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## Two interesting *Russula* species from south India

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Two species of *Russula*, *R. densifolia*, *R. heterophylla* are described based on collections made from Kerala State. Full descriptions and illustrations along with comparison with morphologically similar species are provided. This report forms the first record of these species from south India.

**Key words:** Ectomycorrhiza, south India, taxonomy, new records

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### INTRODUCTION

Family Russulaceae is one of the largest ectomycorrhizal families and includes agaricoid, secotioid, pleurotoid and gasteroid forms (Buyck *et al.* 2008; Morozova *et al.* 2013). Members of this family generally form ectomycorrhizal association with different angiosperm and gymnosperm trees. The monophyletic genus *Russula* Pers. is the most dominant and diverse amongst the four genera with over 750 species known world over. The genus is represented in India by about 157 taxa (Sharma *et al.* 2018). During our ongoing studies on the Russulaceae of Kerala, we came across two species of *Russula*, so far not known from south India, are described and illustrated here.

### MATERIALS AND METHODS

Gross morphological descriptions are based exclusively on fresh materials collected from Kerala State, India. Colour coding follows that of Kornerup and Wanscher (1978). Microscopic characters were studied on dried materials using hand cut sections of basidiomata revived in a 3% solution of KOH, stained with 1% Congo red and examined under a Leica DME 1000 compound microscope. The mean quotient (Q) of spore length divided by spore width was calculated from measurements of 20 spores. Line drawings were made with assistance of an attached drawing tube. All

materials examined are deposited at the Mycological Herbarium of Tropical Botanic Garden and Research Institute, Trivandrum [TBGT (M)].

### RESULTS AND DISCUSSION

1. *Russula densifolia* Secr. ex Gillet, *Hyménomycètes* (Alençon): 231 (1876) [1878]

*Russula densifolia* f. *cremeispora* Shaffer, *Brittonia* 14(3): 276 (1962)

*Russula densifolia* f. *dilatatoria* Shaffer, *Brittonia* 14(3): 275 (1962)

*Russula densifolia* f. *fragrans* Shaffer, *Brittonia* 14(3): 276 (1962)

*Russula densifolia* f. *gregata* Shaffer, *Brittonia* 14(3) : 276 (1962)

*Russula densifolia* f. *subrubescens* Reumaux, *Russules Rares ou Méconnues* (Marlioz): 284 (1996)

*Russula densifolia* var. *caucasica* Singer, *Beih. bot. Zbl.*, Abt. 2 48: 525 (1931)

*Russula densifolia* var. *colettaram* Dagron, *Bull. trimest. Soc. mycol. Fr.* 115(2): 150 (1999)

*Russula densifolia* var. *fumosella* R. Socha, in Socha, Hálek, Baier & Hálek, *Holubinky* (*Russula*) (Praha): 506 (2011)

*Russula densifolia* var. *lateriticola* R. Heim, *Candollea* 7: 383 (1938).

Pileus 5–12.5 cm in diam., applanate, plano-convex to slightly uplifted with a shallow depression at the centre; surface initially white, discolouring brownish orange to greyish orange (5C3/5B3), nonstriate, slimy when wet, soon dry,

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smooth and glabrous; margin incurved in the young stage, straight to sometimes uplifted in mature ones, entire. Lamellae subdecurrent to decurrent, white, up to 3 mm wide, relatively fragile, whitish to dirty yellow, with rusty spots, slowly greyish brown to touch, then blackened, bifurcate towards the base of the stipe in some, crowded with lamellulae of different lengths; edge concolorous to the sides, brittle, straight, entire. Context firm, white, up to 2 cm wide, turning reddish brown (9E6) and then slowly blackening. Stipe 3.5–6.2 × 1–2 cm, central, cylindrical to compressed equal or slightly attenuated at the base, brittle solid, soon becoming hollow; surface chalky white, gradually stained greyish brown (7D3) to reddish brown (9E6), finally blackening, smooth, dry. Odour nil. Taste acrid. Spore print white (Fig.1, 2).

Chemical reaction on the pileal context: FeSO<sub>4</sub>-Grey pink.

Basidiospores 6–7.5 × 6–7.2 μm, (Q=1–1.29 μm, Q'= 1.09 μm), globose to subglobose, rarely broadly ellipsoid, composed of warts and obtuse ridges up to 0.6 μm high, amyloid, connected together by small connectives, forming a partial reticulum, plage inamyloid. Basidia 28.8–33.6 × 6–10 μm, clavate to cylindro-clavate, 4–spored, sometimes 2–spored rarely 1–spored, sterigmata up to 6.8 μm long, thin-walled, with refractive granular and plasmatic contents. Lamella-edge deeply stained pink with Sulfovanilin and orthochromatic in Cresyl blue, heteromerous. Cheilocystidia macrocystidioid, 30–55.6 × 6.8–17 μm, cylindrical to cylindro-clavate, with a mucronate to pointed apex, clavate to ventricose with a broad obtuse apex, thin-walled, filled with brownish refractive contents which turns yellow to brown in KOH, originating deep from the subhymenium. Pleurocystidia similar to cheilocystidia, 30–68 × 6–10 μm, cylindrical with a pointed or mucronate apex, frequently with 1–2 constrictions, with vacuolar contents turning brownish in KOH. Pileal trama heteromerous with sphaerocytes and hyphae, sphaerocytes 15–42 × 15–39 μm, thin-walled, hyaline, without any contents; hyphae thin-walled, hyaline, septate, up to 3 μm wide. Hymenophoral trama heteromerous, composed of sphaerocytes and thin-walled, hyaline hyphae; sphaerocytes 18–30 × 13.8–24 μm. Pileipellis an ixocutis, hyphae thin-walled, hyaline, septate, hyphal ends cystidioid; dermatocystidia 4–6 μm

wide, with much dispersed, abundant with localized brown pigments. Stipitipellis intermixed, with caulocystidia, 54–64 × 4–6 μm, cylindrical to narrowly clavate, with or without a mucronate apex, thin-walled, filled with refractive vacuolar contents. Oleiferous hyphae absent. Clamp connections absent.

**Habitat and phenology:** Solitary to scattered on forest soil, associated with *Myristica malabarica* Lam., *Hopea parviflora* Bedd. May-June; October-November.

**Specimens Examined:** India, Kerala State, Thiruvananthapuram district, JNTBGRI campus: 01 May 2015, TBGT(M) 15607; 29 Sep. 2015, TBGT(M) 15871; 05 Oct. 2015, TBGT(M) 15890; 09 Jun. 2016, TBGT(M) 16307; 10 Jun. 2016, TBGT(M) 16325; 02 Nov. 2016, TBGT(M) 16646; 03 Nov. 2016, TBGT(M) 16654; 04 Nov. 2016, TBGT(M) 16663, TBGT(M) 16664. TBGT (M) 16665; 31 Oct. 2017 TBGT (M) 17208; 25 May. 2018 TBGT (M) 17482.

2. *Russula heterophylla* (Fr.) Fr., Epicr. syst. mycol. (Upsaliae): 352 (1838) [1836-1838]

*Agaricus furcatus* β *heterophyllus* Fr., Syst. mycol. (Lundae) 1: 59 (1821)

*Agaricus galochrous* Fr., Observ. mycol. (Havniae) 1: 65 (1815)

*Agaricus heterophyllus* (Fr.) Sacc., Syll. fung. (Abellini) 5: 446 (1887)

*Agaricus lividus* Pers., Syn. meth. fung. (Göttingen) 2: 446 (1801)

*Agaricus vescus* Vent., in Bulliard, Hist. Champ. Fr. (Paris): tab. 63, fig. 104 (1809)

*Omphalomyces galochrous* (Fr.) Earle, Bull. New York Bot. Gard. 5: 410 (1909)

*Russula furcata* var. *heterophylla* (Fr.) P. Kumm., Führ. Pilzk. (Zerbst): 102 (1871)

*Russula galochroa* (Fr.) Fr., Hymenomyc. eur. (Upsaliae): 447 (1874)

*Russula heterophylla* \* *galochroa* (Fr.) P. Karst., Bidr. Känn. Finl. Nat. Folk 32: 207 (1879)

*Russula heterophylla* f. *adusta* J.E. Lange, Fl. Agaric. Danic. 5: 71 (1940)

*Russula heterophylla* f. *galochroa* (Fr.) Singer, Z. Pilzk. 2(1): 5 (1923)

*Russula heterophylla* f. *laeticolor* Donelli, Mostr. Regg. Fung.: 28 (1995)

*Russula heterophylla* f. *pseudo-ochroleuca* Romagn. ex Carteret & Reumaux [as

‘pseudochroleuca’], Bull. Soc. mycol. Fr. 120(1-4): 201 (2005) [2004]

*Russula heterophylla* f. *pseudo-ochroleuca* Romagn., Bull. mens. Soc. linn. Lyon 31: 175 (1962)

*Russula heterophylla* var. *avellanae* Zvára, Mykologia (Prague) 8: 72 (1927)

*Russula heterophylla* var. *chloridicolor* Carteret & Reumaux, Bull. Soc. mycol. Fr. 120(1-4): 203 (2005) [2004]

*Russula heterophylla* var. *galochroa* (Fr.) Fr., Epicr. syst. mycol. (Upsaliae): 352 (1838) [1836-1838]

*Russula heterophylla* var. *livescens* Gillet, Hyménomycètes (Alençon): 241 (1876) [1878]

*Russula heterophylla* var. *livida* Gillet, Hyménomycètes (Alençon): 241 (1876) [1878]

*Russula heterophylla* var. *virginea* (Cooke & Masee) A. Pearson & Dennis, Trans. Br. Mycol. Soc. 31(3-4): 166 (1948)

*Russula livida* (Gillet) J. Schröt., in Cohn, Krypt.-Fl. Schlesien (Breslau) 3.1(33-40): 546 (1889)

*Russula livida* var. *galochroa* (Fr.) J. Schröt., in Cohn, Krypt.-Fl. Schlesien (Breslau) 3.1(33-40): 546 (1889)

*Russula livida* var. *virginea* (Cooke & Masee) Melzer & Zvára, Arch. P?írodov. Výzk. ?ech. 17(4): 70 (1928) [1927]

*Russula virginea* Cooke & Masee, Grevillea 19(no. 90): 41 (1890)

Pileus 3–4.5 cm diam., globose, slowly expanding convex to plano-convex, finally depressed; surface light brown (5D4) at the centre, brownish orange (5D3/5C3) elsewhere, or with a subtle green tinge (2A3), smooth at the disc, tuberculate-striate towards 3/4 of the margin, sticky when wet; margin long curved, then straightened. Lamellae adnexed, up to 4 mm wide, white, close, without lamellulae, sparsely forked near to the stipe, interveined; edge concolourous with the sides, entire. Stipe 3–3.5 × 0.5–1 cm, central, cylindrical, equal, sturdy and stocky, becoming stuffed with age, tapered and sometimes slightly curved, smooth, dry; surface white, then stained yellow-brown. Context off-white, thin, unchanging, more or less hard when young. Odour not characteristic. Taste mild. Spore print white (Fig. 3).

Chemical reactions: FeSO<sub>4</sub> on stipe surface- pink.

Basidiospores 6.5–8.5 (9) × 5.5–8 μm, (Q= 1–1.3 μm), obovoid to broadly ellipsoid, with amyloid ornamentation composed of isolated obtuse

verrucae, up to 0.3 μm high, mostly isolated, rarely connected together, plage inamyloid. Basidia 32–38.4 × 8.4–10.4 μm, clavate, 4- spored, rarely 1- or 2-spored, thin-walled, with refractive granular contents; Lamella-edge heteromorphous; macrocystidia scattered both on the edges and sides of the lamellae; cheilocystidia cylindrical to cylindroclavate, often mucronate, thin-walled, with granular contents, pale yellow, 40.5–49.5 × 6.5–7 μm. Pleurocystidia similar, 46–54 × 6.5–8 μm, sometimes with a mucronate apex, deep rooting. Pileal trama heteromerous with sphaerocytes and hyphae, sphaerocytes 27– 43 × 21– 40 μm, thin-walled, hyaline; hyphae up to 7 μm wide, thin-walled, hyaline, septate, branched. Hymenophoral trama intermixed with thin-walled, hyaline sphaerocytes and filamentous hyphae. Pileipellis composed of gelatinized, interwoven, thin-walled, hyaline, septate, branched hyphae with one or two septa, up to 4 μm wide interspersed with pileocystidia. Pileocystidia cylindrical, 18.4–40 × 2.4– 4.8 μm, with a capitate obtuse apex, thin-walled, pale yellow in KOH, with granular contents. Centre of the pileus with thick-walled, acute, hyaline hairs 2–3 μm wide. Stipitipellis with crowded caulocystidia, similar to pileocystidia, 28–56 × 3.6– 8 μm; hyphae up to 8 μm wide. Oleiferous hyphae present. Clamp connections absent.

**Habitat and Phenology:** Solitary on forest floor, associated with *Hopea parviflora*. July, September.

**Specimens Examined:** India, Kerala State, Thiruvananthapuram district, JNTBGRI campus: 17 Sept. 2009, TBGT (M) 15550; 18 July 2017, TBGT (M) 16959.

*Russula densifolia* Secr. ex Gillet, appears to be a readily identifiable species among the Compactae. This is a medium sized species, characterized by its initially whitish to brownish orange surface that turns greyish to reddish brown before blackening, smooth, nonstriate margin, decurrent gills, crowded lamellae, abundant lamellulae, globose to subglobose spores with ornamentations reaching 0.6 μm high and the rather inconspicuous dermatocystidia. *R. nigricans* (Bull.) Fr., another blackening species, is very similar, but the unusually thickened, distantly spaced lamellae is very characteristic for *R. nigricans*. *R. adusta* (Pers.) Fr., is also very closely related, but its flesh turns only weakly grey when cut. Direct blackening of the basidiomes separates *R. albonigra*

(Krombh.) Fr., from *R. densifolia*. *Russula densifolia* was earlier reported from northern India.

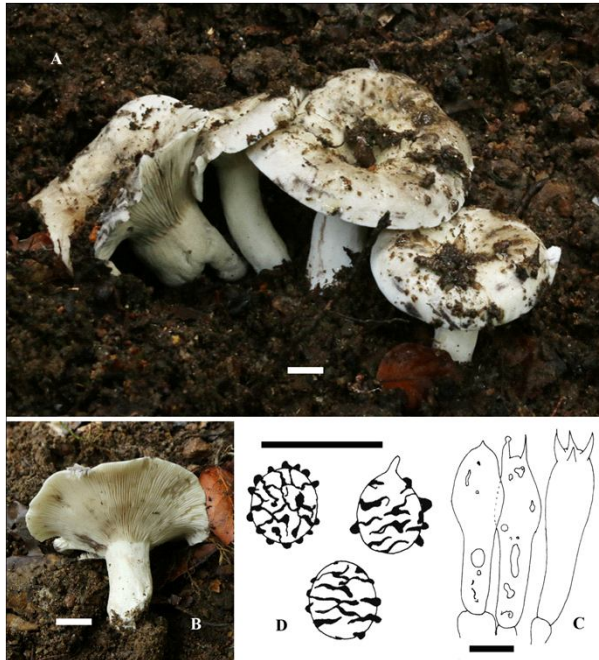


Fig. 1 : *Russula densifolia*

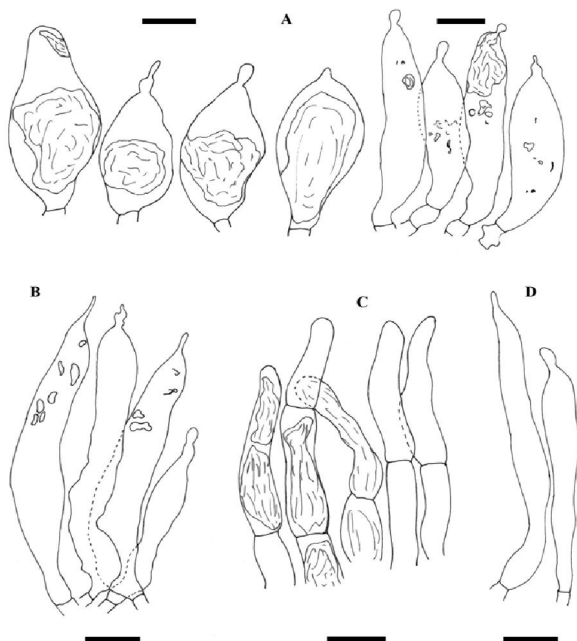


Fig.2 : *Russula densifolia*

*Russula heterophylla* can be recognized by its dry and opaque, green tinted pileus, tuberculate-striate margin, adnexed lamellae lacking lamellulae, finely verrucose basidiospores and epithelial hairs. *Russula heterophylla* is primarily known as a green coloured species . But many other colour combinations like brown, yellowish-

brown, yellow more or less touched with olive or entirely white also prevail. It was reported from Sikkim Himalayas as *Russula furcata* Fr. The species is also known from West Bengal , Uttarakhand; Himachal Pradesh and Sikkim (Das,

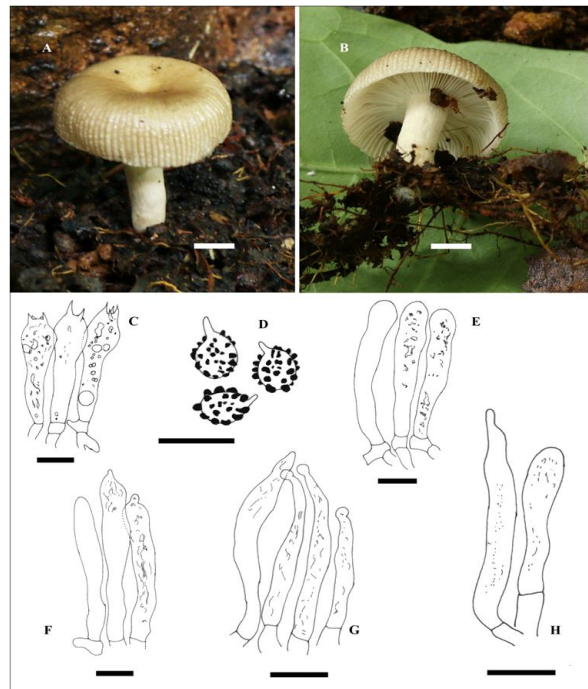


Fig.3: *Russula heterophylla*

2009). The species is so far not reported from south India.

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