

reticulate, with amyloid warts, $(0.2\text{--})0.59\text{--}0.6\text{--}0.61\text{--}(1)\text{ }\mu\text{m}$ high, fused in short crests or with thin interconnections; suprahilar spot present as a distinct amyloid patch. *Basidia* $(23\text{--})32\text{--}38\text{--}43.5\text{--}(56)\text{ }\mu\text{m} \times (9\text{--})10\text{--}11\text{--}12\text{--}(13.5)\text{ }\mu\text{m}$, 4-spored, stout and slightly clavate; basidiola similar. *Lamellar trama* composed mainly of sphaerocytes, intermixed with cystidioid hyphae. *Hymenial cystidia* $60\text{--}65 \times 9\text{--}11\text{ }\mu\text{m}$, clavate to fusiform, thin-walled, weakly SV+ and pale grey in sulfovanillin ($\sim 20\%$ of Woo specimens recorded as maroon or pink). *Marginal cells* not differentiated. *Pileipellis* not sharply delimited from the underlying context of filamentous hyphae and sphaerocytes; suprapellis composed of loosely arranged hyphae with cylindrical terminal cells having obtuse tips. Pileocystidia at pileus surface measuring $(23.5\text{--})27\text{--}31\text{--}35.5\text{--}(41.5) \times (4\text{--})5\text{--}6\text{--}7.5\text{--}(9)\text{ }\mu\text{m}$, septate, with short terminal cells, often somewhat clavate or inflated, obtuse-rounded at the tip; contents refringent. Acidoresistant incrustations absent. *Clamp connections* absent in all parts.

Habitat and distribution: although *Pseudotsuga menziesii* was present at each collection locality, other conifers such as *Tsuga heterophylla*, *Picea stichensis*, and *Pinus contorta* were usually present as well.

Examined material: U.S.A., Washington, Chimacum County Park, $48^{\circ}0'53''\text{N}$; $-122^{\circ}46'39''\text{W}$, 40 m alt., 11 Nov 2001, B. Woo BW951, F-038563 (WTU), GenBank ITS2: KX813576; ibidem, Greenwater Road 70, 1176 Trailhead, $121.619167^{\circ}\text{W}$, $47.140278^{\circ}\text{N}$, 600 m alt., 10 Sep 1995, B. Woo BW597, F-038602 (WTU), GenBank ITS2: KX81331809; ibidem, Oct 2005, B. Woo BW1041, F-038641, GenBank ITS2: KX812940; Old Fort Townsend Jefferson County, $122.790556^{\circ}\text{W}$, 48.074°N , 60 m alt., 29 Oct 1998, B. Woo BW767, F-038908 (WTU), GenBank ITS2: KX813433; ibidem, 11 Nov 2001, B. Woo BW953, F-038562 (WTU, holotype), GenBank ITS2: KX813578; ibidem, Olympia, Priest Point Park, 122.8961°W , 47.06972°N , 30 m alt., 02 Nov 1998, B. Woo BW786, F-038887 (WTU), GenBank ITS2: KX813447; ibidem, Talapus Lake Trailhead FS road 9030, 121.585°W , 47.401°N , 805 m alt., 05 Oct 2005, B. Woo BW1035, F-038628 (WTU), GenBank ITS2: KX812934; ibidem, Olympia, Tolmie State Park, 122.7761°W , $47.120556^{\circ}\text{N}$, 2 m alt., 11 Nov 1999, B. Woo BW849, F-039125 (WTU), GenBank ITS2: KX813499.

Notes: *Russula pseudotsugarum* corresponded to Clade 8 in our phylogeny (Fig. 148), to Woo sp. 52 in Bazzicalupo et al. (in press) and to UNITE SH DOI: <https://plutof.ut.ee/#/datacite/10.15156/BIO/SH315582.07FU>.

All 25 samples of *Russula pseudotsugarum* formed a monophyletic group nested within a well-supported clade that included *R. cessans* Pearson, *R. zelleri* Burl., Woo sp.

51, *R. laricina* Velenovsky and *R. nauseosa*. The European *R. olivina* Ruotsalainen & Vauras, well characterized by its two-spored basidia and particular spore ornamentation, considered as a close relative to these species in Sarnari (1998–2005), was only distantly related in the phylogeny (Fig. 148). *Russula pseudotsugarum* will be difficult to separate morphologically from *R. zelleri* and *R. obsкуроzelleri*, but as its name suggests, it has been found consistently with *Pseudotsuga*, while *R. zelleri* is found with *Picea*.

Russula pseudotsugarum has probably been identified as *R. lilacea* in the Pacific Northwest based on the Grund (1965) key, but *R. lilacea* may not occur in the region. *Russula pseudotsugarum* could easily be confused with *R. obsкуроzelleri* (Clade 7); see notes under that species.

Geographically, samples with sequences identical to *R. pseudotsugarum* ranged from the Pacific Northwest to Mexico: Canada: Sooke Reservoir, Vancouver Island, BC (UDB031541); Bella Coola, BC (HQ650754); Pemberton, BC (JN652960); Campbell River, BC (KP403052, KP403055); BC (KM402893, KP406550, KP406553, KT272154, KT272155); Mexico: Tlaxcala (KP781012) USA: Mt St Helen, Washington (UDB012199); HJ Andrews Experimental Forest, Cascade Range, Oregon (EU526011); California (JF834345, JF834494).

Sequences 1.5% different from *R. pseudotsugarum* were recorded from western and eastern North America and Europe, likely representing *R. zelleri*, *R. cessans*, and *R. laricina*: <https://plutof.ut.ee/#/datacite/10.15156%2FBIO%2F5H177309.07FU>.

Russula rhodocephala Bazzicalupo, D. Miller & Buyck., *sp. nov.*

Index Fungorum number: IF553822; **Facesoffungi number:** FoF 03655, Fig. 156

Etymology: refers to the red colour of the cap.

Holotype: BW337 (WTU, sub nr. F-039507)

Pileus 2–12 cm diameter, very fleshy and firm, convex to shallowly depressed or irregularly wavy with downward margin without striations; surface bright scarlet, deep crimson red to brownish reddish orange. **Lamellae** adnate to slightly decurrent, spacing normal (ca 1 L/mm) to slightly wider, mostly equal although lamellulae can be common and bifurcations occasionally present, cream coloured. **Stipe** shorter than the cap diameter in mature fruiting bodies, robust and cylindrical, flushed with pink or red. **Context** white, unchanging with age or on injury, the lower stipe may bruise yellow, turning pink with FeSO_4 . **Odor** none or weakly pleasant. **Taste** very hot in gills and flesh, (of Woo specimens, 100% recorded as ‘hot’ in both gills and flesh, 50% of flesh recorded as some degree of

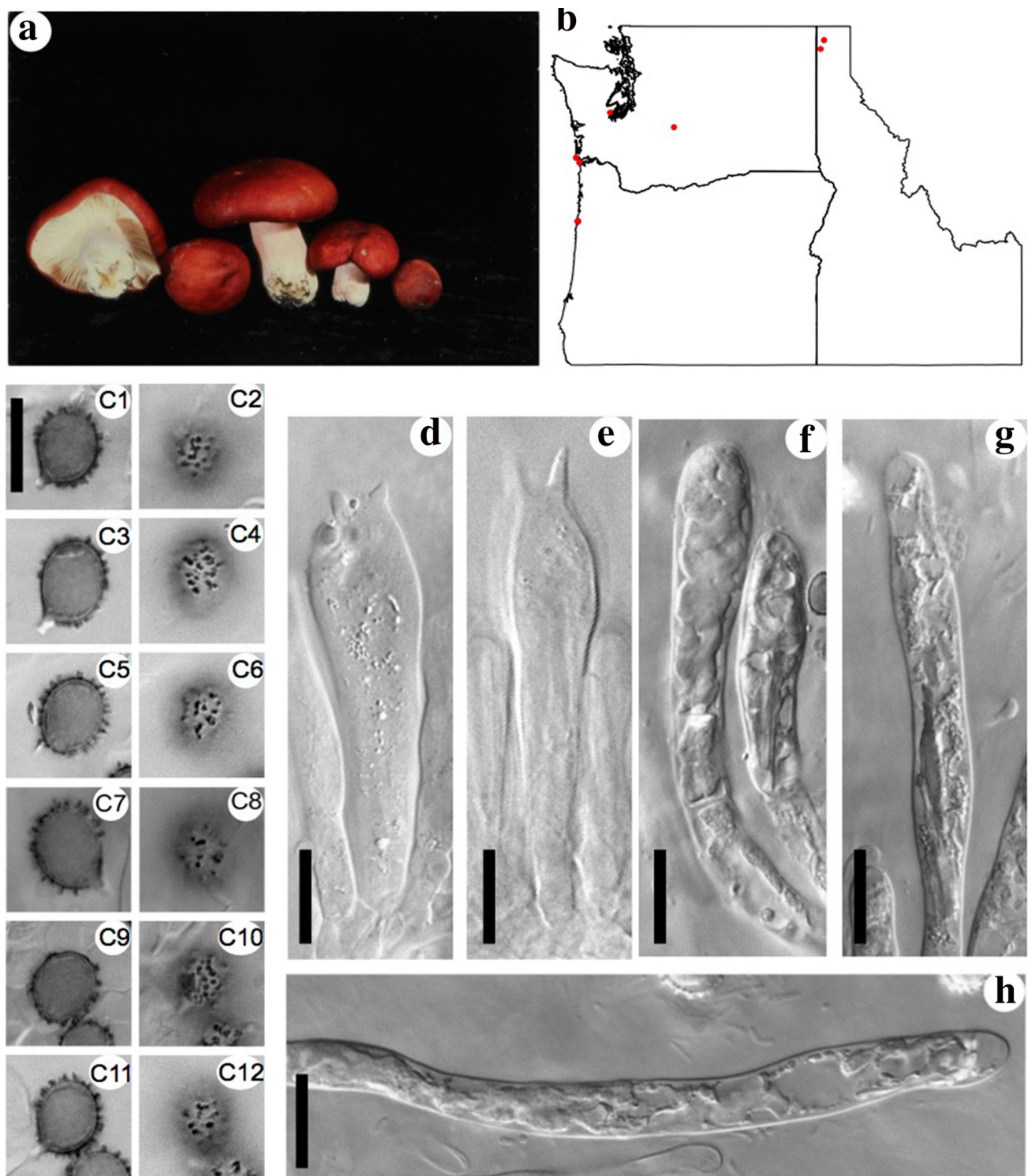


Fig. 156 Morphology and specimen distribution of Clade 4 *Russula rhodocephala* (Woo sp. 35). BW followed by numerals designate Ben Woo samples. **a** Photo by B. Woo, BW337, scanned image from WTU. **b** Distribution of specimens of the Woo collections in Pacific Northwest. **c–h** Micromorphology, all $\times 1000$ magnification. **c** Spores

in median optical section and surface view in Melzer's reagent (c–c2, BW438; c3–c4, BW438; c5–c6, BW337; c7–c8, BW860; c9–c10, BW337; c11–c12, BW463). **d–e** Basidia (BW361, BW463). **f–h** Cap cuticle terminal cells with refringent contents (BW337, BW201, BW201). Scale bars 10 μ m

‘acid’). *Spore print* yellowish, (~ 40% of Woo specimens recorded as Crawshaw B–C, ~ 60% D–E). *Spores* broadly ellipsoid, $(6.2\text{--}7.83\text{--}7.87\text{--}7.92(-10) \times (4.8\text{--}6.28\text{--}6.32\text{--}6.35(-7.5) \mu\text{m})$, $Q = (1\text{--}1.24\text{--}1.25\text{--}1.26(-1.5))$, ornamented with mostly isolated, amyloid, conical warts, $(0.2\text{--}0.68\text{--}0.69\text{--}0.71(-1.4) \mu\text{m})$ high, with rare connections; suprahilar spot a strongly amyloid patch. *Basidia* $(36.5\text{--}41\text{--}45\text{--}49(-55) \times (9\text{--}10\text{--}11\text{--}12(-14) \mu\text{m})$, 4-spored. *Lamellar trama* mainly composed of sphaerocytes, intermixed with cystidioid hyphae. *Hymenial cystidia* $60\text{--}65(-70) \times 7\text{--}8 \mu\text{m}$, broadly clavate, obtuse-rounded at the tip, SV+ and dark purple in sulfovanillin. *Pileipellis* not sharply delimited from the underlying context of filamentous hyphae and sphaerocytes; suprapellis composed of loosely arranged, branching hyphal terminations, with cylindrical terminal cells. Pileocystidia sometimes so long that it was hard to determine their length, when measurable up to ~ 40 μm long and up to 8 μm in width and with obtuse tips; contents refringent, also abundantly continuing as cystidioid hyphae with refractory contents in subpellis and trama. Acidoresistant incrustations absent. *Clamp connections* absent in all parts.

Habitat and distribution: *Pinus contorta*. Known from USA: California, Idaho, Oregon, Washington; Canada: British Columbia.

Examined material: U.S.A., Idaho, Priest Lake, 116.916667°W , 48.565556°N , 765–900 m alt., 29 Sep 1978, B. Woo BW201, F-038413 (WTU), GenBank ITS2: KX813043; ibidem, Priest Lake, North Lake Road, 116.816667°W , 48.748889°N , 770 m alt., 24 Sep 1983, B. Woo BW361, F-038604 (WTU), GenBank ITS2: KX813143; Oregon, Lincoln City, East Devils Lake Park, 124.01194°W , 44.97°N , 6 m alt., 15 Nov 1986, B. Woo BW438, F-038632 (WTU), GenBank ITS2: KX813199; ibidem, 123.997778°W , 44.97°N , 6 m alt., 15 Nov 1999, B. Woo BW860, F-039103 (WTU), GenBank ITS2: KX813506; ibidem, Astoria, Fort Stevens, 123.96861°W , 46.185278°N , 15 m alt., 11 Nov 1989, B. Woo BW486, F-038655 (WTU), GenBank ITS2: KX813231; Washington, Fort Canby State Park, 124.063889°W , 46.285833°N , 6 m alt., 12 Nov 1988, B. Woo BW463, F-038363 (WTU), GenBank ITS2: KX813218; ibidem, Shelton power line, 123.066667°W , 47.250833°N , 60 m alt., 24 Oct 1982, B. Woo BW337, F-039507 (WTU, **holotype**), GenBank ITS2: KX813126.

Notes: *Russula rhodocephala* corresponds to Clade 4 in our phylogeny (Fig. 148), to Woo sp. 35 in Bazzicalupo et al. (in press) and to UNITE SH DOI <https://plutof.ut.ee/#/datacite/10.15156%2FBIO%2FSH218433.07FU> (100% match ITS2).

Until now, *R. rhodocephala* has been referred to as *R. sanguinea* Fr. Both *R. rhodocephala* and *R. sanguinea* are associated with *Pinus* (Bills and Miller Jr 1984). Even

though the European *R. sanguinea* appeared as the sister to our species with significant support (Fig. 148), it differed from our species by more than 3% in the ITS2 region. PlutoF maps showed that their distributions differed. The only records of sequences matching *R. rhodocephala* at 99.5% identity cutoff were from the American west: [Canada: Rocky Point, Victoria, BC (UDB031015), U.S.A.: California (GU180315), corresponding to UNITE SH DOI: <https://plutof.ut.ee/#/datacite/10.15156/BIO/SH297359.07FU>. Relaxing the identity cutoff to 99%, samples with a wider geographical distribution across the United States and Mexico were included: <https://plutof.ut.ee/#/datacite/10.15156/BIO/SH130463.07FU>. Further relaxing the cutoff to 97% cutoff included sequences found from Korea, China and Japan (March 2017): <https://plutof.ut.ee/#/datacite/10.15156%2FBIO%2FSH030433.07FU>. Reflecting their sequence differences, European *Russula sanguinea* corresponded to UNITE SH218425 represented by sample *R. sanguinea* UDB011161, while N. American *R. rhodocephala* (accessioned into GenBank as “*R. sanguinea*”) corresponded to UNITE SH218433.

The spore print colour described should be verified due to the surprisingly wide range recorded by Woo. However, a similar wide variation in spore print colour is given on Mushroomexpert.com for the eastern U.S. taxon identified as *R. sanguinea* (“creamy to yellowish or orange-yellow” (Kuo 2009).

The species could be confused with *R. americana* Singer, which appears a somewhat less robust taxon associating with *Tsuga* and perhaps also *Abies*, and has larger spores, $8.5\text{--}11.5 \times 7\text{--}10.8$ (Singer 1939). *R. americana* also matches the description of *R. rosacea* var. *macropseudocystidiata* Grund. Detailed descriptions can be found in Roberts (2007) who distinguished *R. americana* from *R. rhodocephala* (under the name ‘*R. sanguinaria*’) by its taller and more slender habit and by its association with western hemlock (and possibly *Abies*) rather than pines. Unlike *R. americana*, *R. rhodocephala* is generally found in wet areas, often shows yellow staining on the lower stipe, and it has a more evenly coloured and shiny cap with the epicutis an ixotrichodermis. Most other red-capped, acid species in the area produce whitish gills and spore prints, while the otherwise very similar *R. californiensis* Burl. grows with pine and oak in California, has a pale yellowish spore print, a more distinctly greying stipe, and especially, a distinctly more reticulate spore ornamentation (Burlingham 1936).

Russula salishensis Bazzicalupo, D. Miller & Buyck., *sp. nov.*

Index Fungorum number: IF553823; **Facesoffungi number:** FoF 03656, Fig. 157

Etymology: refers to the Salish Sea.