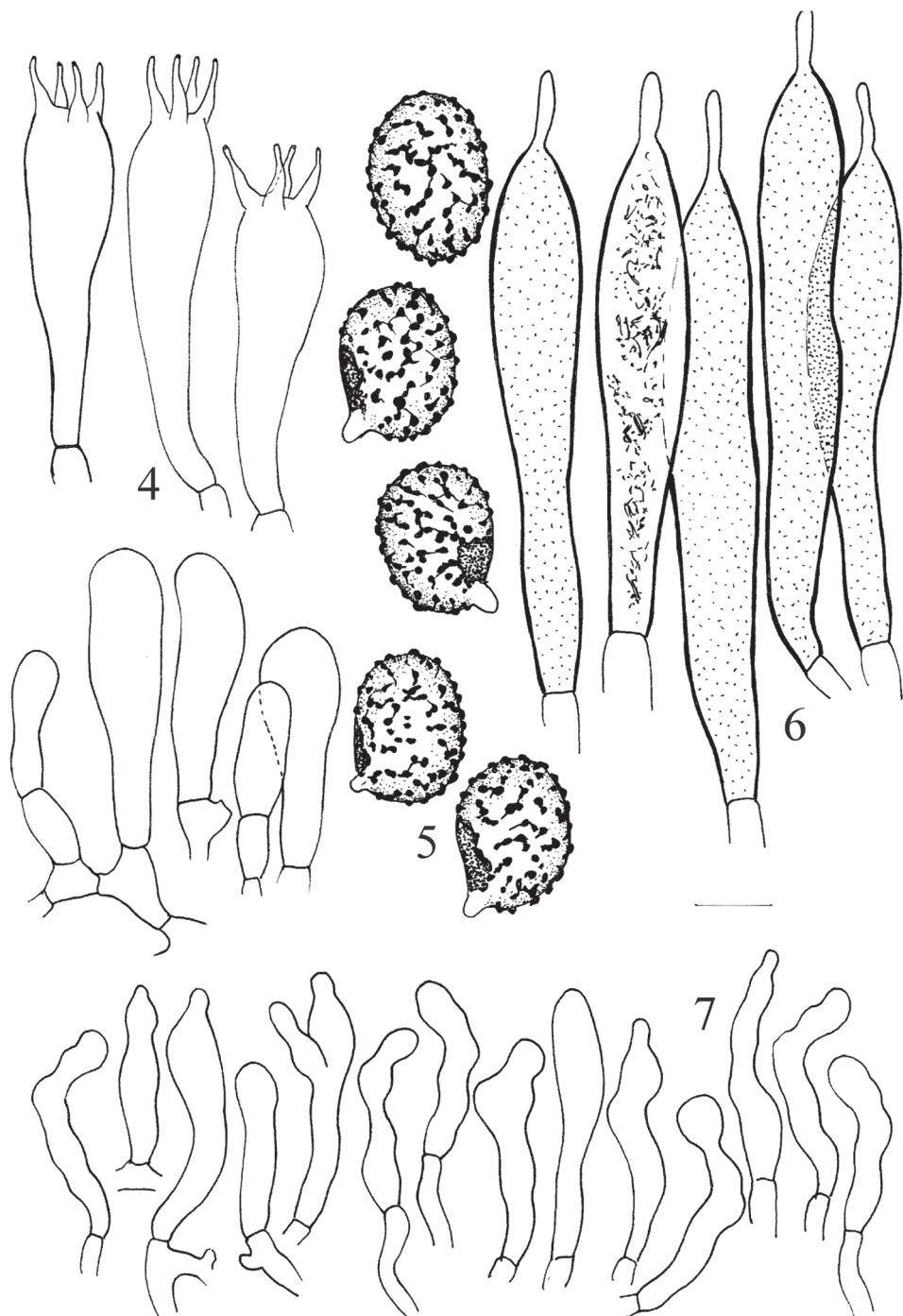


Fig. 4-7. *Russula ochrifloridana* (holotype). 4. Basidia and basidiola. 5. Basidiospores. 6. Pleurocystidia. 7. Marginal cells. Scale bar equals 10 µm, but only 5 µm for spores.



Fig. 8. *Russula ochrifloridana*. Holotype in fresh condition. Photo Donna Mitchell.

mucronate to appendiculate with the apical appendage up to 8 µm long, thin-walled, showing heteromorphous or granular, often indistinct contents. **Marginal cells** present, measuring (20)-23.5-28-32(-37) × 4-5.6-7.5 µm, fusiform to clavulate, sometimes moniliformous or subcapitate. **Pileipellis** orthochromatic in cresyl blue, sharply delimited from the underlying sphaerocytes of the context, ca. 100-130 µm thick and vaguely two-layered (particularly close to the pileus margin); subpellis dense, ca. 50 µm thick; suprapellis of irregular, more loosely arranged, branched hyphal terminations, with terminal cells usually distinctly longer near the pileus margin, (15.5)-20.5-29.1-37.5(-49) × (4)-4.5-4.9-5.5(-6) µm, mostly cylindrical or clavate, sometimes apically constricted, towards the pileus center becoming narrower, 3.5-4.3-5(-6) µm diam., more irregular, mostly repeatedly constricted to undulate and very densely arranged. Pileocystidia only at the surface, scattered, one to multicelled, with the terminal cell usually shorter, measuring ca. (24)-27-41.9-56.5(-79) × (5.5)-6-7.3-8.5(-9.5) µm, thin-walled or nearly so, with indistinct, granulose contents to almost optically empty. **Clamp connections** absent.

Holotypus: UNITED STATES. Florida. Gulf Co., St. Joseph Preserve on Cape San Blas, in *Quercus myrtifolia*, *Q. geminata*, *Pinus elliottii* woodland, 30 Jan. 2005, Donna Mitchell FL05-11 (PC).

Russula grundii Thiers, Mycotaxon 63: 349, 1997.

Fig. 9-15

Original description: Pileus 5-9 cm latus, convexus dein planus, demum subdepressus, glaber, viscidus vel subviscidus, margine pallide luteus et interdum roseo-tinctus, disco plerumque atroluteus, odore piscis, in sicco persisti. Lamellae adnexae vel librae, luteae vel ochraceo-luteae, interdum furcatae; lamellulae nullae. Sapor plusminusve piscis vel mitis vel

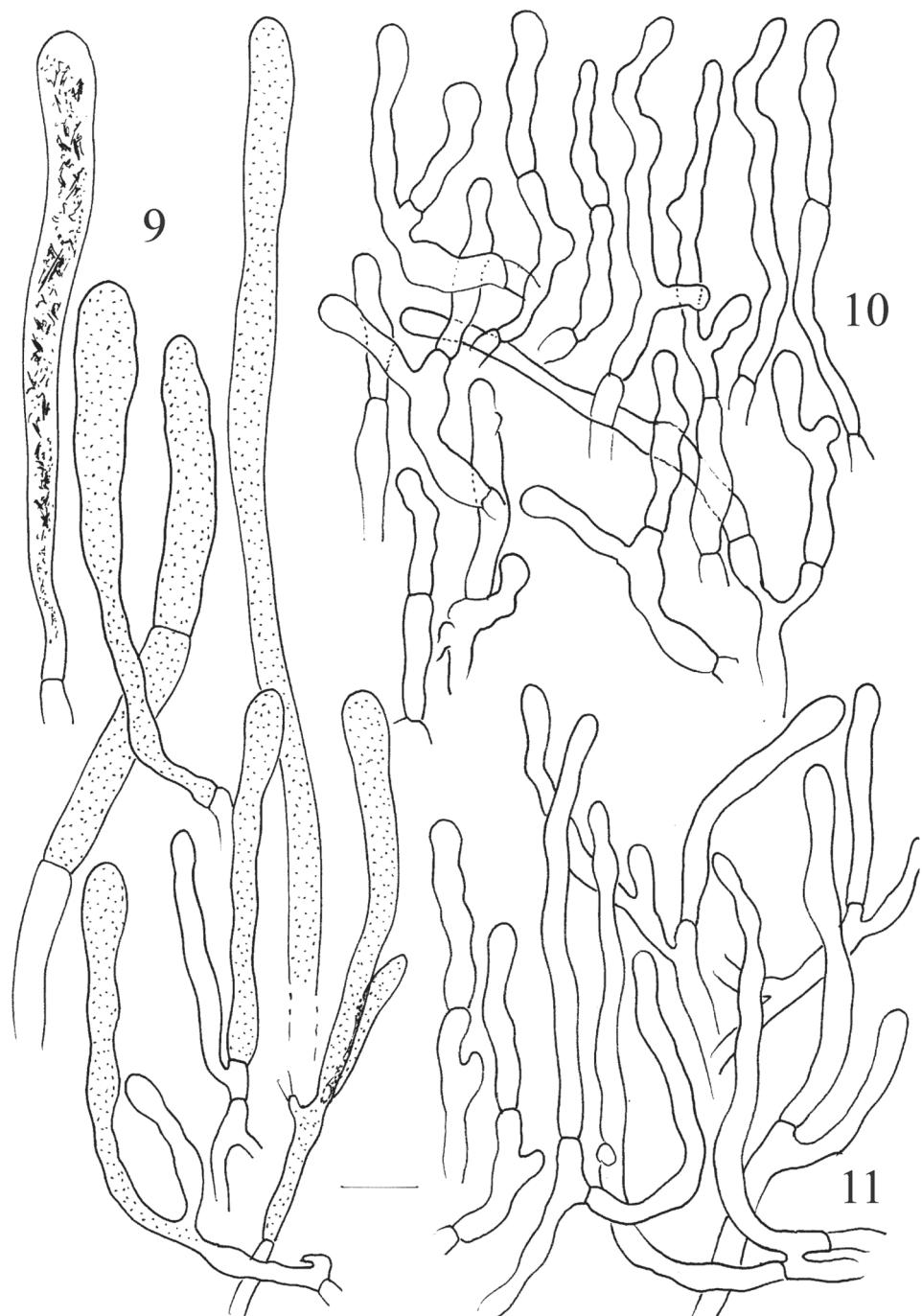


Fig. 9-11. *Russula grundii* (holotype). **9.** Pileocystidia. **10.** Hyphal extremities in the cap center. **11.** Hyphal extremities near the cap margin. Scale bar equals 10 µm.

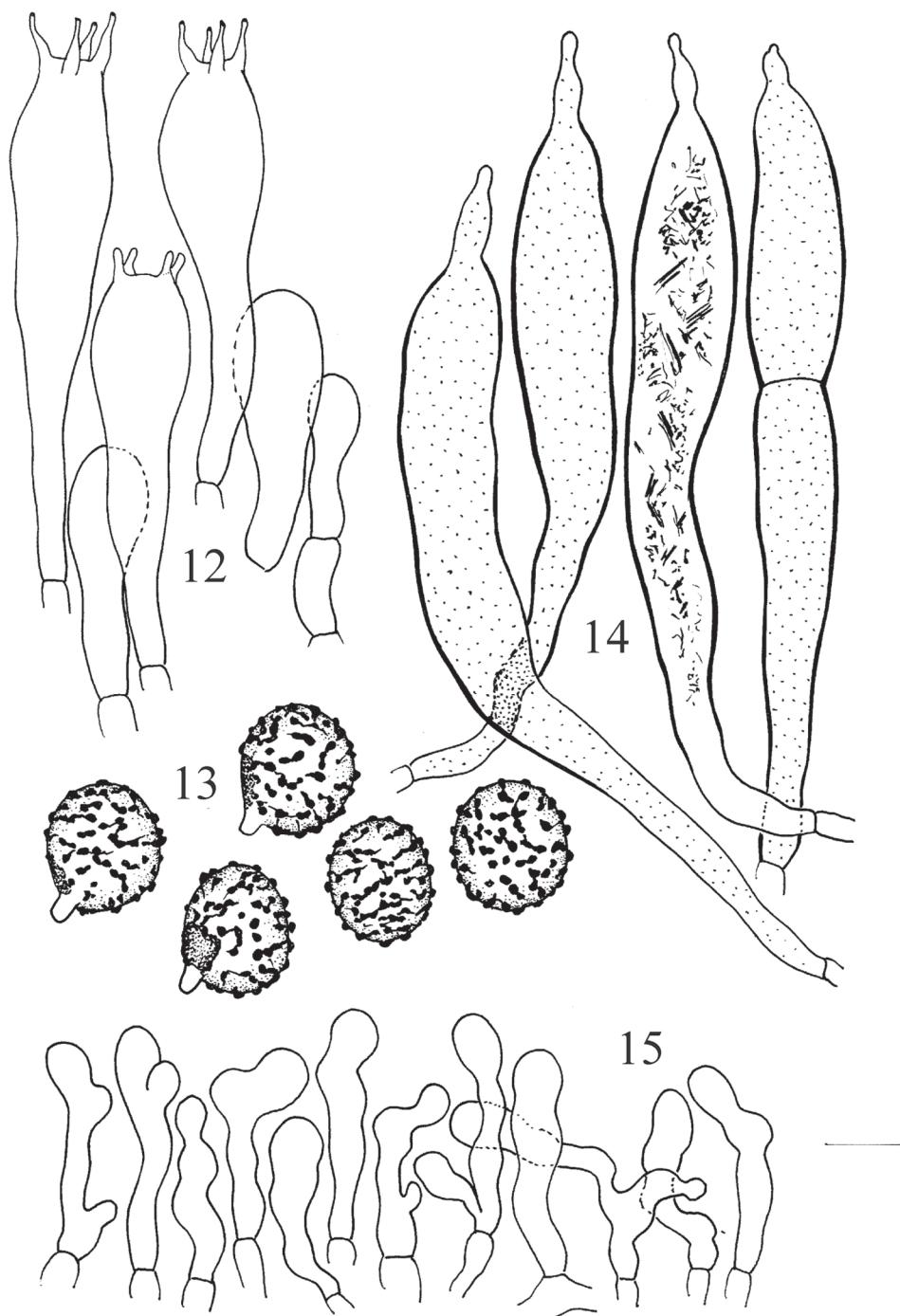


Fig. 12-15. *Russula grundii* (holotype). **12.** Basidia and basidiola. **13.** Basidiospores. **14.** Pleurocystidia. **15.** Marginal cells. Scale bar equals 10 μm , but only 5 μm for spores.

subacris. Stipes 4-8 cm longus, apice 1.5-2 cm crassus, albus; superficies veneta in ferri sulphate. Basidiosporae in cumulo subluteae vel luteae, 7.5-10.5 × 7.5-8.5 µm; reticulum partiale; verrucae 0.5-1.0 µm altae. Hymenii cystidia 80-124 × 5-8 µm, rara vel dispersa, saepe obscura, profunde inclusa in hymenio, fusoidea vel subclavata, apicibus angustatis, elongatis. Cuticula 70-90 µm crassa, epicutis ex hyphis intertextis et pileocystidiis clavatis constans. Holotypus: *H. D. Thiers 51840* (SFSU), Rancho Los Flores prope Los Alamos, Santa Barbara Co., California, 2 February 1988.

Holotype: UNITED STATES. California. Santa Barbara Co.: Rancho Los Flores near Los Alamos, solitary to scattered in soil and duff under coastal live oaks, 2 February 1988, leg. H.D. Thiers (SFSU 51480).

Spores subglobose to ellipsoid, (7.5-)7.8-8.3-8.7(-9.3) × (6.5-)6.8-7.2-7.5(-7.9) µm, Q=(1.06-)1.1-1.16-1.21(-1.27); ornamentation subreticulate, composed of blunt, amyloid warts, 0.3-0.5 µm high, densely disposed (with (5-)6-9(-11) warts in a 3 µm diam. circle on the spore surface) and mostly interconnected by fine lines or fused in chains; suprahilar spot distinctnd amyloid. **Basidia** (42-)47-53-59(-66) × (11-)12-13.1-14(-15.5) µm, 4-spored, clavate-pedicellate; basidiola first cylindrical, then clavate. **Subhymenium** pseudoparenchymatic. **Lamellar trama** mainly composed of large sphaerocytes. **Hymenial cystidia** very dispersed, less than 350/mm², measuring (41-)73-89.4-106(-111) × (9-)10-11.2-12.5(-15.5) µm on gill sides, mostly fusiform-pedicellate and mucronate to appendiculate with an appendage up to 10(-15) µm long, thin-walled or nearly so, in the upper part with distinct heteromorphous contents. **Marginal cells** present but small, (20-)22-25.7-29.5(-31.5) × (4.5-)5-5.8-6.5(-7) µm, irregular, often clavate, moniliformous, nodulose to capitate. **Pileipellis** orthochromatic in cresyl blue, not sharply delimited from the underlying context, thin, 80-100 µm thick, vaguely two-layered; subpellis poorly gelatinized, 40-50 µm deep; suprapellis of ascending, thin-walled, branched hyphal terminations without incrustations, with mostly narrow, cylindrical or clavate terminal cells measuring (19-)22-37.5-53(-79) × (2.5-)3-3.6-4 µm, blunt or occasionally constricted, towards the pileus centre more irregular and often strongly moniliformous, measuring (16-)20.5-32.4-44(-58) × (2.5-)3-3.6-4.5(-5) µm. Pileocystidia only at the surface, very numerous in the center and more dispersed towards the pileus margin, 1(-2) celled, with terminal cells measuring (26-)33-58.2-83(-115) × (5-)6-7.5-9(-10) µm, clavate, obtuse, thin-walled; contents heteromorphous, hardly reacting to sulphovanillin. **Clamp connections** absent in all parts.

Commentary: *R. grundii*, equally based on a single collection, is clearly a member of *Russula* sect. *Xerampelinae* possessing the typical fishy smell and gray-green reaction when treated with FeSO₄ (Thiers 1997). Apart from the holotype, there are no other specimens deposited at SFSU, nor are we aware of any other recent report of this species. Thiers named this *Russula* in honor of D.W. Grund "who first recorded its existence in his doctoral dissertation". This seems highly unlikely to us since Grund (1965) made a revision of *Russula* in Washington state, a far more northern location and outside the distribution range of live oak. Moreover, Grund gave no detailed descriptions for his series of provisionally introduced varieties of *R. xerampelina*, all of which were collected under conifers and with none being even remotely similar to *R. grundii*. Thiers' original description mentions the presence of pinkish pigments near the cap margin and a dark yellow cap center (atoluteus). This makes it plausible that this collection is possibly a discolored form of a usually more vividly colored species. The description of *R. grundii* also mentions a yellow spore print and unchanging flesh. Since there is no reference to a precise color code, it is possible that one should interpret the spore print color within a range going from pale yellow as in *Russula xerampelina* (Schaeff.) Fr. (IVa in Romagnesi 1967) to any intensity of ochre (IIIa-c in Romagnesi 1967).

Table 1. Comparison of selected characters observed by the senior author on the type specimens of *R. ochrifloridana* and *R. grundii* and on specimens of *R. levyana* studied by Adamčík & Buyck (2010). * The number of warts is counted in a 3 µm diam. circle on the spore surface.

	<i>R. ochrifloridana</i>	<i>R. grundii</i>	<i>R. levyana</i>
Cap color	margin almost white, centre brownish yellow	margin pale yellow, centre darker	bright red with purplish tints, often discoloring
Spore length [µm]	9.2-9.7-10.2	7.8-8.3-8.7	8.5-9-9.4
Spore width [µm]	7-7.3-7.7	6.8-7.2-7.5	6.9-7.2-7.4
Q	1.26-1.33-1.4	1.1-1.16-1.21	1.18-1.23-1.29
Number of warts *	6-11	6-9	4-7
Height of the spore ornamentation [µm]	0.3-0.5	0.3-0.5	0.9-1.1
Length of terminal cells of hyphae near margin of pileus	20.5-29.1-37.5	22-37.5-53	19.5-29-38.5
Width of terminal cells of hyphae near margin of pileus	4.5-4.9-5.5	3-3.6-4	3.5-4.4-5
Length of terminal cell of pileocystidia	27-41.9-56.5	33-58.2-83	27.5-53.4-79.5
Pileocystidia septation	mostly two or more cells	mostly one-celled	frequently two or more cells
Habitat	associated with <i>Quercus myrtifolia</i> , <i>Q. geminata</i> , <i>Pinus elliottii</i>	live oak savannah	associated with <i>Pinus palustris</i> and <i>P. taeda</i>
Origin	Florida	California	Florida and Texas

DISCUSSION

Russula grundii, the Californian species, can be defined microscopically as a species that has (1) subreticulate spores with low warts that are frequently interconnected by thin lines or fused into longer chains, and (2) narrow, cylindrical, densely arranged terminal cells in the pileipellis that arise from nodulose and branched basal cells. These features are reminiscent of the European *Russula subrubens* (J.E. Lange) Bon, a red-brown species growing in alpine and lowland habitats with *Salix*. It differs from *R. grundii* not only in habitat, but also by having narrower spores and stable red colours.

R. levyana Murill (see Adamčík & Buyck 2010) has a pileipellis with similar, narrow, cylindrical, more or less moniliformous terminal cells, but its spores are more elongate and have a more prominent ornamentation with warts that are less connected. It grows possibly in association with three needle pines in the southeastern United States.

The newly described *R. ochrifloridana* shares with *R. grundii* the yellow tones in the cap color, low spore ornamentation and more or less similar terminal cells in its pileipellis. However, in the Californian species the spores are more subglobose, the hyphal terminations in the pileipellis distinctly less slender and its pileocystidia are mostly one-celled (see Tab. 1).

R. ochrifloridana on the other hand, is microscopically very similar to *R. levyana*. Moreover, both species are possibly strict associates of three-needle pines. *R. levyana* differs nevertheless from *R. ochrifloridana* by the more spaced and higher ornamentation of the spores and to a lesser extent also by the less septate and less branched hyphal extremities near the pileus margin. *R. levyana* may produce discolored fruit bodies, but these discolored forms are readily recognizable as such and lack the prominent yellow color of *R. ochrifloridana*. The hypothesis that *R. ochrifloridana* might simply represent a discolored form of *R. levyana* Murrill seems therefore unlikely and is supported by differences in their ITS sequence (Buyck unpubl.). In any respect, both species are very closely related.

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