

The Russulas described by Charles Horton Peck

Slavomír ADAMČÍK^a, Soňa JANČOVIČOVÁ^b & Bart BUYCK^{c*}

^a*Institute of Botany, Plant Science and Biodiversity Centre, Slovak Academy of Sciences, Dúbravská cesta 9, SK-84523, Bratislava, Slovakia, email: slavomir.adamcik@savba.sk*

^b*Comenius University in Bratislava, Faculty of Natural Sciences, Department of Botany, Révová 39, SK-811 02 Bratislava, Slovakia, e-mail: sona.jancovicova@uniba.sk*

^c*Institut de Systématique, Ecologie et Biodiversité (ISYEB), Muséum national d'histoire naturelle, CNRS, Sorbonne Université, EPHE, 57 rue Cuvier, CP 39, F-75005 Paris, France, email: buyck@mnhn.fr*

Abstract – In this paper, the authors present modern microscopical studies for 28 type specimens of *Russula* species described by C.H. Peck, thereby completing the revision of all 44 *Russula* taxa described by this author and for which type specimens were available. Our results suggest that with eventual exception of *R. granulata* var. *lepiotoides* (a likely synonym of the type variety) and *R. magnifica* (a likely synonym of *R. polyphylla*), all other *Russulas* described by Peck correspond to well-defined North American taxa. Having been described more than one century ago, Peck's names represent the majority of the earliest described North American *Russula* species and our type revisions are therefore important both for nomenclatural aspects, as well as typification and identification purposes. All studied taxa are illustrated in detail and accompanied by notes including a short recapitulation of previous type revisions, as well as our own re-evaluation of their systematic position as a result of this study.

Morphology / taxonomy / type studies / United States

INTRODUCTION

Russula Pers. is one of the most diverse genera of mushrooms on nearly every continent. Yet, except for Europe, our knowledge of the species diversity on each on the other continents is still very fragmentary (see Buyck *et al.* 2018). As far as North America is concerned, Buyck (2007) calculated ten years ago that already a total of 419 different taxa had been recognized (without accounting for possible synonyms), but he estimated that the real number of taxa might be three to four times higher. During the past ten years, however, only 14 new *Russula* species have been described from North America: ten from the West Coast (Arora & N.H. Nguyen 2014, Bazzicalupo in Hyde *et al.* 2017) and four from the south east (Adamčík *et al.* 2010, Adamčík *et al.* 2015a, Buyck in Liu *et al.* 2015, Buyck *et al.* 2008a). At this pace, it will take approximately one more century to describe the estimated diversity of North American *Russulas*.

At that time (ten years ago), Buyck (2007) also listed the main problems facing those who were interested in North American *Russulas*:

1. Complete absence of local expertise on the genus in North America, at least in the United States (less so in Canada)
2. Lack of detailed modern descriptions and illustrations of microscopic features for the several hundreds of already described American *Russula* species. This resulted not only in the use of inadequate European literature for the identification of local American mycota, but it continued to severely limit the use or interpretation of obtained sequence data for these North American *Russulas* in the absence of positive identifications.
3. Absence of an efficient classification scheme for all American *Russulas* to assist in the identification process. Indeed, as long as most of the North American *Russulas* were impossible to place in any modern section or subsection (as these were mostly defined on the basis of microscopical features of the pileipellis) it was impossible to narrow down the identification of a particular species group.
4. To this had to be added also the fact that the American mycological tradition is not exactly one that promotes detailed illustration of microscopic features as already observed earlier in the case of other genera such as *Cantharellus* Juss. (see Buyck *et al.* 2016).

Now, ten years later, what progress has been made? With regard to the promotion or creation of local expertise, there are now a few hopeful signs. Indeed, two recent PhD programs targeted North American *Russula*, although not entirely from a taxonomic perspective. On the East Coast, there was the PhD of Brian Looney (obtained in 2017, under the supervision of P. Matheny, Knoxville, TN) on macroevolutionary patterns and diversification processes in *Russula*. This PhD resulted, amongst others, in first sequences for 16 type specimens of *Russula* species described by W.A. Murrill (Looney 2015), leading to two new synonyms and the forthcoming description of some new species in subsect. *Roseinae* Sarnari (Looney *et al.*, in prep.). On the West Coast, the more taxonomically oriented PhD of Anna Bazzicalupo (UBC, Vancouver, under the supervision of M. Berbee) targets also the genus *Russula* in the Pacific North West. Thanks to Anna's work (Bazzicalupo *et al.* 2017) we have now a much more precise idea of the *Russula* diversity in the Vancouver area as a result from sequence data obtained for more than 700 *Russulas* from Benjamin Woo's *Russula* collections. The analyses of the obtained ITS2 sequences suggested a total of 72 candidate species in the area, with more than half of these representing possibly still undescribed endemics of the PNW, nine of which have now been described (in Hyde *et al.* 2017). Additionally, Anna also sequenced a short fragment of the ITS1 for 18 types out of the 49 *Russulas* described from the West Coast (see Buyck *et al.* 2015 for the complete list) thus allowing now for the correct interpretation of these older West Coast species. Also Peter Avis (Indiana Univ. Northwest) is continuing his work on the North American section *Ingratae* (Quél.) Maire, including forthcoming descriptions of new species.

In collaboration with Clark Ovrebo (Univ. of Central Oklahoma), Adriana Corrales (Univ. of Florida, under the supervision of M. Smith) is presently studying *Russulas* associated with *Oreomunna* trees (Juglandaceae) in Panama. Although not working directly on North American *Russula* species, her studies will contribute to a better species delimitation and understanding of these North American species with respect to their close relatives in Panama.

As for the publication of well-illustrated, modern microscopic studies of the older American *Russula* types by the authors of the present paper, some progress has been made as well. Detailed microscopic studies of 50 *Russula* types have been published so far (Adamčík & Buyck 2010, 2011a-b, 2012, 2014; Buyck & Adamčík 2011a-c, 2013a-b, Adamčík *et al.* 2010, 2013, 2015b, Buyck *et al.* 2011, 2015), the studied *Russula* species being more or less equally divided between species described by Burlingham, Murrill and Peck. With the present contribution, we add now detailed and illustrated descriptions for an additional 28 types of North American Russulas, thereby completing the morphological revision of all Russulas described by C.H. Peck.

The ultimate goal of our type studies is to present a workable classification system for all North American Russulas. This will not only allow for a more oriented identification and easier naming and future *Russula* collections, especially when using a combined morphological-molecular approach, but it will also make it possible to publish new species when observed features do not correspond to any of the existing types, not only in North America, but also in the mountain forests of Central America where very similar, if not the same species occur (e.g. Buyck & Halling 2004).

Ideally, we hope to progressively offer practical identification keys to all North American species subsection by subsection. At this moment this was only possible for *Lactarioideae* (Buyck & Adamčík 2013b) and *Xerampelinae* (Buyck & Adamčík 2013a), being the only subsections for which we have presumably revised all American types. We are nevertheless confident that this will soon be possible for several other subsections [*Nigricantes* Maire, *Decolorantes* Maire, *Amoeninae* Buyck, “*Polyphyllinae* Singer nom. inval.”, *Virescentinae* Singer, *Foetentinae* (Melzer & Zvára) Singer, *Archaeinae* (R. Heim ex Romagn.) Buyck, *Roseinae*...] as more type studies are awaiting publication. Roughly about 2/3 of all type specimens still need to be revised morphologically and this remains a priority and *sine qua non* condition for future progress. One fact that will probably interfere with these identification keys will be the changing classification of the genus *Russula* as a result of ongoing phylogenetic analyses worldwide. Indeed, the subdivision of the genus in several main clades (equivalent to subgenera) seems now more or less clear (Bazzicalupo *et al.* 2017, Hongsanan *et al.* 2015, Looney *et al.* 2016, Buyck *et al.* 2018) but has changed dramatically compared to all published *Russula*-monographs so far. To a lesser degree, this is now also going to affect the species composition and definitions of well-known subsections and sections, particularly those grouping species with darker spore prints (e.g. see Caboň *et al.* 2017).

Our morphological type revisions will also contribute to future epitypification of species, as it is for the moment impossible to know which of the older species could possibly be close to phylogenetically defined species. Particularly, when sequencing of the old type specimens is unsuccessful, the here provided morphological data will allow for the appreciation of the older species concepts. Epitypification of the older types through newly collected and sequenced specimens will be very important in the coming years.

Several recently published phylogenetic analyses of ITS sequences additionally revealed that some presumably well-known species among North American *Russula* may actually correspond to species complexes. Peck, for example, described *R. earlei* Peck, *R. compacta* Frost and *R. eccentrica* Peck (see below for the type revisions). These three species were generally thought of as being well-characterized by unique field features and were therefore probably chosen as easy subjects for nationwide revisions. In several cases, the resulting, revised descriptions

for these species were then based on a large number of studied, but probably heterogeneous specimens (see Bills & Miller 1984, Bills 1985, Shaffer 1970) as published phylogenetic analyses suggest the existence of more than one phylogenetic species in North America within each of these morphological species concepts: see Das *et al.* (2017a) for *R. compacta*; Buyck *et al.* (2017) for *R. earlei*, and Liu *et al.* (2015) and Arora & Nguyen (2014) for *R. eccentrica*. Because of the important future role and involvement of citizen scientists in the documentation and description of the North American mycota, we can only hope that morphological or ecological differences will allow for the identification of future collections for these “cryptic” species.

For biographical data on Charles Horton Peck we refer to Burnham (1919, <http://www.jstor.org/stable/pdf/3753209.pdf>), to the introduction in Adamčík *et al.* (2013) and to other sources on the internet, such as the portal of NYS (<http://www.nysm.nysed.gov/research-collections/biology/botany-mycology/collections/fungi/charlespeck>)

MATERIALS AND METHODS

This study is based on small fragments of C. H. Peck’s herbarium, deposited in New York State Museum (NYS). These fragments were selected during a study visit by – and then sent on loan to – the first author. For each type specimen, a representative fruiting body (in case the type contained more than one fruiting body) was selected for this study, wrapped in paper and kept clearly labeled together with the rest of the fruiting bodies in the same box. As already stated in Adamčík *et al.* (2013), Peck described his fungi based on a single collection (nearly all deposited at the New York State Museum, NYS). These specimens represent “implicit holotypes”, this means that, if this single collection and accompanying notes correspond to the protologue, the specimen has to be considered as the holotype (Petersen 1980).

Micromorphological characters were observed using Olympus CX-41 and Nikon Eclipse E400 microscopes using 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 are indicated schematically in the illustrations, with the exception of a single element (in some cases a few elements) where contents are indicated as observed in Congo red preparations from dried material. Spores were observed on the lamellae in Melzer’s reagent. All other microscopic observations were made in ammoniacal Congo red, after a short treatment in warm, aqueous KOH to dissolve the gelatinous matrix and improve tissue dissociation. All tissues were also examined in Cresyl blue to verify presence of ortho- or metachromatic reactions as explained in Buyck (1989). Trama and cystidia were examined in sulfovanillin solution, acidoresistant incrustation of primordial hyphae was colored in karbolfuchsin and observed in distilled water after staining for a few seconds in a 10% solution of HCl (cf. Romagnesi 1967).

Spores were scanned with an Artray Artcam 300MI camera and measured by 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 making line drawings. Q gives length/width ratio of the spores. Measurements exclude ornamentation.

Statistics for measurements of microscopical characters are based on 30 measurements and given as a mean value (underlined) plus/minus standard deviation; values in parentheses give measured minimum or maximum values. An estimate for spore ornamentation density in our descriptions is given following Adamčík & Marhold (2000). Herbarium abbreviations follow Index Herbariorum (Thiers, continuously updated). References to the systematic position of species in the discussion refer to Romagnesi (1987) for ease of understanding (see http://www2.muse.it/russulales-news/romagnesi_1987.asp).

TAXONOMY

1. *Russula abietina* Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 54: 180. 1902.

Figs 1-2

Original description:

[pp. 180-181]: *Pileus thin, fragile, convex, becoming nearly plane or slightly depressed in the center; viscid when moist, the viscid pellicle separable, tuberculate striate on the margin, flesh white, taste mild; lamellae subdistant, ventricose, narrowed towards the stem, rounded behind and nearly free, whitish, becoming pale yellow, the interspaces venose; stem equal or tapering toward the top, stuffed or hollow, white; spores bright yellowish ochraceous, rough, subglobose, .0003-.0004 of an inch broad.*

The fir tree russula is closely related to the youthful russula, R. puellaris Fr., from which it is separated by the viscid cap, the gills rather widely separated from each other and nearly free, the stem never yellowish or becoming yellow where wounded, and the spores having an ochraceous hue. They are much brighter and more highly colored in the mass than the mature gills. The cap varies much in color, but the center is generally darker than the rest. It may be dull purple or greenish purple with a brownish or blackish center or sometimes with an olive green center, or it may be olive green or smoky green with a brownish center. Olive green and purplish hues of various shades are variously combined, but sometimes the margin is grayish and the center olive green. The flesh is white and its taste is mild. The gills are white when young, or barely tinged with yellow, but they become pale yellow with age. They are neither crowded nor widely attached to the stem and are connected with each other by cross veins, which can be seen at the bottom of the interspaces. The stems are rather slender, soft or spongy within, sometimes becoming hollow and occasionally tapering upward. They are very constantly and persistently white. The cap is 1-2.5 inches broad; the stem 1-2.5 inches thick. This russula grows under or near pine, spruce or balsam fir trees. It occurs from July to October. It is tender and palatable. The stems also are tender and may be cooked with the cap.

Under or near balsam fir and spruce trees. North Elba. June and July. Edible. For description of the species see Edible fungi, p. 173.

Lectotype (designated here): North Elba, N.Y. [New York], July 1900, C. H. Peck (NYSf7); isotype: pl. 72, figs 1-11.

Spores broadly ellipsoid, (7.3-)8-8.4-8.8(-9.4) × (6.2-)6.6-7.0-7.3(-7.4) μm, Q = 1.16-1.21-1.26(-1.37); ornamentation composed of crested, relatively distant, amyloid spines [(3-)4-6(-7) in a 3 μm diam. circle], 0.7-1(-1.2) μm high, connected with moderately numerous, fine line connections [(0-)1-3 in the circle], frequently fused in short crests [0-2(-5) fusions in the circle], isolated spines rare; suprahilar spot amyloid, small. **Basidia** 30-32-34(-37) × (10-)10.5-11-12(-12.5) μm, 4-spored, broadly clavate; basidiola first ellipsoid, then broadly clavate or cylindrical, ca. 4-11 μm wide. **Hymenial cystidia** on sides of lamellae widely dispersed, less

than 500/mm², measuring (43-)52-69-85(-120) × (8-)8.5-9-10(-11) μm, clavate or fusiform, apically acute or rarely obtuse, mainly appendiculate, with appendage 3-7.5(-9) μm long, thin-walled, with crystalline-heteromorphous contents disappearing towards the basal septum, slowly turning pale brown in sulfovanillin; near the lamellae moderately numerous, clavate or fusiform, measuring (33-)36.5-44-51.5 (-67) × (5-)6-7.8-9.5(-10) μm, with obtuse or acute tips, appendiculate or not, with dispersed, mainly granulose contents, sometimes optically empty. **Marginal cells** mainly moniliform, cylindrical or fusiform, occasionally flexuous or with lateral nodules, measuring (16-)17-23-29.5(-40) × (3-)3.5-5-6(-8) μm, apically usually obtuse, but often constricted. **Pileipellis** orthochromatic in Cresyl blue, not sharply delimited from the underlying sphaerocytes of the context, vaguely divided in 40-50 μm deep suprapellis of dense, erected hyphae submersed in 10-20 μm thick gelatinous matter, gradually passing into a dense, 50 μm deep subpellis of intricate, horizontally oriented, 3-4 μm wide hyphae. Acidoresistant incrustations absent. Terminal cells of hyphae near the pileus margin measuring (15-)22.5-30.5-38.5(-55) × 2.5-3-3.5(-4) μm, mainly narrowly cylindrical, apically mostly obtuse and not constricted; subterminal cells usually equally wide, nodulose, branched and intricate. Pileipellis near the pileus center similar, with terminal cells measuring (10-)13.5-22.5-27(-40) × 3-3.5-4 μm, usually shorter and slightly wider than to those near the pileus margin. Pileocystidia moderately numerous, with short and small terminal cells measuring (16-)21-28.5-35.5(-43) × (5-)6-7-18.5(-10) μm, cylindrical or fusiform, obtuse, mainly two-celled, occasionally one-celled, some or with three and more cells, descending to the subpellis and the pileus trama, in Congo red with heteromorphous contents especially in the terminal cells, hardly react to sulfovanillin, thin-walled. **Clamp connections** absent in all parts.

Notes: The type – or rather the ‘original material’ – consists almost certainly of several individual collections totalling ca. 26 basidiomata lying freely inside the herbarium box with an additional eight specimens contained in four small paper bags inside of the box (bag B containing five basidiomata, the other three each with a single basidioma). Our observations are based on only one of the 26 basidiomata that were not wrapped in paper (it was labeled and annotated as such by the first author). This original material was previously studied by Singer (1947) and later (in 1955) by G. N. Groves who left some written observations with the specimens but did not publish his findings. Singer considered the type heterogeneous, with halve of the specimens corresponding to *R. blackfordiae* Peck (which he considered a synonym of *R. versicolor* Jul. Schäff.) and the other halve to *R. sphagnophila* Kauffman. We think this is unlikely as both these species are strict associates of *Betula*. Moreover, both these species have different spores, being smaller in the former and having more isolated, sharp spines in the latter.

Peck's original description (Peck 1902a) clearly depicts *R. abietina* as a typical member of subg. *Tenellula* Romagn. (Romagnesi 1987): small and fragile basidiomata with tuberculate-striate pileus margin, mild taste, producing an ochraceous or pale yellow spore print and having pileocystidia with small terminal cells and weak sulfovanillin reaction. Peck's species is most likely another strict conifer associate of which there exist several in this subgenus, e.g. all species of subsect. *Laricinae* (Romagn.) Bon.

Russula abietina is actually one of the more frequently identified russulas in North America, both on the East and West coast. Peck considered his species closely related to *R. puellaris* Fr., but clearly differing from the latter by “the stem never yellowish nor becoming yellow where wounded”. The latter important feature has been maintained to define Peck's species in parts of North America

(e.g. in Quebec – see <https://www.mycoquebec.org>) In Europe, Bon (1987) considered it a mere variety of *R. puellaris*, an opinion that is also followed in MushroomObserver (http://mushroomobserver.org/name/show_name/963). Sarnari (2005) did not study the original material but considered *R. abietina* to be very close to *R. sapinea* Sarnari. The latter is the only European species of the sect. *Laricinae* with a pale yellow spore print, as well as a not hollowing but, however, yellowing stipe. Except for the latter character, practically all characters delimiting *R. sapinea* from other conifer-associated species of subg. *Tenellula* fit also the protologue of *R. abietina*.

Kibby & Fatto (1990) accept it as a good independent species with affinities to *R. sericeonitens* Kauffman and *R. amygdaloides* Kauffman. The spore ornamentation of *R. abietina*, composed of rather scattered and prominent, large spines, distinct short crests and numerous line connections, may help to distinguish it from most of the above-mentioned species. The recently described *R. obscurozelleri* Bazzical., D. Mill. & Buyck and *R. pseudotsugarum* Bazzical., D. Mill. & Buyck are both close relatives of European *Laricinae* and the former was also confirmed (through similarity of ITS sequences) from New Foundland. Epitypification of Peck's species is needed to clarify its precise relationship to any of these species from the PNW.

2. *Russula aeruginascens* Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 53: 843. 1900.

Figs 3-4

Original description:

Pileus convex, becoming umbilicate or centrally depressed, glabrous, viscid when moist, even on the margin, greenish or yellowish green, flesh white, taste tardily acrid; lamellae narrow, close, many of them once or twice forked, adnate or slightly decurrent, white; stem equal, spongy within, white; spores white, subglobose, .0003 of an inch broad.

Pileus 2 to 3 inches broad; stem 1 to 2 inches long, 6 to 10 lines thick. Woods. Claryville. August.

*This species closely resembles *R. aeruginea*, from which it is separated by its acrid taste, its even margin and its close forked lamellae.*

Holotype: Claryville [Sullivan County, New York], August, C. H. Peck (NYSf90).

Spores broadly ellipsoid, (7-)7.2-7.5-7.8(-8.1) × (5.6-)5.7-5.9-6.2(-6.5) μm, Q = (1.18-)1.23-1.27-1.31(-1.33), ornamentation composed of moderately numerous (5-7 in a 3 μm diam. circle) amyloid warts, 0.3-0.5(-0.7) μm high, rarely connected with short line connections [0-1(-2) in the circle], occasionally fused in pairs or short chains [0-2(-4) fusions in the circle], the majority of warts isolated; suprahilar spot indistinct, smooth, not amyloid. **Basidia** 41-45.5-49.5(-56) × (6.5-)7.5-8.5-9.5 μm, 4-spored, narrowly clavate; basidiola first cylindrical, then narrowly clavate, ca. 3-7(-9) μm wide. **Hymenial cystidia** on sides of lamellae moderately numerous to numerous, 1000-2500/mm², measuring (45-)50-57-65(-76) × (6-)6.5-7.5-8.5(-9) μm, mainly narrowly fusiform, sometimes subcylindrical, apically acute and with small capitate appendage of 1-2 μm diam., thin-walled, with crystalline-heteromorphous contents, turning gray in sulfovanillin; on gill edges very numerous, clavate to subcylindrical, rarely fusiform, measuring (35-)38-47.5-57(-64) × (5.5-)6-6.7-7.5(-8) μm, apically obtuse, with yellowish heteromorphous contents. **Marginal cells** hardly differentiated, similar to basidioles. **Pileipellis** strongly metachromatic in Cresyl blue (dark purple incrustations on the hyphae), sharply delimited from the underlying sphaerocytes of the context, vaguely divided in 30-60 μm deep suprapellis of dense, strongly gelatinized, ascending or repent hyphal terminations and a ca. 100-120 μm deep subpellis of even denser, intricate, more horizontally oriented,

strongly gelatinized, 2-5 μm wide hyphae. Acidoresistant incrustations absent. Terminal cells of hyphae in pileipellis near the pileus margin very variable in shape and length, measuring (8-)20.5-37.5-55(-70) \times 2.5-3.5-4(-4.5) μm , partly in dense clusters and then shorter and often moniliform, flexuous-nodulose or branched, others more dispersed and longer and usually less flexuous-nodulose, apically often attenuated; subterminal cells equally wide, often nodulose or branched, but towards the pileus trama more regular. Pileipellis near the pileus center similar, with terminal cells measuring (21-)26-48-47.5(-55) \times 3.5-5-6.5(-9.5) μm , sometimes with distinctly thickened cell walls. Pileocystidia near the pileus margin numerous, very slender, very various in length, measuring (17-)31-60.5-89.5(-115) \times 3.5-4.5-5(-7) μm , narrowly clavate, narrowly fusiform or subcylindrical, apically usually acute and with apical constriction or small appendage, always one-celled, in Congo red with heteromorphous-banded contents, weakly react in sulfovanillin (grayish-pinkish), thin-walled; near the pileus center more irregular, mainly very long and without appendage. Cystidioid hyphae in the pileus trama and subpellis present, with contents graying in sulfovanillin. **Clamp connections** absent in all parts.

Notes: Peck's mention of frequently forked lamellae and a greenish pileus with even margin combined with the non-amyloid suprahilar spot and strong metachromatic reaction of the hyphal extremities at the pileus surface leave little doubt about the placement of *R. aeruginascens* in subsect. *Cyanoxanthinae* Singer. This was also Peck's conviction who mentioned later (Peck 1907b) that *R. aeruginascens* was only a yellowish green form of *R. variata* Banning. Singer (1943), who did not even consider *R. variata* as an independent species, considered both American species to be synonyms of typical European *R. cyanoxantha* (Schaeff.) Fr. (Singer 1958).

Recent phylogenetic analyses have now made it clear that *Cyanoxanthinae* are genetically much more diverse than previously admitted on the basis of their very similar morphology (e.g. Zhang *et al.* 2017). *R. aeruginascens* shares with *R. variata* the frequently forked lamellae, but lacks the typical areolate aspect of the pileus surface. *Russula simulans* Burl. (Burlingham 1921) might be a later synonym. A molecular approach will be needed to distinguish among American *Cyanoxanthinae*.

3. *Russula albella* Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 50: 101. 1897. **Figs 5-6**

Original description:

Pileus thin, fragile, dry, plane or slightly depressed in the center, even or obscurely striate on the margin, commonly white, sometimes tinged with pink or rosy red, especially on the margin, flesh white, taste mild; lamellae entire, white, becoming dusted by the spores; stem equal, solid or spongy within, white; spores white, globose; .0003 in. broad.

Pileus scarcely 2 to 3 in. broad; stem 1 to 2 in. long, 3 to 4 lines thick.

Dry soil of frondose woods. Port Jefferson. July.

*Closely allied to *R. lactea*, but differing in its fragile texture, entire lamellae, more slender stem and in the pileus not cracking into areolae.*

Holotype: Port Jefferson [New York], July, C. H. Peck (NYSf110).

Spores (7.1-)7.5-7.8-8.2(-8.6) \times (5.9-)6.2-6.4-6.6(-7.1) μm , Q = (1.13-)1.19-1.22-1.26(-1.29), ornamentation of relatively dense [5-8(-9) in a 3 μm diam. circle] amyloid warts, 0.5-0.7 μm high, connected by numerous, fine line connections (2-5 in the circle), occasionally fused in pairs or triplets, rarely also short chains (0-4 fusions in the circle), ornamentation forming incomplete reticulum, isolated warts absent; suprahilar spot amyloid. **Basidia** 32-36.5-41(-49) \times (8.5-)9.5-10.5-11(-12) μm , 4-spored, narrowly clavate; basidiola clavate, narrowly ellipsoid or

subcylindrical, ca. 5-9 μm wide. **Hymenial cystidia** on sides of lamellae moderately numerous, ca. 1400/mm², measuring (40-)47-57-66.5(-79) \times 10-11-12(-13) μm , mainly fusiform, apically acute, often mucronate, with very short and narrow, 1-5 μm long appendage, thick-walled (walls ca. 0.5-1 μm thick), with crystalline-heteromorphous contents, turning distinctly gray in sulfovanillin; near gill edge dispersed, fusiform, rarely clavate, measuring (40-)42.5-48.5-54(-59) \times (8-)9-10-11(-12) μm , apically acute and often mucronate. **Marginal cells** on edge of gills hardly differentiated, very narrow or similar to basidiola, measuring (8-)14-19.5-24.5(-30) \times (2.5-)4.5-6.0-7.5(-8) μm . **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from the underlying sphaerocytes of the context, strongly gelatinized throughout, 180-210 μm deep; vaguely divided in a 50-60 μm deep suprapellis of aeriferous hyphae, gradually passing to 130-160 μm deep subpellis of dense, intricate, anastomosed, 2-3 μm wide hyphae. Acidoresistant incrustations absent. Terminal cells of hyphae in pileipellis near the pileus margin measuring (22-)24.5-38.5-52.5(-95) \times 2-2.6-3(-4) μm , mainly narrowly cylindrical to filiform, flexuous, sometimes with diverticules or lateral branches, apically obtuse or rarely also slightly attenuated; subterminal cells mainly branched and with lateral nodules. Hyphal endings near the pileus center similar in shape and size to those near the margin, with terminal cells measuring (14-)21.5-35.5-50(-75) \times 2-2.5(-3) μm . Pileocystidia very abundant, mainly one-celled (ca. 70 %) and clavate, the rest two- to multi-celled with terminal cells near the pileus margin measuring (17-)27-47.5-68(-90) \times (5.5-)6.5-7.5-8.5(-9) μm , subcylindrical and originated deep in the subpellis, apically obtuse, in Congo red with granular-heteromorphous contents, in sulfovanillin with distinct and strong reaction, thin-walled or with slightly thickened walls. Cystidia continuing in subpellis; cystidioid hyphae present in trama of pileus and lamellae. **Clamp connections** absent in all parts.

Notes: Considering the equal lamellae, mild taste and white spore print, one would expect to observe under the microscope either a non-amyloid suprahilar spot (if it were a species of subg. *Heterophyllidia* Romagn.) or to find incrustated primordial hyphae instead of dermatocystidia (for species in subg. *Incrustatula* Romagn.). However, the numerous, sulfovanillin-positive dermatocystidia combined with a distinctly amyloid suprahilar spot on the spores clearly indicate that this species belongs in the *Russula* subg. *Russula* (sensu Romagnesi 1987) as also suggested by the slender filiform hyphal terminations. The white spore print suggests either subsection *Citrinae* (Romagn.) Bon or, because of the pinkish red pileus, rather than subsection *Russula*, even if both subsections are exclusively composed of acid species in Europe. Because of the mild taste, a placement in subsection *Atropurpurinae* (Romagn.) Bon is certainly another good option as it harbors quite some species with a very variable or occasionally mild taste. Kaufman (1909, 1918) interpreted *R. albella* as possible synonym of *R. albida* Peck. Singer (1926, 1935, 1942a) first classified the species repeatedly in subsect. *Lepidinae* (Melzer & Zvára) Singer, but after having studied the type specimen (Singer 1943), he was uncertain about its classification.

4. *Russula albidula* Peck, Bull. Torrey Bot. Club 25: 370. 1898.

Figs 7-8

Original description:

Pileus broadly convex or nearly plane, glabrous, white, even on the margin, flesh white, taste acid; lamellae moderately close, adnate or slightly decurrent, some of them forked at or near the stem, white, the interspaces venose; stem equal, even, solid, white; spores subglobose, 7.5-10 μ long, 6-7.5 μ broad.

Pileus 2.5-5 cm. broad; stem 2.5-3.8 cm. long, 8-12 mm. thick.

Pine woods. November. Earle.

The whole plant is white when fresh, but in dried specimens the pileus and lamellae are sometimes tinged with yellow. The species may be separated from R. lactea by its acrid taste, from R. virginea by its acrid taste and larger spores and from R. anomala by the even margin of the pileus.

Holotype: Alabama [New York], Oct. '96, *F. S. Earle* (NYSf132); isotype in NY.

Spores subglobose to ellipsoid, (7.1-)7.5-7.8-8.1(-8.3) × (5.1-)5.8-6.1-6.4 (-6.6) μm, Q = (1.11-)1.2-1.28-1.35(-1.53); ornamentation of relatively dense [(5-)6-8 warts in a 3 μm circle], amyloid warts, 0.4-0.7 μm high, connected by numerous, fine line connections [(1-)2-4(-5) in the circle], fused in short or longer chains [0-4(-6) fusions in the circle], ornamentation forming incomplete reticulum; suprahilar spot amyloid. **Basidia** (36-)37.5-41.5-45.5(-53) × 9-10-11(-12) μm, 4-spored, narrowly clavate; basidiola narrowly clavate or subcylindrical, ca. 4-9 μm wide. **Hymenial cystidia** on sides of lamellae moderately numerous, ca. 1200-1400/mm², measuring (46-)54-72-89.5(-112) × 8-10-12(-14) μm on sides, fusiform, apically acute, without or with inconspicuous, short, 3-5 μm long appendage, near the basal septum thick-walled (walls ca. 0.5-1 μm thick), with crystalline-heteromorphous contents, turning strongly gray in sulfovanillin; near gill edge dispersed, fusiform, rarely clavate, measuring ca. 24-77 × 5-8 μm, apically usually acute and often mucronate. **Marginal cells** hardly differentiated, similar to basidiola but more distinctly clavate, often flexuous and nodulous, measuring (13-)15-20-25(-31) × (4-)5-6.5-8.5(-11) μm. **Pileipellis** orthochromatic in Cresyl blue, not sharply delimited from the underlying sphaerocytes of the context, strongly gelatinized throughout, vaguely two-layered; suprapellis 50-60 μm deep, of irregularly oriented hyphae; subpellis 140-180 μm deep, of horizontally oriented and slightly intricate, often anastomosing, 2-3.5 μm wide hyphae. Acidoresistant incrustations absent. Terminal cells of hyphae near the pileus margin measuring (20-)23.5-37-50.5(-84) × (3-)3.5-4-4(-4.5) μm, mainly narrowly cylindrical, flexuous, moniliform, often nodulous or with lateral short branches, apically obtuse; subterminal cells mainly branched and equal in width. Hyphal endings near the pileus center similar in shape and size to those near the margin, measuring (27-)31.5-45.5-59(-77) × (3-)3.5-4-5 μm. Pileocystidia very abundant, terminal cells near the pileus margin measuring (15-)38->100 × (4.5-)5-6-6.5(-7) μm, subcylindrical or narrowly clavate, apically usually obtuse but often also constricted or rarely with an appendage, mainly one-celled (ca. 90 %), rarely with a short terminal cells and a long basal, thin-walled or with slightly thickened cell walls near the bases, often very long (longer than 100 μm) and descending deep to subpellis, contents in Congo red granular-heteromorphous, in sulfovanillin turning gray but often only with greyish opalescent bodies, in Cresyl blue orthochromatic but with greenish tints. Cystidia present also in subpellis and cystidioid hyphae present in trama of the pileus and lamellae. **Clamp connections** absent in all parts.

Notes: When faced with an acrid species having numerous, sulfovanillin-positive, subcylindrical to slightly clavate, non-mucronate pileocystidia and slender, poorly differentiated hyphal extremities, one thinks of a possible placement in *R. subg. Russula*. Additionally, the very long, one-celled cystidia point to subsect. *Sardoninae* Singer. Peck (1898) described his species as completely white but he did not mention the spore print color. Because Peck's descriptions usually mention darker colors for spore print or lamellae, it is probable that the spore print was not darker than cream.

Singer classified Peck's species first close to *R. emetica* (Schaeff.) Pers. (Singer 1926, 1942b) or *R. helodes* Melzer (Singer 1932), but transferred it later to subsect. "*Sanguininae*" (Melzer & Zvára) ined. (Singer 1951 and onwards), which was also the opinion of Beardslee (1914), who suggested already that *R. albidula* might be related to *R. sanguinaria* (Schumach.) Rauschert. *Russula rhodocephala* Bazzical. D. Miller & Buyck, recently described from the West Coast, is obviously very close, even more so as it shares the same host tree (*Pinus*) with Peck's species (Bazzicalupo *et al.* 2017). Molecular data are needed to delimit species within this larger species complex (see also Bazzicalupo *et al.* 2017).

5. *Russula anomala* Peck, Ann. Rep. N.Y. St. Mus. Nat. Hist. 50: 99. 1897.

Figs 9-10

Original description:

Pileus thin, fragile, nearly plane or somewhat centrally depressed, with no viscid or separable pellicle, distinctly striate on the margin, white, flesh white, taste acid; lamellae thin, moderately close, adnate, entire or with occasional short one intervening, white, dusted with white spores when dry; stem equal, solid or spongy within, white; spores subglobose, .0003 to .00035 in. broad.

Pileus 1 to 1.5 in. broad; stem 1 to 1.5 in. long, 3 to 4 lines thick.

Damp ground under trees. Port Jefferson. July.

*This plant has the fragile pileus and striate margin characteristic of the tribe Fragiles, but its pileus is destitute of the viscid separable pellicle which also belongs to species of that tribe. If it had a viscid pileus it would approach *Russula fragilis* so closely that it might be regarded as a white variety of this species. It will probably be better to refer it to the tribe Rigidae, notwithstanding the fragile character of its pileus and its distinctly striate margin.*

Holotype: [USA, New York State] Port Jefferson, Suffolk Co., July, C. H. Peck (NYSf282).

Spores broadly ellipsoid, (7-)7.4-7.8-8.2(-8.7) × (5.7-)6-6.3-6.6(-7) μm, Q = (1.17-)1.2-1.24-1.29(-1.32); ornamentation of large, obtuse, moderately distant [(3-)4-6 warts in a 3 μm circle] amyloid spines, 0.6-0.8 μm high; line connections rare (0-1 in the circle), occasionally fused in pairs or small groups [0-2(-3) fusions in the circle], the majority of spines isolated; suprahilar spot amyloid, large. **Basidia** (37-)38-40.5-43(-47) × (8-)9.5-10.5-11.5 μm, 4-spored, clavate, pedicellate; basidiola first cylindrical or ellipsoid, then narrowly clavate, 5-9 μm wide. **Hymenial cystidia** on sides of lamellae moderately numerous, ca. 1100-1500/mm², very variable in size, measuring (47-)53.5-67.5-81(-102) × (7.5-)8.5-10-11.5(-13) μm on sides, fusiform, thin-walled, apically mucronate and with 5-9 μm long appendix, with heteromorphous (crystalline) contents, larger ones turning black in sulfovanillin; near the gill edge mainly fusiform, occasionally clavate, measuring (28-)32.5-42.5-52(-65) × (4.5-)5.5-7-8 μm, usually without appendage, apically acute or obtuse, in Congo red partly or completely filled with heteromorphous contents. **Marginal cells** similar to basidiola but smaller, measuring (12-)15-18.5-21.5(-25) × (3-)3.5-4.5-6(-7) μm, cylindrical or clavate, some nodulous, rarely irregularly coralloid. **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from the underlying sphaerocytes of the context, 100-130 μm deep; vaguely divided in 40-50 μm deep suprapellis of horizontally oriented or repent, non-gelatinized hyphae with ascending apices; and 55-80 μm deep subpellis of horizontally oriented, gelatinized, 2-5 μm wide hyphae. Acidoresistant incrustations absent. Terminal cells of hyphae near the pileus margin measuring (15-)24.5-33.5-42(-56) × 2-3 μm, cylindrical, usually flexuous, thin-walled, apically obtuse; subterminal cells usually equally wide and long, mainly unbranched, sometimes following by another unbranched cells. Hyphal endings near

the pileus center similar to those near pileus margin but more flexuous, measuring (20-)25-31-36.5(-42) × 2.5-3-3.5 μm, often with nodules, lateral branches or coralloid; subterminal cells more frequently branched, often with lateral projections or branches. Pileocystidia near the pileus margin clavate and one-celled, measuring (55-)65-97-130(up to more than 200) × 5.5-7-8.5(-10) μm, thin-walled, apically obtuse, sometimes subapically constricted or capitate, the shorter and smaller ones originating in the suprapellis, longer and wider ones in the subpellis, contents heteromorphous (banded or partly crystalline), weakly reacting in sulfovanillin; near the pileus center one-celled or very rarely two-celled, measuring (20-)27.5-59-90.5 (->100) × 2.5-6-9(-17) μm, showing distinct differences between those restricted to suprapellis that are often very small and subcylindrical; and others originating in subpellis that are sometimes very voluminous, longer than 100 μm, flexuous and with lateral projections or branched. Cystidioid hyphae in the pileus trama and lamellae dispersed, in subpellis very abundant and with strongly heteromorphous contents. **Clamp connections** absent in all parts.

Notes: Field characters of this species, including acrid taste, white spore print and white pileus without any red tints, as well as the very slender hyphal extremities, clearly suggest a placement in *Russula* subg. *Russula*, similar to the previous species (*R. albidula*) from which it differs already clearly in spore ornamentation. An interesting character mentioned in the protologue by Peck (1897) is the dry pileus, which agrees with our observations of a non-gelatinized suprapellis under the microscope. The combination of one-celled pileocystidia and irregular cystidioid hyphae in the subpellis are unknown from any white-spored European species, whereas isolated spines and capitate, one-celled cystidia near the pileus margin reminds of species in subsect. *Sardoninae*.

6. *Russula ballouii* Peck, *Bull. New York State Mus. Nat. Hist.* 167: 31. 1913.

Figs 11-12

Original description:

Pileus thin, broadly convex, nearly plane or slightly depressed in the center, yellow when moist, grayish yellow when the moisture has escaped, the pale brick-red cuticle cracking into minute scales everywhere except in the center; lamellae thin, narrow, close, adnate or subdecurrent, pale yellow, becoming pruinose or dusted by the white spores; stem firm, equal or slightly tapering downward, the surface colored and adorned like the pileus; spores subglobose, 8-10 μ.

Pileus 2-3 cm broad, stem 2-3 cm long, 8-10 mm thick.

Woods, especially under poplar trees. Near Bullshead, Richmond co. October. W. H. Ballou.

Pileus tenuis, late convexus, subplanus vel in centro leviter depressus, humidus luteus, siccus griseo-luteus, ubique, disco excepto, squamis minutis lateritiis ornatus; lamellae tenues, angustae, confertae, adnatae vel subdecurrentes, pallide vel pruinosae; stipes firmus, aequalis vel leviter sursum crassus, pileo similis ornatus et coloratus; spores subglobosae 8-10 μ.

Holotype: [USA, New York State] Staten Island, N.Y., Richmond Co., Sept. 1912, H. W. Ballou #60 (NYSf416).

Spores broadly ellipsoid, (7.3-)7.5-8-8.4(-9) × (6-)6.2-6.5-6.8(-7.2) μm, Q = (1.15-)1.19-1.23-1.27(-1.3); ornamentation of relatively distant and large, obtuse, (3-6 in a 3 μm diam. circle) amyloid warts, 0.4-0.7 μm high, connected by frequent, fine line connections [(1)-2-4 in the circle] and occasionally also fused in pairs or short ridges (0-3 fusions in the circle), forming an almost complete reticulum, without isolated warts; suprahilar spot amyloid, large. **Basidia** (37-)43-47.5-52(-55) ×

(8.5-)9-10.5-12(-13) μm 4-spored, narrowly clavate, pedicellate; basidiola first cylindrical or ellipsoid, then narrowly clavate, 4.5-11 μm wide. **Hymenial cystidia** on sides of lamellae moderately numerous, ca. 1000-1200/mm², measuring (47-) 53.5-65.5-77.5(-102) \times 7.5-9-10(-11) μm on sides, narrowly clavate or narrowly fusiform, apically acute or obtuse, occasionally with 2-4(-8) μm long appendage, thin-walled, with heteromorphous-banded contents, weakly graying in sulfovanillin; near the gill edge dispersed, mainly fusiform, rarely clavate or subcylindrical, measuring (35-)40.5-53-66(-79) \times (5-)5.5-6.5-7(-7.5) μm , mainly with acute apices, occasionally with 2-3 μm long appendage, with heteromorphous (crystalline or granulous) but often dispersed contents and sometimes also optically almost empty. **Marginal cells** well differentiated and abundant, cylindrical, rarely clavate or fusiform, often flexuous, measuring (16-)19-25-30.5(-37) \times (3-)3.5-4-5(-6) μm , thin-walled, apically mainly obtuse. **Pileipellis** with dark blue-green incrustations in Cresyl blue on hyphae near the surface, sharply delimited from the underlying sphaerocytes of the context, ca. 130-160 μm deep; vaguely divided in a 70-85 μm deep suprapellis of not gelatinized but strongly yellow-incrusted, repent and often fasciculate hyphae; gradually passing into a gelatinized subpellis of horizontally oriented, irregularly inflated, 2-7 μm wide hyphae that are often constricted near septa and are covered with a glutinous coating that is easily observed in Congo red. Acidoresistant incrustations absent, but all hyphae in suprapellis with opalescent, yellow incrustations, especially strong and well visible near the surface and becoming fine downwards. Hyphal terminations in pileipellis near the pileus margin unbranched, variable in length, often very long, with terminal cells measuring (15-)22-38.5-55 (-69) \times 3-4-4.5(-5) μm , usually cylindrical, slightly moniliform, apically obtuse, thin-walled, some with refringent, yellow contents; subterminal cells usually equal in width and length, without refringent, yellow contents, usually not branched. Pileipellis near the pileus center similar, hyphal termination less fasciculate and shorter, with terminal cells measuring (17-)24-39.5-55(-75) \times (2.5-)3-3.5-4.5(-5) μm . Pileocystidia dispersed and usually only present in subpellis, rarely observed in suprapellis near the pileus margin, one-celled and usually very long, ca. (4)4.5-6 (-6.5) μm wide, sometimes very flexuous, near apical part moniliform and often irregularly swollen, apically obtuse and rarely with an appendage, rarely with yellow incrustations (usually close to the surface); contents heteromorphous-banded in Congo red, distinctly but weakly reacting in sulfovanillin. Cystidioid hyphae in pileus and lamellar trama not observed. **Clamp connections** absent in all parts.

Notes: Buyck & Mitchell (2003) considered this species a good member of sect. *Ochroleucinae* Romagn. (syn.: sect. *Viscidinae* Sarnari), notwithstanding the fact that it has predominantly been placed in subg. *Ingratula* Romagn. by most previous authors (Burlingham 1915, Singer 1942a, Bills & Miller 1984). *Russula tennesseensis* Singer is widely accepted as a later synonym of Peck's species.

The type description mentions a very small species (< 3 cm diam.) and most probably this is not representative of the normal size of Peck's species. Bills & Miller (1984) also note that collections from the Appalachians have a much larger pileus, with a diam. up to 9(-15) cm wide, which is equally our experience with *R. ballouii* in the more southern states (Buyck unpubl.), but the existence of a cryptic species cannot be excluded.

The yellow incrustations are very abundant in suprapellis, where long unbranched hyphae form large yellow clusters, corresponding to the scales described in the protologue, and are especially apparent near the pileus margin.

In comparison with the closely related *R. lentiginosa* Buyck & Mitchell, this species has distinct pileocystidia, but these are very dispersed and usually restricted to the subpellis. The suprapellis contains some terminal cells of hyphae with refringent, oily contents, but those are not distinct in shape from other hyphal terminations and are not interpreted here as pileocystidia (similar cells are also present in European *R. viscida* Kudrna). Some other yellowish-orange species with incrustations that were previously supposed to be close relatives (Bills & Miller 1984), such as *R. flavida* Frost and *R. burlinghamiae* Singer, are unrelated as suggested by recent sequence data (Buyck *et al.* 2018).

7. *Russula basifurcata* Peck, Ann. Rep. N.Y. St. Mus. Nat. Hist. 38: 90. 1885.

Figs 13-14

Original description:

Pileus firm, convex, umbilicate, becoming somewhat funnel form, glabrous, slightly viscid when moist, the thin pellicle scarcely separable except on the margin, dingy-white, sometimes tinged with yellow or reddish-yellow, the margin nearly even; lamellae rather close, narrowed toward the base, adnate or slightly emarginate, many of them forked near the base, a few short ones intermingled, white becoming yellowish; stem firm, solid, becoming spongy within, white; spores elliptical, pale yellow, uninucleate or shining, 0.00035 in. long, .00025 broad; flesh white, taste mild, then bitterish.

Pileus 2 to 3 inches broad, stem 8 to 12 lines long, 5 to 6 lines thick.

Dry hard ground in paths and wood roads. Caroga. July.

*This species belongs to the section Fragiles, but in some respects it closely resembles pale forms of *R. furcata*, from which it is separated by the absence of any silky micor and by the yellowish color and elliptical shape of the spores and by the yellowish hue of the lamellae.*

Holotype: [USA, New York State] Caroga, July, C. H. Peck (NYSf446).

Spores narrowly ellipsoid to oblong, (7.3)7.6-8.1-8.6(-9.2) × (4.5-)4.8-5.2-5.5(-5.9) μm, Q = (1.42-)1.46-1.58-1.69(-1.83); ornamentation of numerous, fine, unequally large, obtuse [(7-)8-10(-11) in a 3 μm diam. circle] amyloid warts, 0.1-0.3 μm high, connected with occasional short line connections (0-2 line connections in the circle), frequently fused in short to longer chains [(0-)2-4(-5) fusions in the circle]; isolated warts occasional; suprahilar spot not amyloid, smooth, relatively large. **Basidia** 42-47-51(-61) × (6.5-)7-7.5-8(-8.5) μm, 4-spored, narrowly clavate, pedicellate; basidiola first cylindrical, then narrowly clavate, 3-7 μm wide. **Hymenial cystidia** on sides of lamellae moderately numerous, ca. 1100-1600/mm², measuring (60-)74-90-105(-125) × (8.5-)9-10-11(-12) μm on sides, fusiform or lanceolate, apically acute to acute-pointed, frequently with 2-6 μm long appendage, often with thickened walls (up to 0.5 μm), in Congo red with heteromorphous, granular contents, moderately reacting in sulfovanillin; near the gill edge dispersed, lanceolate or clavate, measuring ca. 60-95 × 7.5-14 μm, with acute or obtuse apices, usually without an appendage, in Congo only partially with heteromorphous contents. **Marginal cells** very conspicuous, subulate to narrowly lageniform, with very narrow, thin-walled, long necks that easily break off, sitting on a ventricose thick-walled, basal part, together measuring (57-)64-74.5-85(-98) × 4.5-6-7(-8) μm, optically empty. **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from the underlying sphaerocytes of the context, ca. 400-430 μm deep, not gelatinized or only slightly so near the surface; vaguely divided in a 75-100 μm deep suprapellis of dense, erect or ascending hyphae arranged in a trichoderm, gradually passing into a ca. 300-350 μm deep subpellis of intricate, dense, 3-7(-10) μm wide hyphae. Acidoresistant incrustations absent. Terminal cells of hyphae in pileipellis near the

pileus margin measuring (22-)34-51-68(-91) × (4-)4.5-5.5-6(-6.5) μm, subulate or lageniform, rarely subcylindrical and shorter, apically usually long-attenuated and constricted to 1-3 μm, occasionally mucronate, near the basal septum ventricose, walls not thickened; subterminal cells always distinctly shorter, ellipsoid or subcylindrical, measuring (7-)9.5-15-21(-32) × (4-)4.5-6-7.5(-10) μm, followed by 1-3 other unbranched, short cells; near the pileus center almost forming an epithelium, composed of chains of ellipsoid cells, with usually ellipsoid, pyriform, lageniform or occasionally long, subulate and thick-walled terminal cells, measuring 13-27.5-44(-76) × (4-)4.5-6-7(-10) μm. Pileocystidia near the pileus margin dispersed, one-celled, measuring (19-)23-32-41.5(-59) × 6-7.5-8.5(-10) μm, mainly clavate, occasionally lageniform or fusiform, thin-walled, apically obtuse or rarely constricted to capitate, contents heteromorphous in Congo red, weakly reacting in sulfovanillin, usually originating in a chain of ellipsoid unbranched cells; near the pileus center usually not originating from chains of ellipsoid cells and apically more frequently with a small capitulum. Cystidioid hyphae in subpellis and trama absent. **Clamp connections** absent in all parts.

Notes: The combination of an inamyloid suprahilar spot on the spores and a pileipellis with hyphal terminations composed of chains of short, ellipsoid cells terminating in a long, subulate apical cells are indicative of subg. *Heterophyllidia* subsections *Amoeninae*, *Virescentinae*, *Heterophyllae* (Fr.) Jul. Schäff. and *Griseinae* Jul. Schäff. (following Romagnesi 1987). Sect. *Amoeninae* can be excluded because *R. basifurcata* possesses distinct pileocystidia and hymenial gloeocystidia, as in all other three sections, including indeed also *Virescentinae* (see Buyck 2004a). The presence of thick-walled, subulate terminal cells (or ‘crins’ in the sense of Romagnesi 1967) is in Europe only documented for species of *Heterophyllinae*. In particular *R. heterophylla* (Fr.) Fr. has a similar color range as *R. basifurcata* and shares also the strongly forking lamellae close to their attachment to the stipe. In North America, thick-walled, subulate extremities in pileipellis and along the gill edge are also the main characteristic of the type of *R. modesta* Peck, but that species has much smaller spores (see Adamčík *et al.* 2013).

The nearly oblong, minutely ornamentated spores of *R. basifurcata* would fit very well in *Virescentinae*, a section in which Buyck also identified a still undescribed North American species that shares the possession of thick-walled subulate terminal cells (“*R. brevicylindrata*” sp. ined. – see <http://www2.muse.it/russulales-news/>). On the other hand, the mention of the distinctly colored (dark cream?) spore print for *R. basifurcata* suggest rather a placement in *Griseinae* (which is the placement it was generally assumed to take, e.g. Singer 1986). In conclusion, we think that this species certainly belongs in subg. *Heterophyllidia* and because of relatively large clavate and obtuse pileocystidia it is probably a member of the sect. *Griseinae*.

8. *Russula blackfordiae* Peck, *Bull. New York State Mus. Nat. Hist.* 139: 43. 1910.

Figs 15-16

Original description:

Pileus fleshy but thin, broadly convex or nearly plane, viscid when moist, striate on the margin, whitish or pale gray, brown in the center; flesh white, taste mild; lamellae thin, narrow, close, adnate, pale yellow or cream color; stem equal, glabrous, stuffed or hollow, white; spores pale yellow, globose, 8-9 μ broad.

Pileus about 2.5 cm broad, the stem about 2.5 cm long, 4-6 mm thick.

Ellis, Mass. October. Mrs. E. B. Blackford.

*This species differs from *Russula fallax* (Schaeff.) Sacc. in the color of the pileus, the closer and yellowish lamellae the mild taste and the color of the spores. The viscid*

pellicle of the pileus is separable. The species belongs to the section *Fragiles*, second subsection.

Pileus carnosulus, late convexus subplanusve, quum humidus, viscidus, margine striatus, albidus, pallido-griseusve, centro brunneus, carne alba, sapore miti; lamellae tenues, angustae, confertae, adnatae, flavidae vel cremeae; stipes aequalis, glaber farctus vel cavus, albus; sporae globosae, flavae, 8-9 μ latae.

Holotype: Ellis, Mass. [Massachusetts], Oct. 1909, *Mrs. E. B. Blackford* (NYSf493); Isotypes in BPI and FH (fide G. Bills).

Spores broadly ellipsoid, (7.1-)7.5-7.9-8.3(-8.9) \times (6.1-)6.3-6.6-6.9 (-7.4) μ m, Q = (1.14-)1.16-1.2-1.24(-1.29), ornamentation of very large, conical, obtuse, rather distant [3-5(-7) in a 3 μ m diam. circle] amyloid spines, 0.6-0.9 μ m high, frequently connected by line connections [(0-)1-3(-4) in the circle], occasionally fused in pairs or short chains (0-3 fusions in the circle), isolated warts rare; suprahilar spot amyloid. **Basidia** (27-)29-31.5-34(-36) \times (8.5-)10-11.5-12.5(-13.5) μ m, 4-spored, broadly clavate; basidiola first ellipsoid or cylindrical, then clavate, 5-11 μ m wide. **Hymenial cystidia** dispersed to moderately numerous, ca. 550-900/mm², measuring ca. 43-68 \times 7.5-9 μ m, mainly fusiform, rarely clavate, apically mainly acute and occasionally with a small appendage, thin-walled, contents heteromorphous (crystalline or amorphous), hardly react in sulfovanillin; near the lamellar edge narrowly fusiform to subcylindrical, measuring (32-)47-59-71(-79) \times (6.5-)7-8-9 (-9.5) μ m, apically usually acute, rarely with short appendages, thin-walled, contents heteromorphous and often crystalline. **Marginal cells** ill-differentiated, usually distinctly clavate, measuring (16-)18-21-24(-27) \times (4.5-)6-8-10(-11.5) μ m. **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from underlying sphaerocytes of the context, two-layered; subpellis 15-25 μ m deep, formed of poorly gelatinized, horizontally oriented, densely intricate, ca. 1.5-3(-4) μ m wide hyphae; suprapellis 25-35 μ m deep, a loose tissue composed of ascending, strongly gelatinized hyphal terminations; terminal cells of hyphal extremities near the pileus margin (14-)16-23-29.5(-47) \times (2.5-)3-3.5-4(-4.5) μ m, variable in shape, subulate, fusiform, lanceolate or cylindrical, apically mostly constricted (to 1.5-3 μ m wide) to obtuse-rounded, sometimes slightly moniliform, thin-walled; subterminal cells usually equally wide and long, mainly branched, often with lateral nodules or short branches. Hyphal terminations near the pileus center short-septate, with terminal cells measuring (10-)12.5-16-19.5(-24) \times (2.5-)3-3.5-4.5(-5) μ m, mainly cylindrical, occasionally clavate, ellipsoid, lageniform or fusiform, apically usually obtuse; subterminal cells more frequently unbranched contrary to those near the pileus margin. Pileocystidia near the pileus margin mainly one-celled, occasionally 2-3(-4) celled and then originating in subpellis, terminal cells measuring (18-)26.5-33-50(-69) \times (3.5-)4-5-6(-7) μ m, subcylindrical, thin-walled; subterminal cells when present usually unbranched and equally wide and long; contents heteromorphous (granulose-crystalline), weakly but distinctly greying in sulfovanillin; near the pileus center shorter, with terminal cells measuring (12-)18-25.5-33.5(-48) \times 4-4.5-6.5(-7) μ m. Acidoresistant incrustations absent. Cystidioid or oleiferous hyphae frequent in lower subpellis and adjacent pileus trama, dispersed in deeper layers. **Clamp connections** absent in all parts.

Notes: Peck (1910) defined a species (originally published as orthographic variant "*R. blackfordae*") with small basidiomata, yellowish spores and mild taste. These characters would suggest a possible placement in subg. *Tenellula*. The type was already studied by Singer (1943) who treated the species as synonym of the European *R. versicolor* Jul. Schäff. (subg. *Tenellula*, subsect. *Puellarinae* Singer), a strongly yellowing species with often slightly acid taste that is mostly associated with *Betula*. We disagree with Singer's opinion because micromorphological

characters observed on the type of *R. blackfordiae* are very different from those described for *R. versicolor* (Sarnari 2005, Romagnesi 1967). Indeed, Peck's species has less septate pileocystidia, hyphal terminations with mostly attenuated tips near the pileus margin, as well as larger spores with more dispersed, larger spines. We refrain from proposing a more precise placement within subg. *Tenellula* for *R. blackfordiae*, which seems to us a good, rather small, North American species with pale pileus, yellowish lamellae and mild taste.

9. *Russula compacta* Frost in Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 32: 32. 1879.

Figs 17-18

Original description:

Pileus fleshy, compact, convex, sometimes centrally depressed, dry, whitish, sometimes tinged or spotted with reddish or yellowish hues, becoming dingy or reddish alutaceous when old or dry, the margin thin but even; lamellae broad, sub-distant, unequal, a few of them forked, nearly free, white, becoming brown when bruised or dried; stem equal, firm, rather short, solid, white, changing color like the pileus; spores subglobose, nearly smooth, .00035' in diameter; flesh whitish or subalutaceous, taste mild, odor when drying very disagreeable.

Plant 2'-4' high, pileus 3'-5' broad, stem 8"-12" thick.

Ground in open woods. Sandlake and Brewerton. Aug. and Sept.

*Our specimens do not fully agree with Mr. Frost's manuscript description, but they approach so near an agreement that we have not thought best to separate them. The pileus is sometimes split on the margin. The change of color in the pileus and stem is nearly the same, but the lamellae become darker than either. The disagreeable odor is retained a long time by the dried specimens. The species belongs to the section *Compactae*.*

Lectotype [designated by Shaffer, *Lloydia* 33(1): 55. 1970]: [USA, New York State] Sandlake, Adirondak, Rensselaer Co., Aug., C. H. Peck (NYSf3627).

Spores subglobose to broadly ellipsoid, (7.5-)8-8.4-8.7(-9) × (6.4-)6.8-7.1-7.5(-8) μm, Q = (1.1-)1.14-1.17-1.21(-1.24), ornamentation composed of distant, obtuse, large (3-6 in a 3 μm diam. circle) amyloid warts, (0.4-)0.5-0.8(-1) μm high, connected by numerous fine line connections [2-4(-5) line connections in the circle] and occasionally also fused in pairs or short ridges [0-2(-3) fusions in the circle], ornamentation reticulate, isolated warts absent; suprahilar spot not amyloid, small. **Basidia** (40-)45-50-55(-61) × (10-)10.5-11-12(-12.5) μm, 4-spored, narrowly clavate, pedicellate; basidiola first cylindrical and flexuous, then narrowly to broadly clavate and more even, 4.5-9 μm wide. **Hymenial cystidia** moderately numerous, ca. 1000-1300/mm², measuring (53-)57-67.5-77.5(-90) × (7-)7.5-8.5-9.5(-10) μm, narrowly fusiform or rarely narrowly clavate, apically acute, occasionally mucronate, often with 3-12 μm long appendage, thin-walled, optically empty except of relatively small, heteromorphous, refringent inclusions in central or apical part, weakly react in sulfovanilin; near the lamellar edge similar, measuring (49-)56.5-65-74(-79) × 7-8-9(-10) μm. **Marginal cells** similar to basidiola, sometimes in shape transition to cystidia, mixed with dispersed basidia, measuring (17-)27.5-35.8-44(-50) × (5-)6.5-8.5-10(-12) μm, often with oleiferous yellowish inclusions. **Pileipellis** orthochromatic in Cresyl blue, not sharply delimited from the underlying sphaerocytes of the context, ca. 40-50 μm deep; vaguely divided in 20-25 μm deep suprapellis of strongly gelatinized, repent, loosely arranged hyphae forming a cutis, and ca. 20-25 μm deep subpellis of narrower, ca. 3-8(-10) μm wide, horizontally oriented, intricate, less gelatinized, dense hyphae. Acidoresistant incrustations absent. Hyphal terminations in pileipellis near the pileus margin relatively wide, terminal cells measuring (27-)37.5-51-64(-76) × (5-)5.5-7-8(-9) μm, cylindrical or clavate, apically obtuse, usually moniliform, often flexuous, usually thin-walled; subterminal cells equally long but

often wider (up to 15 μm), rarely branched, often with thick walls (up to 1 μm), covered by glutinous-zebrate coating. Pileipellis near the pileus center similar, terminal cells often more voluminous, measuring (25-)35.5-57-79(-123) \times (5-)6-7.5-9(-11.5) μm , variable in shape and length, even more moniliform, thin-walled. Pileocystidia very dispersed, observed only near the pileus margin, one-celled or two-celled, with terminal cells measuring ca. 36-94 \times 5-6.5 μm , subulate, apically mucronate, with 2-5 μm long appendage, thin walled; contents dispersed and represented by a few inclusions and sometimes optically empty, hardly react in sulfovanillin. Cystidioid hyphae in subpellis and trama absent. **Clamp connections** absent in all parts.

Notes: Because of the unequal lamellae, the hard, brittle trama and typically dull colors, *R. compacta* was classified initially in sect. *Compactae* Fr. (Peck from 1888 onwards; Singer 1926, 1932, 1935). Singer (1938) then changed his opinion and discussed also a possible placement (depending on whether or not the context would also turn green with FeSO_4) within sect. *Xerampelinae* (Singer) Jul. Schäff. because of the strong trimethylamine (fishy) smell and browning flesh. When he later confirmed the green color reaction to FeSO_4 on fresh collections, Singer (1939) consequently transferred *R. compacta* to *Xerampelinae* Singer, but then changed again opinion, once he had seen fresh collections of *R. crassotunicata* Singer (Singer 1958). As a result, a new subsect. *Crassotunicatinae* Singer was distinguished for species with a green reaction to FeSO_4 , but lacking the amyloid suprahilar spot, bright pileus colors and darker spore prints of the *subsect. Xerampelinae*.

First analyses of sequences obtained for Peck's species demonstrated clearly that it was more related to *Compactae* than to *Xerampelinae* (Buyck *et al.* 2008; Kong *et al.* 2015) and *R. compacta* became recently the type species of a new subgenus that is otherwise entirely composed of tropical species: subg. *Malodora* Buyck & V. Hofst. (in Hongsanan *et al.* 2015). Only a few months ago, Das *et al.* (2017a) described two Chinese relatives of *R. compacta* while additionally demonstrating that Peck's species corresponds actually to a species complex in North America.

Our morphological analysis of the type specimen reveal indeed the particular character of the pileipellis of this species. However, contrary to all previously published descriptions for the type or other collected material (Singer 1943, Hesler 1960a, Shaffer 1970) our study demonstrates the presence of true pileocystidia which are inconspicuous and restricted to the suprapellis (a similar situation as in the *R. virescens*-group). It is perhaps important here to state that we only checked the lectotype (original material from Sandlake) chosen by R.L. Shaffer (1970).

10. *Russula crustosa* Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 39: 41. 1886.

Figs 19-20

Original description:

Pileus at first convex, then nearly plane or centrally depressed, slightly viscid when moist, striate on the margin, brownish-yellow, greenish or subolivaceous, the cuticle cracking and forming small spot-like areolae or pseudo-verrucae; lamellae nearly entire, some of them forked at the base, narrowed behind and nearly free, white; stem cylindrical, stuffed or hollow, white; spores white, subglobose, .0003 to .00035 in. broad; flesh white, taste mild.

Pileus 3 to 5 in. broad, stem 1 to 2.5 in. long, 6 to 12 lines thick.

Rocky ground in thin woods. Day. July and Aug.

*This plant approaches *R. aeruginea* so closely, that it may be a question whether it is a distinct species or a mere variety. It differs in the breaking up of the cuticle and in*

having the disk generally paler instead of darker than the rest of pileus. The cuticle usually remains entire on the disk, which is of a dingy yellowish hue, while toward the margin the color is greenish or smoky-green, though in some instances it also is yellowish or dirty straw-color. The greenish specimens so closely resemble *R. virescens*, that in a dry time they might easily be confused with that species. The viscid pileus and its striate margin will distinguish it. The lamellae are rather narrow anteriorly.

Holotype: Day, Saratoga Co [Saratoga County, New York], August, C. H. Peck (NYSf913).

Spores broadly ellipsoid, (6.3-)6.5-6.8-7.1(-7.3) × (4.7-)5-5.3-5.6(-5.9) μm, Q = (1.19-)1.23-1.28-1.33(-1.38); ornamentation subreticulate, of numerous [(5-)6-9(-10) in a 3 μm diam. circle] amyloid warts, (0.2-)0.3-0.5 μm high, connected with frequent, fine line connections [(0-)1-3(-4) in the circle], frequently fused in short to long chains [(0-)1-4(-5) fusions in the circle], isolated warts absent; suprahilar spot smooth, relatively small, not amyloid. **Basidia** (29-)30-32-33.5(-35) × (7.5-)8-9.5-10.5(-11) μm, 4-spored, clavate; basidiola first cylindrical or narrowly ellipsoid, then clavate, ca. 5-8 μm wide. **Hymenial cystidia** on sides of lamellae dispersed, 450-600/mm², measuring (59-)63-69-75(-80) × (7-)8-9.5-11(-13) μm, mainly fusiform, apically acute and sometimes attenuated, usually mucronate, usually with 2-12(-15) μm long appendage, thin walled, contents heteromorphous (granular, banded or crystalline), hardly react in sulfovanillin; near gill edge absent. **Marginal cells** not differentiated. **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from the trama; distinctly two-layered; composed ca. 25-45 μm deep, virescens-like suprapellis of ramifying chains of short inflated cells with attenuated terminal cells, near the cap margin disrupting into patches; subpellis ca. 60-70 μm deep, strongly gelatinized, of loose, very flexuous, intricate, irregularly oriented, but near the trama very dense and horizontally oriented, ca. 2-4 μm wide hyphae. Acidoresistant incrustations absent. Terminal cells of hyphae in pileipellis near the pileus margin relatively short, measuring (13-)15-21.5-28(-33) × (3.5)4-6-8.5(-11) μm, subcylindrical, subulate, fusiform or lageniform, often ventricose, frequently apically narrowed, thin-walled; subterminal cells usually subglobose, more voluminous and distinctly wider, measuring (8-)11-14.5-18(-22) × (5.5-)8.5-12.5-16(-19) μm. Pileipellis near the pileus center of usually smaller cells, with terminal cells measuring (7-)8.5-12-15.5(-20) × (2.5-)3-4.5-6(-8) μm. Pileocystidia dispersed, inconspicuous, one-celled, measuring (14-)15.5-29-42.5(-62) × (3.5-)4-5-6(-7) μm, narrowly fusiform or subcylindrical, apically usually with small globose appendage, thin-walled, contents usually heteromorphous-banded, or sometimes only with few, refringent inclusions, hardly reacting in sulfovanillin, mainly originating from inflated cells of suprapellis, but some distinctly longer arising in subpellis. Cystidioid hyphae present in the subpellis near the pileus trama, turning grey in sulfovanillin. **Clamp connections** absent in all parts.

Notes: *Russula crustosa* has always been interpreted as a close relative of *R. virescens* (Schaeff.) Fr. because both species share the areolate aspect of the pileus surface when mature, the relatively small spores without amyloid suprahilar spot, the inconspicuous, capitulate, SV-negative pileocystidia, and the typical *virescens*-structure of the pileipellis. The distinction between the two species, however, has for a very long time remained obscure, principally because *R. crustosa* was also believed to be sometimes green. In 2007, Buyck posted a key to North American *Virescentinae* on the internet (http://www2.muse.it/russulales-news/id_virescentinae.asp#6) as the result of a small multigene sequencing project on *R. virescens* and allies from the time when he was hosted by Vilgalys' lab. This key resumes the main differences between the various entities in the USA, showing that

Virescentinae are hyper-diverse in North America. There are at least twelve different species, including *R. cf. virescens* (a satellite species of the European *R. virescens*) and *R. crustosa*, but also, *R. cf. mustelina* Fr. and several provisionally named taxa. Except for *R. parvovirescens* Buyck, Mitchell & Parrent, which is easily recognized because of its unique pileipellis structure (Buyck *et al.* 2006), none of these provisional species have been officially described as there are a plethora of old *Russula* names available for greenish – brownish mild species that have been described in the previous century from the Eastern United States. As long as all these type specimens have not been re-examined, the description of new taxa is impossible (at least it is to us). As such, this subsection perfectly illustrates the urgent need for a detailed microscopic revision of all earlier type specimens! Our previous type studies of North American *Russulas* revealed already a significant number of species that belong most likely in *Virescentinae* such as *R. albiduliformis* Murrill, *R. flocculosa* Burl., *R. subgraminicolor* Murrill, *R. heterosporoides* Murrill and *R. maculosa* Murrill (Buyck & Adamčík 2011a).

One of the principal conclusion of Buyck's study was that *Virescentinae* is composed of two distinct species groups, one centering around *R. virescens* and the other around the here examined *R. crustosa*, with species of this latter group being recognizable by the presence of 'cystidioid hyphae' (or submerged dermatocystidia) near the subpellis-trama transition, but not deeper within the underlying trama.

11. *Russula earlei* Peck, *Bull. New York State Mus. Nat. Hist.* 67: 24. 1903.

Figs 21-22

Original description:

Pileus fleshy, firm, hemispheric, becoming broadly convex or nearly plane, sometimes centrally depressed, glabrous, very viscid, the margin even when young but sometimes rimose and uneven when old, stramineous, becoming paler with age, flesh whitish or yellowish, taste mild; lamellae thick, distant, adnate, with a few intermediate short ones near the margin, whitish becoming yellowish; stem short, firm, equal or nearly so, solid, becoming spongy within, white; spores white, subglobose, .0002-.00024 of an inch broad.

Pileus 1.5-2.5 inches broad; stem 1-1.5 inches long, 3-5 lines thick. Among fallen leaves in woods.

Port Jefferson. August.

The spores of this species are unusually small for the genus. This character, with the pale glutinous pileus and distant lamellae, marks the species as very distinct. I take pleasure in dedicating it to its discoverer, Professor F. S. Earle.

Holotype: [USA, New York State] Port Jefferson, Suffolk Co., August, *F. E. Earle* (NYSf1045); isotype in NY (fide G. Bills)

Spores ellipsoid, (5.1-)5.5-5.8-6.1(-6.6) × (3.7-)3.9-4.2-4.5(-4.9) μm, Q = (1.23-)1.3-1.37-1.45(-1.52), ornamentation composed of fine, obtuse, numerous [(7-)8-11 in a 3 μm diam. circle] amyloid warts, 0.2-0.4 μm high, connected by very rare line connections [0-1(-2) in the circle] and occasionally also fused in pairs or short chains [(0-)1-4(-5) fusions in the circle], warts mainly isolated; suprahilar spot not amyloid, smooth, small. **Basidia** (28-)32-35.5-39(-41) × 5-6-6.5 μm, 4-spored, narrowly clavate to subcylindrical; basidiola first cylindrical, then narrowly clavate, 3.5-5 μm wide. **Hymenial cystidia** abundant, ca. 5500-6000/mm², measuring (40-)43-55.5-67.5(-80) × 4-5.5-6(-6.5) μm, subulate or subcylindrical, apically obtuse and without an appendage, thin-walled, with heteromorphous (granular) contents, moderately strongly graying in sulfovanillin; near the gill edge dispersed, similar to pleurocystidia on lamellar sides but usually shorter, measuring (24-)32-41-50(-65) × (3.5-)4-5-6(-7) μm. **Marginal cells** poorly differentiated; yet, edge occupied by very

abundant, cylindrical, slightly subulate or slightly fusiform cells, similar to basidioles, measuring (14-)15-19-22.5(-25) × 4-4.5-5(-6) μm, apically usually obtuse-rounded. **Pileipellis** with abundant metachromatic coating on some hyphae in Cresyl blue, not sharply delimited from the underlying sphaerocytes of the context, vertically more or less homogeneous except of narrow layer of more filamentous and more gelatinized hyphae near the surface, ca. 115-120 μm deep, composed of intricate, mainly horizontally oriented, weakly gelatinized, irregularly inflated, 5-15 (-25) μm wide hyphae. Acidoresistant incrustations absent. Pileipellis near the pileus margin composed of very various hyphal terminations, some in shape remind those of *Virescentinae* and are shorter, others are long, unbranched, with usually not distant septa, terminal cells measuring (7-)11.5-23.9-36.5(-54) × (2.5-)3.5-5.2-6.5(-7.5) μm, irregular in shape, mainly subcylindrical, often subulate, clavate, ellipsoid or pyriform; subterminal cells usually shorter and distinctly wider, ca. 4-10(-15) μm wide, usually not branched, cylindrical, ellipsoid or subglobose. Pileipellis in the pileus center very different, composed of narrow, filiform, more branched and more flexuous hyphal terminations, terminal cells measuring (15-)22-33.2-44(-58) × (2-)2.5-3.2-4(-5.5) μm, cylindrical, apically attenuated or obtuse, often with thickened walls (cell walls up to 0.5 μm); subterminal cells usually equally wide and long. Pileocystidia present, more numerous near the pileus margin, one-celled, measuring (26-)47.5-92.1-136(-more than 150) × (2.5-)3-4.3-5.5(-6.5) μm, subcylindrical or narrowly fusiform, apically usually mucronate and with globular appendage, very flexuous (especially towards their apices), some very long and originating deep in trama, contents in Congo red heteromorphous-granulose or banded, not changing color or indistinctly reacting in sulfovanillin, near the pileus center sometimes with glutinous coating visible in Congo red. Cystidioid hyphae in pileus trama, subpellis and lamellae present but inconspicuous, with refringent yellowish contents. **Clamp connections** absent in all parts.

Notes: The holotype has been examined at least already by Shaffer and Bills, and according to Bills (in Bills & Miller 1984) there is an isotype deposited at NY Herbarium. Buyck (1998) placed *R. earlei* in *Russula* subsect. *Archaeinae* (*R. Heim* ex Romagn.) Buyck and he commented on this species based on his observations on a collection from Texas that he illustrated with line drawings of pileipellis and hymenium structures. Our observations on the type agree with these observations (e.g. very small spores and basidia, metachromatic reactions in Cresyl blue in the pileipellis). Recently, *Archaeinae* have been upgraded at level of subgenus, subg. *Archaea* Buyck & V. Hofst. (in Hongsanan *et al.* 2015), which is phylogenetically sister to subg. *Compactae* (Fr.) Bon, something that had been predicted only by Sarnari (1998). Our type study reveals a quite different pileipellis structure when comparing between pileus center and margin, which is something that has to be kept in mind when studying more collections in future. There is more than one species in *Archaeinae* in North America. Buyck (2004b) already described *R. fattoensis* Buyck and *R. lewisii* Buyck as possible close North American relatives to *R. earlei*, but these species have not yet been sequenced.

12. *Russula eccentrica* Peck, *Bull. New York State Mus. Nat. Hist.* 150: 61. 1911.

Figs 23-24

Original description:

Pileus fleshy but thin, firm, eccentric or deformed, at first centrally depressed, with even incurved margin, becoming nearly plane, dry, glabrous, brownish or brownish gray, faintly reddish brown when dry, flesh white, odor disagreeable; lamellae thin, subdistant,

broad, adnate or adnexed, pallid or tinged with pink, becoming reddish where wounded, reddish brown and subpruinose with age or in drying; stem smooth, equal, spongy within, white; spores subglobose, even or nearly so, 6-7 μ in diameter.

Pileus 5-10 cm broad, stem 4-6 cm long, 1.5-3 cm thick.

Grassy ravine in open oak woods. Near St Louis, Missouri. August. Rare and local. N. M. Glatfelter. This is the third species known in which wounds assume a reddish color. From *Russula nigricans* (Bull.) Fr. it differs in its dry and eccentric pileus not becoming blackish and from *R. densifolia* Secr. in its eccentric pileus and subdistant pinkish tinged lamellae. It belongs to the section *Compactae*.

Pileus carneus, tenuis, firmus, eccentricus vel deformatus, primus centro depressus, margine leve incurvato, deinde subplanus, siccus, glaber; brunneus vel brunneo-griseus, siccitate leviter rufo-brunneus, carne alba, odore ingrato; lamellae tenues, subdistantes, latae, adnatae vel adnexae, pallidae vel subincarnatae, rufescentes ubi vulneratae, in aetate vel siccitate rufo-brunneae et subpruinosae; stipes aequalis, levis, intus spongiosus, albus; sporae subgloboasae, subleves, 6-7 μ in diam.

Holotype: [USA], Ms. [Missouri], St. Louis Co., St. Louis, 31 Jul 1909, under pine, leg. N.M. Glatfelter, (NYSF1049).

Spores broadly ellipsoid, (6-)6.5-6.9-7.2(-7.8) \times (5-)5.3-5.6-5.9(-6) μ m, Q = (1.11-)1.18-1.23-1.29(-1.36); ornamentation subreticulate, composed of very fine and numerous [(8-)9-11(-12) in a 3 μ m diam. circle] amyloid warts, 0.1(-0.2) μ m high, connected by fine line connections [2-4(-5) in the circle] or frequently fused in short to longer chains [3-7(-8) fusions in the circle], isolated warts rare or absent; suprahilar spot not amyloid, smooth, very small. **Basidia** (52-)56.5-61-65(-69) \times (6.5-)7.5-8-9.5 μ m, 4-spored, narrowly clavate to subcylindrical; basidiola first cylindrical, then narrowly clavate. **Hymenial cystidia** on sides of lamellae numerous to abundant, 2500-4500/mm, measuring (54-)62-76-90.5(-100) \times (7-)7.5-8-9(-10) μ m, usually subulate or narrowly lageniform, apically mainly obtuse, occasionally acute or mucronate (up to 5 μ m long appendage), thin-walled, with heteromorphous contents that are not graying – or very indistinctly so – in sulfovanillin; near the gill edge abundant, measuring (27-)32-46.5-61(-88) \times (4-)4.5-6-7.5(-10) μ m, mainly subulate or lageniform, typically with strongly mucronate, capitate, often flexuous apices, containing heteromorphous-crystalline or sometimes banded contents. **Marginal cells** less conspicuous, cylindrical, subulate, lageniform or pyriform, measuring (10-)12.5-21-30(-39) \times (3.5-)4-6-8(-9.5) μ m, usually narrowing apically. **Pileipellis** orthochromatic, but some hyphal terminations with dark brown to black parietal pigment that turns dark blue-green in Cresyl blue, not sharply delimited from the underlying sphaerocytes of the context, ca. 100-120 μ m deep; vaguely divided in 70-80 μ m deep, strongly gelatinized suprapellis of repent hyphae forming a cutis; and denser and less gelatinized, ca. 30-40 μ m deep subpellis of horizontally oriented, intricate, ca. 2-5 μ m wide hyphae. Incrustations absent. Pileipellis near the pileus margin of flexuous, often moniliform, rarely also inflated hyphae, with terminal cells measuring (22-)32.5-48-62.5(-82) \times (3-)4-6-7.5(-11) μ m, irregular in shape, subcylindrical, subulate or fusiform, apically usually attenuated or constricted, occasionally with lateral nodules or branches; subterminal cells equally long or shorter, usually distinctly wider (6-10 μ m wide), mainly not branched, occasionally with lateral branches, less moniliform and flexuous. Pileipellis near the pileus center of similar structure, with terminal cells measuring (31-)37-52-67(-82) \times (3.5-)4-5.5-7(-7.5) μ m. Pileocystidia numerous in supra- and also subpellis, one-celled, measuring (48-)70-105-140(>200) \times (4-)5.5-6.5-7(-8) μ m, near the pileus margin subcylindrical, subulate or narrowly fusiform, distinctly moniliform, apically capitulate, very flexuous especially towards apices, near the pileus center narrower, with heteromorphous-crystalline contents, not or indistinctly changing color in

sulfovanillin. Cystidioid hyphae in pileus trama frequent. **Clamp connections** absent in all parts.

Notes: The type specimen of *R. eccentrica* has been revised multiple times as evidenced by the associated revision notes by R.L. Shaffer, G. Bills, R. Fatto and G.N. Groves. According to G. Bill's thesis there is an isotype at BPI. The particular interest in this species might perhaps be explained by the unique characters it possessed at the time: clearly pinkish lamellae and reddening context but without turning blackish as in other species of subg. *Compactae*. It has been discussed and described in detail in several papers, e.g. by Bills (1985) who considered *R. morgani* Saccardo (\equiv *R. incarnata* Morgan nom. illeg.) a probable synonym and *R. subnigricans* Hongo from Japan as a close relative. First sequence data have since allowed for the description of two new North American relatives (*R. cortinarioides* Buyck & V. Hofst. (in Liu *et al.* 2015) and the Californian *R. cantharellicola* Arora & N.H. Nguyen (Arora & Nguyen 2014) and also demonstrated that *R. polyphylla* was a close North American relative (see below). Das *et al.* (2017a) placed all these species now in a new sect. *Polyphyllae* Buyck & V. Hofst., which forms a distinct, well supported clade in *Russula* subg. *Compactae*.

13. *Russula flavida* Frost in Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 32: 32. 1879.

Figs 25-26

Original description:

Pileus fleshy, convex, slightly depressed in the center, not polished, yellow, the margin at first even, then slightly striate-tuberculate; lamellae nearly entire, venose-connected, white, then cinereous or yellowish; stem firm, solid, yellow, sometimes white at the top; spores yellow, subglobose, .00025'-0.0003' in diameter; flesh white, taste mild.

Plant 2'-3' high, pileus 2'-3' broad, stem 4"-6" thick. Ground in woods. Sandlake. Aug.

Holotype: Sandlake [New York], Aug. & Sept., C. H. Peck (NYSf3626).

Spores broadly ellipsoid, (7.1-)7.6-7.9-8.3(-8.6) \times (5.8-)6.4-6.7(-7) μm , $Q = (1.18-)1.2-1.25-1.3(-1.34); ornamentation subreticulate, composed of obtuse, moderately large and relatively dense [(4-)6-8(-9) in a 3 μm diam. circle] amyloid warts, 0.4-0.5 μm high, merged in short ridges [(1-)2-5(-6) fusions in the circle], which are interconnected by numerous fine line connections [1-3(5) in the circle]; suprahilar spot amyloid, relatively large and conspicuous. **Basidia** (26-)29-32-35.5 (-37) \times 10-11-12(-13) μm , 4-spored (towards lamellar edge often 2-spored), narrowly clavate; basidiola subcylindrical, narrowly ellipsoid or clavate, ca. 7-11 μm wide. **Hymenial cystidia** very rare to absent but widely dispersed near the lamellar edge, there measuring ca. 45- 62 \times 7.5-12.5 μm , fusiform or clavate, apically obtuse or acute and with 2-26 μm long, often flexuous appendage, with heteromorphous or granulose, often very dispersed contents that hardly react in sulfovanillin. **Marginal cells** similar to hyphal terminations in pileipellis, mainly lageniform or subulate, often slightly moniliform, measuring (18-)23-29-35(-39) \times (3.5-)4-6-5.5(-7) μm , apically usually flexuous and attenuated; mixed with occasional basidia or basidioles. **Pileipellis** near the surface orthochromatic in Cresyl blue, but in deeper layers with some indistinctly metachromatic incrustations, sharply delimited from the underlying sphaerocytes of the context, strongly gelatinized in all parts, ca. 160 μm deep; vaguely divided in 70-80 μm deep suprapellis of relatively dense, ascending hyphae; gradually passing to pseudoparenchymatic structure of ca 80-90 μm deep subpellis composed of 3-7 μm wide hyphae, but near the trama composed of horizontally oriented and densely arranged, narrow, 2-4 μm wide hyphae. Incrustations very abundant in suprapellis and in the pseudoparenchymatic layer of subpellis, bright$

golden-yellow, visible also in water and in Congo red, present on all types of hyphae but not on the attenuated terminal parts of the hyphae near the pileus surface, only indistinctly acidoresistant. Pileipellis near the pileus margin of flexuous, often moniliform, unbranched hyphae arising from a pseudoparenchyma, with terminal cells measuring (15-)23-32-41(-50) × (2.5-)3-4-5(-5.5) μm, mainly subulate and apically attenuated, thin-walled; subterminal cells usually equally long but distinctly wider (4-6 μm), often with slightly thickened walls (up to 0.5 μm). Pileipellis near the pileus center of similar structure, with terminal cells more variable in shape, measuring (13-)18-31-44(-61) × (2-)2.5-4-5(-6) μm, some longer, attenuated ones mixed with shorter, lageniform or subulate cells. Pileocystidia very narrow, 2-4 celled, with terminal cells measuring (15-)19-23-27(-32) × (3-)3.5-4-5(-5.5) μm, mainly cylindrical, thin-walled but sometimes especially near the pileus center with thickened walls (ca. to 0.5 μm), in Congo red with opalescent heteromorphous contents or inclusions, but usually only in the terminal cells, not changing in sulfovanillin, usually with strong incrustations covering most of its surface and sometimes distinctly acidoresistant. Cystidioid hyphae in subpellis or trama absent. **Clamp connections** absent in all parts.

Notes: Singer (1939 and onwards) placed this species in *Amoeninae* (subg. *Heterophyllidia*), but that is contradicted by its microscopic features (amyloid suprahilar spot, pileocystidia, strong incrustations). Bills & Miller (1984) considered it close to *R. ochroleuroides* Kauffman, which is in our opinion a close relative of *R. lepida* Fr. (*Lepidinae*). A BLAST of available ITS sequences in GenBank (collections BB) suggests that *R. flavida* is most similar to *R. aurata* Fr. (subsect. *Auratinae* Bon) which is member of *Russula* subg. *Polychromidia* Romagn.

Abundant yellow incrustations that are not metachromatic, not convincingly acidoresistant and not limited to the pileocystidia only, combined with inconspicuous SV-negative pileocystidia and presence of thick-walled hyphae are characters known from species in subsect. *Lepidinae* as suggested by American authors. The phylogenetic placement of *R. flavida* still requires a relevant phylogenetic study.

14. *Russula granulata* (Peck) Peck, *Ann. Rep. N.Y. State Mus. Nat. Hist.* 53: 843. 1902. **Figs 27-28**

Syn.: *Russula foetens* var. *granulata* Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 39: 57. 1886.

Original description:

Variety *granulata* has the cuticle of the pileus rough with small granular scales.

Holotype: [USA, New York State] Denning, Ulster co., Aug., C. H. Peck (NYSf1401).

Spores broadly ellipsoid, (6.5-)6.7-7-7.3(-7.8) × (5-)5.4-5.6-5.9(-6.2) μm, Q = (1.18-)1.21-1.25-1.29(-1.34); ornamentation composed of obtuse, relatively large, moderately distant [4-7(-8) in a 3 μm diam. circle] amyloid warts, (0.4-)0.6-0.7(-1) μm high, mostly isolated, but some connected by fine line connections [0-2(-3) in the circle] and occasionally also fused in pairs or short ridges [0-2(-3) fusions in the circle]; suprahilar spot not or indistinctly amyloid, covered by irregularly distributed, fine warts. **Basidia** (47-)49.5-53-56.5(-59) × 9-10-11(-11.5) μm, 4-spored, narrowly clavate, pedicellate; basidiola first cylindrical, then narrowly clavate. **Hymenial cystidia** numerous on sides of lamellae, ca. 1700-2300/mm², measuring (55-)61.5-69-76(-81) × 7-8-9(-9.5) μm, narrowly fusiform

or rarely narrowly clavate, thin-walled, apically acute or obtuse and occasionally with 1-4(-6) μm long appendage, contents optically empty, in sulfovanillin staining dark black; near gill edge measuring (40-)44.5-51-57.5(-63) \times 6-7-8(-9) μm , narrowly fusiform, narrowly clavate or subcylindrical, apically usually obtuse and often with 1-4 μm long appendage, contents optically empty. **Marginal cells** not differentiated, similar to basidiola, measuring (8-)13-17.5-22(-25) \times 3.5-5-6(-8.5) μm . **Pileipellis** orthochromatic in Cresyl blue but incrustations of pileocystidia turn dark blue-green, not sharply delimited from the underlying sphaerocytes of the context, ca. 200-240 μm deep; vaguely divided in 80-120 μm deep suprapellis of strongly gelatinized, loosely and irregularly arranged, repent hyphae; and 100-150 μm deep, less gelatinized and gradually denser subpellis of horizontally oriented, ca. 2-5 μm wide hyphae. Acidoresistant incrustations at surface of pileocystidia distinct, especially near their basal parts. Pileipellis near the pileus margin composed of unbranched hyphal terminations, with terminal cells measuring (17-)23-31-40(-53) \times 3.5-4.5-5.5(-7) μm , cylindrical or clavate, apically obtuse, often weakly flexuous, not moniliform, thin-walled; subterminal cells usually equal in width and length. Pileipellis near the pileus center similar in structure but composed of hyphal terminations with conspicuously closer septa, terminal cells smaller, measuring (11-)13.5-19-24.5(-28) \times (3-)3.5-4-5(-5.5) μm . Pileocystidia near the pileus margin widely dispersed, usually one-celled and originating deep in subpellis, measuring ca. 59 to more than 100 μm , 4-6 μm diam., subulate to fusiform, thin-walled, apically slightly narrowed (near apices 2.5-4.5 μm wide); contents refringent, yellow, not heteromorphous, weakly reacting in sulfovanillin. Pileocystidia near the pileus center more frequent but dispersed, measuring ca. 26-85 \times 3.5-4.5 μm , usually narrowly fusiform to setiform, apically acute-pointed, with small narrow appendages. Cystidioid hyphae in subpellis numerous, flexuous or twisted, often with lateral projections, with similar contents and reactions to chemical reagents as pileocystidia, in the pileus trama and lamellae dispersed. **Clamp connections** absent in all parts.

Notes: Features of spores and pileipellis have never questioned the initial placement of this species in subg. *Ingratula*. Our observations on this type are very similar to the ones we made for the type of *R. foetentula* Peck (Adamčík *et al.* 2013). Indeed, both types have few to almost no typical fusiform or subulate pileocystidia near the pileus margin and share similar spores. The type of *R. granulata* has less reticulated spores, less fusiform pileocystidia near the pileus center and pleurocystidia that are not mucronate and often fusiform. When Singer had studied the type, he admitted that his *R. obtecta* Singer was a later synonym of Peck's species. The floccose, disrupted pileus surface of *R. granulata* was responsible for placing it (Singer 1951 and onwards) together with *R. affinis* Burl. and *R. obtecta* Singer, in a separate subsection, *Obtectae* Singer, where it remained up to the latest edition of his 'Agaricales' (Singer 1986). Singer also considered *R. affinis* as probable synonym of *R. granulata*, but our unpublished observations have revealed that the former has a very different type of pileipellis with well-differentiated pileocystidia.

Also Shaffer (1972) accepted *R. granulata* as a good species and *R. foetentula* as a synonym of *R. subfoetens* W.G. Sm.. He recognized the latter by acrid taste and the absence of a flocculose or granulose aspect of the pileus surface.

15. *Russula granulata* var. *leptoides* Atk. in Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 67: 37. 1903. **Figs 29-30**

Original description:

This variety differs from the typical form in its pileus, whose upper surface soon becomes rimose squamose. It was common, in August, in the woods about Piseco, Hamilton county.

Holotype: [USA, New York State] Piseco, Hamilton co., C. H. Peck (NYSf3631).

Spores broadly ellipsoid, (6.8-)6.9-7.3-7.6(-8) × (5.4-)5.6-5.8-6.1(-6.3) μm, Q = (1.16-)1.19-1.24-1.29(-1.33); ornamentation subreticulate, composed of obtuse, large, moderately distant [5-8(-9) in a 3 μm diam. circle], amyloid warts, 0.6-0.7 μm high, connected by occasional to rare fine line connections [0-2(-3) in the circle] and occasionally also fused in pairs or short ridges [(0-)1-3(-4) fusions in the circle], isolated warts frequent, suprahilar spot not or indistinctly amyloid, covered by irregularly distributed, fine warts. **Basidia** (40-)44-49-54(-59) × (7-)8-9.5-10.5 (-11.5) μm, 4- spored, narrowly clavate, pedicellate, some (collapsed) basidia with yellow refringent contents; basidiola first cylindrical, then narrowly clavate. **Hymenial cystidia** on sides of lamellae moderately numerous, ca. 1000-1300/mm², measuring (61-)69-76-83(-85) × (7-)7.5-8.5-10(-10.5) μm, narrowly fusiform, rarely narrowly clavate or narrowly lanceolate, apically acute or obtuse, usually mucronate and with 2-4(-5) μm long appendage, thin-walled; contents yellowish, not heteromorphous or sometimes with fine granulations in the upper part, staining black in sulfovanillin; near the gill edge measuring (45-)49-61-73(-85) × (5-)5.5-7-8 μm, narrowly fusiform, narrowly lanceolate or subcylindrical, in Congo red optically empty or with yellow and slightly granulose contents, apically mainly acute and with 1-4 μm long appendage. **Marginal cells** not differentiated; edge mostly occupied by cells measuring (9-)13-20-27.5(-35) × (4-)5-7-8.5(-9.5) μm, mainly cylindrical or clavate, apically obtuse, often with yellow refringent contents, mixed with some cystidia and basidia. **Pileipellis** orthochromatic in Cresyl blue (pileocystidia stain dark blue-green), sharply delimited from underlying sphaerocytes of the context, ca. 65-75 μm deep, almost homogeneous throughout, composed of strongly gelatinized, horizontally oriented, ca. 2.5-7.5 μm wide hyphae, near surface forming cutis of more loosely arranged and less gelatinized hyphae. Acidoresistant incrustations present on surface of pileocystidia, especially at their basal parts. Pileipellis near pileus margin composed of mostly loosely arranged, repent, hyphal terminations, with terminal cells measuring (23-)29.5-35-40.5(-45) × 4-5-5.6(-7) μm, cylindrical or subulate, often slightly flexuous but not moniliform, thin-walled; subterminal cells equal in length but often wider, mainly unbranched. Pileipellis near the pileus center composed of more closely septate hyphal terminations forming an irregular trichoderm, with terminal cells measuring (10-)12-17-22(-25) × 3.5-5-6(-7) μm, mainly cylindrical or clavate, subterminal cells similar to those near pileus margin, but more frequently branched. Pileocystidia near the pileus margin widely dispersed, usually one-celled, very long and originating deep in subpellis, almost always longer than 100 μm, 5-7(-8) μm wide, apically usually attenuated to 2.5-5 μm, contents yellow, refringent (particularly near the apices), with dispersed inclusions, downwards become more banded and heteromorphous, thin-walled, weakly react in sulfovanillin (brownish-grey). Pileocystidia near the pileus center more frequent, measuring (18-)20-41-62(to more than 100) × (3-)3.5-4.5-5(-6) μm, mainly narrowly fusiform, subulate or setiform, apically acute-pointed and with small appendages, usually with yellowish refringent, not heteromorphous contents.

Cystidioid hyphae dispersed in trama of pileus and lamellae. **Clamp connections** absent from all parts.

Notes: This name is completely ignored in the American literature, except for Singer who mentioned it only once in 1932. Considering its similarity to the type variety, we think it is most likely a synonym of the former.

16. *Russula integra* var. *rubrotincta* Peck, *Ann. Rep. N.Y. State Mus. Nat. Hist.* 54: 164. 1902. **Figs 31-32**

Original description:

Stem slightly tinged with red. Lake Placid. September. Miss N. L. Marshall and Miss H. C. Anderson. The specimens sent to me for identification exhibit nearly all the essential characters of *R. integra*, but the stem is slightly reddish instead of clear white. The pileus is dark red, and the lamellae are somewhat dusted by the yellowish spores.

Holotype: Lake Placid [New York], Sept., *Misses Marshall + Anderson* (NYSf2260).

Spores broadly ellipsoid to ellipsoid, (8.2-)9-9.4-9.7(-10) × (6.9-)7.1-7.3-7.6(-7.9) μm, Q = (1.19-)1.24-1.28-1.32(-1.38); ornamentation subreticulate, composed of rather large, obtuse, moderately distant (4-7 in a 3 μm diam. circle), amyloid warts, 0.3-0.6 μm high; these are connected by occasional to frequent line connections [0-3(-4) in the circle] and often fused in short ridges or crests [0-3(-5) fusions in the circle], isolated warts rare; suprahilar spot large, amyloid. **Basidia** (44-)46.5-50-53(-54) × (12-)12.5-14-15(-15.5) μm, 4-spored, clavate, pedicellate; basidiola first cylindrical, then narrowly clavate. **Hymenial cystidia** on sides of lamellae moderately numerous, ca. 600-900/mm², measuring (60-)71-82.5-94(-102) × (11-)11.5-12.5-14(-15) μm, fusiform or clavate, pedicellate, apically mainly tapering but usually without an appendage, often distinctly thick-walled (up to 1 μm) but not at their tip, mainly with abundant or dispersed, oleiferous or banded contents, occasionally optically empty, moderately to strongly graying in sulfovanillin; near the gill edge clavate or fusiform, measuring (35-)41.5-53-65(-80) × 7.5-8.5-9.5(-10) μm, apically mainly obtuse, without appendages, contents mainly optically empty, often slightly thick-walled (walls up to 0.5 μm). **Marginal cells** not differentiated, cells similar to basidiola, often pedicellate, flexuous, measuring (18-)21-25-29(-33) × (3.5-)4.5-5.5-7 μm. **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from underlying sphaerocytes of the context, ca. 100 μm deep; two-layered with 60-75 μm deep, strongly gelatinized suprapellis of ascending or erect (and often near the surface repent) hyphal terminations; subpellis 30-40 μm deep, dense and less gelatinized, of horizontally oriented, irregularly inflated, ca. 2-6 μm wide hyphae. Acidoresistant incrustations absent. Hyphal terminations near the pileus margin very flexuous, often moniliform or nodulose; terminal cells measuring (19-)22-31-39.5(-51) × 3-4-4.5 μm, subcylindrical or attenuated, few also lanceolate, apically mainly distinctly constricted to 1.5-3 μm, thin-walled; subterminal cells usually equally wide, mainly branched and nodulose, few unbranched. Hyphal terminations in the pileus center even more branched and flexuous, terminal cells measuring (25-)31-45-58.5(-70) × 3-4(-5) μm, usually longer and sometimes branched or coralloid. Pileocystidia near the pileus margin dispersed, one- or two-celled, narrow and long, terminal cells measuring 32-61-94(>150) × (3-)3.5-4.5-5.5(-6) μm, subcylindrical or narrowly clavate, apically obtuse, sometimes with slightly thickened walls; contents heteromorphous-granular, rarely crystalline, often poor or even absent, hardly reacting to sulfovanillin; near the pileus center similar, usually arranged in clusters, with terminal cells shorter, measuring (26-)28-42-56.5

(-70) × (3.5)4.5-5.5-6.5 μm. Cystidioid hyphae absent from subpellis and pileus trama. **Clamp connections** absent in all parts.

Notes: *Russula integra* var. *rubrotincta* was combined at the rank of species by Burlingham (1915). Her opinion, which she defended also later (Burlingham 1944), was not shared by Singer (1942b and onwards) who considered Peck's variety a synonym of the European *R. paludosa* Britzelm.

The type shows pileocystidia with weak or negative reaction to sulfovanillin and no incrustations. Also hyphal terminations in pileipellis are extremely flexuous-moniliform and often branched (remining somewhat the pileipellis structure in the genus *Flammulina* P. Karst.). These features are different from *R. paludosa*, while the absence of incrustations make it unfit in the *R. integra* (L.) Fr. complex. On the other hand, pileocystidia that do not react in sulfovanillin are typical for subject. *Xerampelinae* Singer and one of our recent collections from Québec (Canada) shows similar flexuous hyphal terminations in the pileipellis. Consequently, we opt for the moment for a potential placement in the latter subsection.

17. *Russula luteobasis* Peck, Bull. Torrey Bot. Club 31: 179. 1904. Figs 33-34

Original description:

Pileus convex, becoming nearly plane, even or slightly and indistinctly striate on the margin, rosy red or pink, becoming paler or yellowish either wholly or in the center only, the cuticle separable, flesh white or whitish; lamellae adnate or adnexed, equal, creamy yellow or whitish, becoming dingy with age or in drying; stem nearly equal, slightly furfuraceous, stuffed, white, yellow at the base; spores subglobose, 8 μ long, sometimes only 7 μ broad.

Pileus 2.5-7 cm. broad; stem 2.5-5 cm. long, 4-12 mm. thick.

Near St. Louis, Mo. June to August. N. M. Glatfelter: A species well marked by the change of color in the pileus and the yellow base of the stem.

Holotype: St. Louis, Ms. [Missouri], N. M. Glatfelter (NYSf1771).

Spores broadly ellipsoid to ellipsoid, (6.7-)7.1-7.5-7.9(-8.5) × (5.3-)5.5-5.7-5.9(-6.4) μm, Q = (1.24-)1.26-1.31-1.36(-1.44); ornamentation reticulate, composed of moderately large, obtuse, dense [(6-)7-9(-10) in a 3 μm diam. circle] amyloid warts, 0.1-0.3 μm high, connected by frequent fine line connections [1-3(-4) in the circle], fused in short or long chains [(2-)3-5(-6) fusions in the circle], without isolated warts; suprahilar spot amyloid, relatively large. **Basidia** (25-)28-35.5-43 (-57) × (9-)9.5-11-12(-13) μm, 4-spored, narrowly or broadly clavate, sometimes pedicellate; basidiola clavate or subcylindrical. **Hymenial cystidia** on sides of lamellae widely dispersed, less than 300/mm², measuring ca. 47-80 × 8-12 μm on sides, fusiform or clavate, apically acute or obtuse, mainly with 4-10 μm long appendage, thin-walled; contents granular-crystalline, sometimes none, slowly and weakly turning grey in sulfovanillin, absent from gill edge. **Marginal cells** well differentiated, measuring (22-)26-32.5-39(-50) × (4-)4.5-6-7(-9) μm, narrowly lageniform, subulate, or fusiform, often apically attenuated, in shape reminding somewhat the hymenial cystidia. **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from the underlying sphaerocytes of the context, ca. 90-120 μm deep, two-layered; suprapellis relatively dense, ca. 40-60 μm deep, of erect hyphal terminations arranged in a hymeniderm; subpellis ca. 50-70 μm deep, of horizontally oriented, narrow and cylindrical hyphae. Incrusted pileocystidia present in suprapellis, but incrustations not acidoresistant or very indistinctly so. Terminal cells of hyphae in pileipellis near the pileus margin measuring 13-19-25(-33) × 4.5-6-8(-10) μm, mainly clavate, often also broadly ellipsoid, apically obtuse-rounded or rarely

constricted, thin-walled; subterminal cells usually equally long, narrower, cylindrical, mainly branched, sometimes nodulose. Hyphal terminations in the pileipellis near the pileus center shorter and more branched, terminal cells measuring (7-)10-13-16.5(-19) × (3.5-)4.5-5.5-6(-7) μm, broadly clavate, ellipsoid, subcylindrical, often nodulose or lobate; subterminal cells often inflated and implemented in pseudoparenchymatic subpellis. Pileocystidia near the pileus margin 2-4 celled, often fasciculated, cylindrical, terminal cells measuring (16-)20-28.5-36.5(-40) × 4-5-5.5(-6) μm, apically obtuse, thin-walled, contents in Congo red often brownish-yellow (especially in terminal cells), not heteromorphous, with negative reaction in sulfovanillin, incrustations refringent and insensitive to Cresyl blue. Pileocystidia near the pileus center inconspicuous, shorter but wider, mainly 2-celled, clavate and in shape similar to other hyphal terminations, usually thick-walled. Cystidioid hyphae absent from subpellis and pileus trama. **Clamp connections** absent in all parts.

Note: Mild taste, pale spore print and bright coloration of the pileus suggest that this species is a member of subgenus *Incrustatula*, *Polychromidia* or *Coccinula* Romagn. Some microscopic characters suggest a possible affinity to *R. lepida*, where it was placed also by Singer (1975, 1986): indeed, the spores have a large amyloid suprahilar spot and low reticulate ornamentation, as well as incrustations in the pileipellis that are not staining in any reagent. However, the latter incrustations are abundant but limited to the pileocystidia which are well-differentiated by their shape but optically empty. Long multi-celled cylindrical pileocystidia might correspond to primordial hyphae except for the absence of acidoresistant incrustations. The overall structure of the pileipellis reminds *R. chamaeleontina* (Lasch) Fr., but the latter has a yellow spore print and primordial hyphae with acidoresistant incrustation. Also a relationship to *R. aurata* is possible because there are no heteromorphous contents in the pileocystidia and base of the stipe is equally yellow, but that species has neither cystidia nor incrustations.

18. *Russula magnifica* Peck, *Bull. New York State Mus. Nat. Hist.* 67: 24, 1903.

Figs 35-36

Original description:

Pileus fleshy, firm, convex and umbilicate when young, centrally depressed or infundibuliform when mature, glabrous, viscid when young and moist, even, but the cuticle sometimes rimose squamose in the center, even on the margin, the thin pellicle subseparable, flesh white or whitish, odor and taste alkaline, strong and disagreeable; lamellae narrow, crowded, unequal, adnate or slightly decurrent, whitish with a faint pinkish reflection, becoming reddish brown where bruised and rusty brown when old; stem equal or narrowed downward, solid, becoming spongy or sometimes cavernous within when old, white; spores white, even or nearly so, subglobose, .0003-.0004 of an inch long, .00025-.0003 broad.

Pileus 4-10 inches broad; stem 2-5 inches long, 8-18 lines thick. Among fallen leaves in woods. Port Jefferson. August.

This is the largest species of *Russula* known to me. It is related to *R. delica* and *R. brevipes*, from which its large size, peculiar odor and viscid pileus separate it. Sometimes the surface of pileus is irregularly spotted with small unequal depressions or cavities. The odor persists in the dried specimens.

Lectotype (designated here): [USA, New York State] Port Jefferson, Suffolk Co., Aug., C. H. Peck (NYSf1836); isotype: pl. N, figs 1-4.

Spores ellipsoid, (8.1-)8.2-8.6-8.9(-9.6) × (5.8-)6-6.3-6.6(-7) μm, Q = (1.23-) 1.29-1.36-1.44(-1.58); ornamentation reticulate, composed of fine, dense, numerous [7-9(-10) in a 3 μm diam. circle] amyloid warts, 0.1-0.3 μm high, connected by numerous, fine line connections [3-6(-8) in the circle] and frequently also fused in

pairs or short ridges [0-4(-5) fusions in the circle], without isolated warts; suprahilar spot not amyloid, small. **Basidia** (43-)47-51-54.5(-58) × (8.5-)9.5-10-11(-11.5) μm, 4-spored, narrowly clavate to subcylindrical; basidiola first cylindrical, then narrowly to broadly clavate, 4.5-9.5 μm wide. **Hymenial cystidia** on sides of lamellae numerous, ca. 1900-2700/mm², measuring (65-)68-88-107.5(-159) × (9-)9.5-11-12(-13) μm, fusiform or subulate, apically acute-pointed and mucronate and often with 3-11 μm long appendage, thin-walled, contents usually optically empty except for a few granulations or crystalline inclusions close to apical part, rarely completely filled with heteromorphous contents, weakly reacting in sulfovanillin; on gill edge absent. **Marginal cells** undifferentiated, similar to basidiola and measuring (10-)14.5-19-23(-25) × (3.5-)4.5-6-7.5(-8) μm. **Pileipellis** orthochromatic in Cresyl blue, well delimited from the underlying sphaerocytes of the context, ca. 45-52 μm deep, vaguely two-layered; suprapellis a cutis 10-15 μm deep, slightly gelatinized; subpellis ca. 35-40 μm deep, of loose, horizontally oriented, intricate, strongly gelatinized, ca. 3-6 μm wide hyphae. Acidoresistant incrustations absent. Hyphal terminations near the pileus margin loosely arranged, repent, relatively narrow; terminal cells measuring (29-)44.5-62.5-80.5(-102) × 3.5-4.5-5.5(-6) μm, often flexuous, thin-walled, rarely with nodules or lateral branches, cylindrical, apically obtuse or rarely attenuated, mainly moniliform; subterminal cells equal in length and width, scarcely branched. Hyphal terminations in the pileus center more flexuous and moniliform, with shorter terminal cells measuring (28-)30-39-48(-62) × (3.5-)4-5-6(-7.5) μm, frequently nodulose or branched. Pileocystidia near the pileus margin very conspicuous and large, usually very long, originating deep in subpellis or trama and with basal septum difficult to trace, mostly longer than 100 μm, ca. (5.5-)7-8-9.5(-11.5) μm wide, flexuous, with often moniliform, attenuated or mucronate apices, slightly thick-walled (0.5-0.8 μm thick); contents poor, with small granular or oleiferous, rarely some crystalline, inclusions, apically optically empty, insensitive to sulfovanillin. Few pileocystidia near the pileus center originating in pileipellis are shorter and inflated towards apices. Cystidioid hyphae in subpellis and pileus trama very frequent, with contents similar to pileocystidia. **Clamp connections** absent in all parts.

Notes: Singer (1943) gave a description for the microscopic characters of the type and concluded that it was probably identical with *R. polyphylla* Peck (see below). In 1951, he formally introduced the synonymy and classified *R. polyphylla* in a newly erected subsection *Polyphyllinae* Singer. Burlingham (1944) also compared both types but maintained the two species separate. In our opinion, the recent concept of *R. polyphylla* is identical with *R. magnifica* and synonymy of both species is very probable.

19. *Russula mariae* Peck, *New York St. Mus. Ann. Rept.* 24: 74. 1872. **Figs 37-38**

Original description:

Pileus fleshy, convex, subumbilicate, at length expanded and centrally depressed, minutely pulverulent, bright pink red (crimson lake), the disk a little darker, margin even; lamellae rather close, reaching the stem, some of them forked, venose-connected, white, then yellowish, stem equal, solid, colored like the pileus except the extremities which are usually white; spores globose, nearly smooth, 1/3000" in diameter; flesh of the pileus white, red under the cuticle, taste mild.

Plant 2' high, pileus 1.5'-2' broad, stem 3"-6" thick. Dry ground in woods. Catskill mountains. July.

The minute colored granules, which give the pileus a soft pruinose appearance, are easily rubbed off on paper, and water put upon the fresh specimens is colored by them.

Holotype: Catskill Mts. [USA, New York, Catskill Mountains], leg. Char. H. Peck (NYSf1866).

Spores subglobose to broadly ellipsoid, (6.8-)7-7.3-7.6(-8) × (5.6-)6-6.3-6.6(-6.9) μm, Q = 1.12-1.17-1.2(-1.25); ornamentation almost completely reticulate, composed of large, relatively distant [4-5(-6) in a 3 μm diam. circle] amyloid warts, 0.6-0.9(-1.1) μm high, connected by frequent, often long and thick line connections [(1-)2-4 in the circle], occasionally fused in short or long ridges (0-3 fusions in the circle), without isolated warts; suprahilar spot indistinctive, small and weakly amyloid. **Basidia** 40-43-44.5(-46) × (8-)9.5-10.5-12 μm, 4-spored, clavate or fusiform; basidiola first ellipsoid or cylindrical then clavate. **Hymenial cystidia** on sides of lamellae numerous 1500-3000/mm², measuring (46-)56-76-95.5(-117) × (7-)8.5-10-11.5(-12.5) μm, subulate or fusiform, with acute and sometimes slightly tapering tips, never mucronate nor appendiculate, with slightly thickened walls (up to 0.5 μm); contents optically empty, insensitive to sulfovanilline; on gill edge crowded but small, measuring (22-)28.5-38.5-48.5(-62) × (5-)6-7-8(-8.5) μm, fusiform, subulate or narrowly lageniform, sometimes with slightly thickened walls and often with yellowish refringent contents especially in attenuated apical part. **Pileipellis** slightly metachromatic in Cresyl blue, sharply delimited from underlying sphaerocytes of the context, ca. 220-250 μm deep; well divided in ca. 100 μm deep suprapellis composed of clusters of ascending or erect and mainly subulate hyphal terminations, at some places disconnected and revealing well delimited, ca. 125-150 μm deep subpellis of dense, frequently anastomosed, horizontally oriented, flexuous, intricate and near the trama subparallel, gelatinized and slender (ca. 250 μm wide) hyphae. Acidoresistant incrustations absent. Pileipellis near the pileus margin of *virescens*-like structure, composed of clusters of subulate or narrowly lageniform terminal cells of hyphae, measuring (19-)37-51-64(-73) × (4.5)5.5-6.5-7.5(-9) μm, mainly distinctly attenuated, apically constricted to (1-)1.5-2.5-3(-3.5) μm, mixed with some shorter fusiform or subcylindrical terminal cells; these sitting on a short chain of (0-)1-2(-3) unbranched, usually distinctly shorter and wider, ellipsoid or ventricose cells; subterminal cells measuring (7-)9.5-14-18.5(-23) × (4.5)5-7-9(-11.5) μm. Pileipellis near the pileus center with erect, shortly septate and branching hyphal terminations arising from a layer of inflated, ellipsoid or subglobose cells; terminal cells mainly subulate, measuring (24-)35.7-49-62.5(-75) × (4-)5-6-7(-7.5) μm, often with distinctly thickened cell walls, occasionally secondarily septate; arising from short chains of 1-3 inflated cells; subterminal cells measuring (5-)6-8.5-11(-13.5) × (4.5)5-7-9(-15) μm. Pileocystidia, primordial hyphae and SV positive cystidioid hyphae absent in all parts. **Clamp connections** absent in all parts.

Notes: *R. mariae* is among the first Russulas to be described from North America probably because it is such a common and widely distributed species in the United States (Bills & Miller 1984) and, additionally, it presented Peck (1872) with the possibility to dedicate one of his first beautiful new mushrooms to his wife. There have been some doubts as to a possible co-identity with European *Amoeninae* (Singer 1942a), but in such cases Peck's name would have nomenclatural priority (e.g. *R. amoena* Quél., Quélet 1881). Bills & Miller (1984) compared both species and they pointed out that structure of pileipellis and number of "pleurocystidia" were distinguishing characters. Also in America, several close species exist and Bills & Miller (1984) discussed differences with *R. amoena*, but synonymized *R.alachuana* Murrill, *R. subcyanoxantha* Murrill and *R. subviridella* Murrill with Peck's species.

20. *Russula ochrophylla* Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 50: 100. 1897.

Figs 39-40

Original description:

Pileus firm, convex becoming expanded and often somewhat centrally depressed, even or rarely very slightly striate on the margin when old, purple or dark purplish-red, flesh white, purplish under the adnate cuticle, taste mild; lamellae entire, a few of them forked at the base, subdistant, adnate, at first yellowish, at length bright ochraceous-buff, dusted by the spores when dry, the interspaces somewhat venose; stem equal or nearby so, solid or spongy in the center; reddish or rosy tinted, paler than the pileus; spores bright ochraceous-buff, globose, verruculose, .0004 in. broad.

Pileus scarcely 2 to 4 in. broad; stem 1.5 to 2.5 in. long, 6 to 10 lines thick. Grassy ground under oak trees. Menands. July.

Var. albipes n. var. Pileus deep red; stem white; otherwise like the type.

*In the size of the plant and the color of the pileus and stem this is almost exactly like *Russula drimeia*, as shown by Cooke's *Illustr. pl. 1023*. It also agrees in nearly all points with the description of that species, differing only in the color of the lamellae and spores and its mild taste. It is therefore with some hesitation that I have separated it as a distinct species. The flavor has been made a character of such prime importance in distinguishing the species of *Russula* that in Masee's recent work, *British fungus flora*, all the British species are grouped in two Sections, one of which depends upon its species having a mild taste, the other, an acrid one. It scarcely seems right, to disregard the character to which so much importance has been given, and therefore I have recognized it. In the figure of *R. drimeia*, to which I have referred, the lamellae are of a canary yellow, a color which I have not seen in the lamellae of our plant. In it they are at first yellow, but when mature and in the dried state both they and the spores are almost exactly the color called in Ridgway's *Nomenclature of Colors*, ochraceous-buff. If there is any departure they are a shade brighter.*

*The mild taste of our plant led me to try its edible qualities. The flavor was not at all disagreeable, but the firmness of the flesh was such that it might be called rather tough, and it would probably exclude this species from the first class of edible mushrooms. If stewed in milk of cream the liquid assumes some of the purplish or pinkish-purple hue of the mushroom. This coloration would probably be avoided if the mushroom were peeled before stewing. According to Cooke, the flavor of *R. drimeia* is "so intensely peppery that after tasting a small fragment, the tongue tingled for more than half an hour".*

Holotype: [USA, New York State] Menands, Albany Co., July, C. H. Peck (NYSf2140).

Spores broadly ellipsoid, (8.3-)8.6-9-9.4(-10) × (6.4-)6.9-7.3-7.7(-8.4) μm, Q = (1.16-)1.19-1.23-1.28(-1.33); ornamentation composed of large, conical, acute, relatively distant [3-6(-7) in a 3 μm diam. circle] amyloid spines, 0.6-0.9(-1.1) μm high, rarely connected by short line connections [0-1(-2) in the circle] and occasionally fused in pairs or short chains (0-2 fusions in the circle), with frequent isolated warts; suprahilar spot large, amyloid. **Basidia** (34-)36.5-41-45(-51) × (9-)10-11-12.5 (-14) μm, 4-spored, rarely also 2-spored, clavate; basidiola first ellipsoid or cylindrical, then narrowly clavate. **Hymenial cystidia** on sides of lamellae dispersed, ca. 350-550/mm², measuring (59-)69-78-87(-91) × 7.5-9.5-11(-13) μm, fusiform, rarely clavate, apically narrowing and occasionally with 2-8 μm long appendage, often thick-walled (up to 1 μm); contents crystalline or amorphous, hardly reacting in sulfovanillin, orthochromatic in Cresyl blue; near gill edge slightly smaller, measuring (32-)47-59-71(-79) × (6.5-)7-8-9(-9.5) μm, more rarely with short appendages, thin-walled, filled with contents usually only in upper half. **Marginal cells** well-differentiated, narrower than basidiola, cylindrical, occasionally clavate, lageniform or lanceolate, measuring (17-)18-22-25.5(-29) × (2-)3.5-4.5-5(-6) μm, slightly moniliform to obtuse at apex. **Pileipellis** orthochromatic in Cresyl blue, not sharply delimited from underlying sphaerocytes of the context, 165-185 μm deep,

vaguely two-layered; suprapellis 90-120 μm deep, of erect or ascending, slightly gelatinized hyphal terminations forming a dense trichoderm; subpellis 80-90 μm deep, of less gelatinized, horizontally oriented, intricate, ca. 2-8 μm wide hyphae that are inflating toward septa before abruptly constricting on septa itself. Acidoresistant incrustations absent. Pileipellis near the pileus margin composed of hyphal terminations represented by two well defined types, the first more numerous narrowing toward apex, the second more rare, subcylindrical and obtuse rounded; terminal cells of the attenuated hyphae measuring (11-)20.5-27-33.5(-40) \times (3-)3.5-4-4.5(-5) μm , subulate, fusiform or lanceolate, apically constricted to 1-2 μm , moniliform and often also flexuous, occasionally nodulose, thin-walled; terminal cells of obtuse hyphal terminations (14-)21.5-40-58(-75) \times 4-4.5-5 μm , cylindrical or narrowly clavate, similar to the pileocystidia but optically empty except of occasional crystalline inclusions, without any incrustations or reactions to any reagent; subterminal cells usually equally wide and long, branched or not, often with lateral nodules or short lateral branches. Pileipellis in the pileus center denser, terminal cells of subulate hyphal terminations (22-)26.5-35-43.5(-56) \times (2.5-)3-4-5 (-5.5) μm , and of obtuse hyphal terminations (14-)16-22.5-29(-34) \times 4-4.6-5.5(-6) μm , occasionally with thickened walls. Pileocystidia, cystidioid hyphae or oleiferous hyphae absent in all parts. **Clamp connections** absent.

Notes: The type of *R. ochrophylla* lacks SV-positive pileo- or hymenial cystidia and has no incrustations in pileipellis. There are only two groups of *Russula* that lack both pileocystidia and incrustations in pileipellis, but have an amyloid suprahilar spot: subsect. *Olivaceinae* Singer and *Auratinae* Bon. The purple color of the pileus and red stipe are more in favor of subsect. *Olivaceinae*, as also suggested by Singer (1943). Buyck & Adamčík (2013a) tentatively placed two other North American species in this group based on their type studies: *R. arnoldae* Murrill and *R. cremeirosea* Murrill. Both are in many ways similar to *R. ochrophylla*, but they have almost exclusively obtuse subcylindrical terminal cells in the pileipellis.

21. *Russula ochrophylla* var. *albipes* Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 50: 100. 1897. **Figs 41-42**

Original description:

Var. albipes n. var. Pileus deep red, stem white; otherwise like the type.

Holotype: [USA, New York State] Menands, Albany Co., July, C. H. Peck (NYSf147).

Spores subglobose to broadly ellipsoid, (8.2-)8.5-9-9.5(-10.1) \times (7.3-)7.4-7.8-8.1(-8.5) μm , $Q = (1.09-)$ 1.13-1.16-1.19(-1.21); ornamentation composed of large, conical to subcylindrical and relatively distant [4-6(-7) in a 3 μm diam. circle], amyloid warts, 0.6-0.9(-1.1) μm high, connected by occasional line connections [0-2(-3) in the circle], often fused in short or longer ridges [0-3(-5) fusions in the circle], without isolated warts; suprahilar spot large, amyloid. **Basidia** (29-)30.5-33.5-36.5(-38) \times (9.5-)10.5-12.5-14(-15.5) μm , 4-spored, clavate or broadly fusiform; basidiola first ellipsoid or cylindrical, then narrowly clavate. **Hymenial cystidia** on sides of lamellae widely dispersed, ca. 200-400/mm², measuring (55-)56.5-63-69.5 (-77) \times (7.5-)8.5-10-11(-11.5) μm , mainly fusiform, rarely clavate, apically narrowing and with 1-6(-14) μm long appendage, contents crystalline to granular, hardly reacting in sulfovanillin (showing yellowish tints); near gill edge mainly clavate, (19-)37-52.5-68(-82) \times (6.5-)7.5-8-9(-9.5) μm , occasionally with 2-6 μ long appendage, often slightly thick-walled (up to 0.5 μm) or secondarily septate, contents sometimes poor or absent. **Marginal cells** well differentiated, irregular in shape and

usually distinctly nodulose or lobate, measuring (10-)14.5-19-24(-27) × (3-)3.5-5-6 (-7.5) μm, moniliform, flexuous, apically obtuse-rounded. **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from underlying sphaerocytes of the context, 35-45 μm deep, two-layered; suprapellis 20-35 μm deep, of loosely arranged and strongly gelatinized, ascending hyphal terminations; subpellis 15-20 μm deep, of horizontally oriented, intricate, irregularly inflated, dense, less gelatinized and ca. 2-6 μm wide hyphae. Acidoresistant incrustations absent. Hyphal terminations near the pileus margin flexuous and strongly branched, with terminal cells (11-)22.5-31-39.5(-47) × 2.5-3.5-4(-5.5) μm, subulate or subcylindrical, apically attenuated to 1.5-2.5 μm, usually distinctly moniliform, thin-walled; subterminal cells equally wide or wider, often shorter, mainly branched, mainly irregular in shape and implemented in subpellis, occasionally unbranched. Terminal cells of hyphae in the pileus center less moniliform, narrower and longer, measuring (22-)30.5-39.5-48.5 (-59) × 2-3-3.5 μm. Pileocystidia numerous, near the pileus margin one or two-celled, small, with terminal cells measuring (21-)31.5-42-52(-56) × 3.5-4.5-5(-5.5) μm, subcylindrical, moniliform, apically obtuse, thin-walled, filled with banded or crystalline contents, in sulfovanillin with dispersed opalescent grayish crystals; near the pileus center longer and often with three or more cells, with terminal cells usually shorter, measuring (16-)21.5-30-38.5(-47) × 3-4-5(-5.5) μm. Cystidioid hyphae in subpellis rare, absent in trama of pileus and lamellae. **Clamp connections** absent in all parts.

Notes: *R. ochrophylla* var. *albipes* has never been accepted since its description. Singer (1943) synonymized already *R. ochrophylla* var. *ochrophylla* with *R. olivacea* Pers. based on his type study. Our revision of the typical variety confirmed that it has neither pileocystidia nor primordial hyphae, confirming thus its possible affinity to subsection *Olivaceinae* Singer. However, var. *albipes* is certainly unrelated to the type variety because it has small, SV negative pileocystidia, very narrow attenuated hyphal terminations in pileipellis and crestate spores, thereby suggesting its affinity to *R. romellii* Maire.

22. *Russula palustris* Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 53: 842. 1900.

Figs 43-44

Original description:

Pileus thin, fragile, subglobose or hemispheric, then convex or nearly plane, viscid when moist, the thin pellicle separable, varying in color from reddish buff to pale purplish red, obscurely tuberculate striate on the margin, flesh white, tinged with reddish buff under the pellicle, taste tardily acrid; lamellae entire, moderately close, whitish becoming yellowish, interspaces venose; stem equal, glabrous, spongy within or hollow, fragile, white, sometimes tinged with red; spores subglobose, .0003 to .0004 of an inch broad, uninucleate.

Pileus 2 to 3 inches broad; stem 1.5 to 3 inches long, 4 to 6 lines thick. Swamps under alders. Jayville, St Laurence co. August.

*Allied to *R. decolorans*, but smaller, thinner, more fragile, tardily acrid and not discoloring or assuming cinereous hues with age.*

Holotype: Jayville [New York], July, C. H. Peck (NYSf2248).

Spores broadly ellipsoid, (7.3-)7.5-7.9-8.3(-9) × (5.8-)6.1-6.4-6.7(-7.2) μm, Q = (1.15-)1.19-1.24-1.29(-1.37); ornamentation composed of large, subglobose, obtuse, relatively distant [(3-)4-6(-7) in a 3 μm diam. circle], amyloid warts, (0.5-)0.6-0.8 μm high, connected by occasional line connections (0-2 line in the circle), frequently fused in pairs or small groups [(0-)1-3(-4) fusions in the circle], with few isolated warts; suprahilar spot relatively small, amyloid. **Basidia** (32-)33.5-36.5-39.5(-41) × (11-)101.5-12.5-13.5 μm, 4-spored, clavate, often pedicellate; basidiola

first ellipsoid or cylindrical, then narrowly clavate. **Hymenial cystidia** on sides of lamellae poorly differentiated, probably dispersed, measuring (35-)49-58-67 × (6.5-)7.5-9.5-11(-12.5) μm, fusiform, rarely clavate, apically mainly tapering and often with 2-5 μm long appendage, thin-walled; contents very poor, amorphous, often lacking, insensitive to sulfovanillin, orthochromatic in Cresyl blue; near gill edge equally rare and poorly differentiated, mainly fusiform, measuring (35-)41-47-53(-57) × (5-)6-7.5-8.5(-10.5) μm, apically narrowing and with a short appendage (1-10 μm), thin-walled, often without contents or only some dispersed inclusions in apical part. **Marginal cells** well differentiated, abundant, mainly subulate or lanceolate, some narrowly cylindrical, measuring (21-)23.5-30.5-37.5(-50) × (3-)3.5-4.5-5.5(-6.5) μm, apically attenuated or constricted, often flexuous. **Pileipellis** orthochromatic in Cresyl blue, not sharply delimited from underlying sphaerocytes of the context, 70-90 μm deep, obscurely two-layered; suprapellis 40-50 μm deep, of erect or ascending, strongly gelatinized, loose hyphal terminations; subpellis 35-40 μm deep of non-gelatinized, horizontally oriented, very dense, intricate, ca. 3-6 μm wide hyphae. Acidoresistant incrustations absent. Hyphal terminations near the pileus margin very flexuous or often with moniliform fragments, with terminal cells measuring (22-)28-38-47.5(-55) × 3-3.5-4(-4.5) μm, subcylindrical, apically obtuse and rarely constricted, thin-walled; subterminal cells equally wide, mainly branched, often with nodules or short lateral branches. Terminal cells near the pileus center shorter, measuring (12-)15-23-31(-42) × 2.5-3.5-4(-5) μm. Pileocystidia near the pileus margin clavate, 1-3(-4)-celled, thin-walled, with terminal cells measuring (31-)34-45.5-59(-68) × 5-6.5-7(-7.5) μm, and subterminal cells usually narrower and longer; contents crystalline to granular, weakly reacting in sulfovanillin; near the pileus center similar but smaller, measuring (19-)24.5-37.5-49.5(-60) × 4.5-5.5-7(-8.5) μm. Cystidioid hyphae either absent or inconspicuous. **Clamp connections** absent in all parts.

Notes: According to Peck's notes, he visited the type locality only in August of the year 1889, although the protologue states that the type was collected in July.

The very young Singer (1926) first considered *R. palustris* as close to *R. queletii* Fr., a few years later as related to *R. helodes* (Singer 1932), but after he had studied the type (Singer 1943), he classified it in subsect. *Sanguininae* Singer as synonym of *R. exalbicans* (Pers.) Melz. & Zvára. We think that several characters contradict this: Peck's species has a thin and fragile pileus, a spongy or hollow stipe and two to four-celled pileocystidia. Further classification of *R. palustris* must be confirmed by comparison of recently collected material, but the ecology of this species seems important. Indeed, it is apparently a typical species of swamps (as also suggested by the thin context, hollow stipe... (cf. *R. gracillima* Jul. Schäff. or *R. sphagnophila*), the lamellae turn yellowish (suggesting a darker spore print unless it is close to *R. pumila* Rouzeau & Massart) and it is said to fruit under alder. If alder should indeed be the only host, then the list of possible russulas should be very short as alder has few and highly specific fungal associates.

23. *Russula polyphylla* Peck, *Bull. Torrey Bot. Club* 25: 370. 1898. **Figs 45-46**

Original description:

Pileus convex and centrally depressed or subinfundibuliform, glabrous, somewhat areolate, pale flesh color, odor strong, taste mild; lamellae numerous, narrow, close, adnate or subdecurrent, dingy flesh color; stem equal, hollow, colored like the pileus; spores subglobose, about 7.5 μ long, 6-7.5 μ broad.

Pileus 7.5-12.5 cm. broad; stem 5-7.5 cm. long, 1.2-2.5 cm. thick.

Woods. July. Earle.

Holotype: [USA, Alabama] Vaughns, Baldwin Co., Aug., *F. S. Earle* (NYSf2405).

Spores ellipsoid, (7.4-)7.8-8.3-8.8(-9.4) × 5.4-5.8-6(-6.2) μm, Q = (1.28-)1.35-1.45-1.55(-1.68); ornamentation reticulate, composed of fine, numerous [(6-)7-9 in a 3 μm diam. circle], amyloid warts, 0.3-0.4 μm high, connected by numerous, fine line connections (3-5 line in the circle), frequently fused in pairs or short ridges [1-3(-4) fusions in the circle], without isolated warts; suprahilar spot not amyloid, small. **Basidia** (40-)43-47-50.5(-55) × (7.5-)8-9-10 μm, 4-spored, narrowly clavate, pedicellate; basidiola first cylindrical and flexuous, then narrowly to broadly clavate. **Hymenial cystidia** on sides of lamellae dispersed to moderately numerous, ca. 600-900/mm², measuring (97-)99-112.5-126(-155) × (11-)11.5-13-14.5(-16) μm, narrowly fusiform or subulate, apically narrowing, usually mucronate and with one or two (rarely three) 3-12 μm long appendages, thin-walled, filled with poor crystalline contents, weakly reacting in sulfovanillin; practically none near the gill edge. **Marginal cells** undifferentiated, cells on edge similar to basidiola, often with oleiferous, yellowish inclusions. **Pileipellis** orthochromatic in Cresyl blue, not sharply delimited from the underlying sphaerocytes of the context, ca. 60-65 μm deep, vaguely two-layered; suprapellis 30-35 μm deep, of slightly gelatinized hyphae forming a dense cutis; subpellis ca. 30 μm deep, of narrower, horizontally oriented, strongly gelatinized, ca. 2.5-5(-7.5) μm wide hyphae. Acidoresistant incrustations absent. Hyphal terminations near the pileus margin loosely arranged, repent, relatively narrow, with terminal cells measuring (25-)36-49-61.5(-69) × 3.5-4.5-6(-8) μm, very variable, mainly narrowly subulate or narrowly cylindrical, some wider and shortly cylindrical to ventricose, sometimes slightly moniliform; subterminal cells very variable in length and width, often disproportional in size compared to terminal cells, occasionally with lateral projections. Pileipellis near the pileus center damaged by parasitic fungi. Pileocystidia usually very long, arising deep in trama and with basal septum difficult to trace, very rarely shorter than 100 μm, 5-6-6.5(-7) μm wide, often moniliform, thin-walled, near the apex attenuated to 2.5-4.5(-7) μm, with abundant, heteromorphous-crystalline contents in their lower parts, not or indistinctly grayish in sulfovanillin. Cystidioid hyphae in subpellis and pileus trama abundant. **Clamp connections** absent in all parts.

Notes: *R. polyphylla* shares with *R. magnifica* Peck the long, aseptate cystidia that are arising from deep within the trama and have SV- contents. Singer (1943 and onward) considered both species as synonyms, but our type studies confirm Burlingham's (1944) argument that *R. magnifica* has broader spores with lower spore ornamentation. In addition, pleurocystidia of *R. polyphylla* are wider, longer and more dispersed and pileocystidia are narrower. The type of *R. polyphylla* has also more distinct, often crystalline contents. Molecular data are needed to reveal the existence of one or more species

24. *Russula pusilla* Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 50: 99. 1897.

Figs 47-48

Original description:

Pileus very thin, nearly plane or slightly and umbilicately depressed in the center, glabrous, slightly striate on the margin, red, sometimes a little darker in the center, the thin pellicle separable, flesh white, taste mild; lamellae broad for the size of the plant, subventricose, subdistant, adnate or slightly rounded behind, white, becoming yellowish-ochraceous in drying; stem short, soft, solid or spongy within, white; spores faintly tinged with yellow, .0003 in. broad.

*Pileus scarcely 1 in. broad; stem 6 to 12 lines long, 2 to 3 lines thick.
Bare ground in thin woods. Port Jefferson. July.*

The coloring matter of the pileus may be rubbed upon paper and produce on it red strains if the surface is previously moistened with water or dilute alcohol. This is one of the smallest Russulas known to me. The pileus is less than an inch broad and the stem less than an inch long in all the specimens seen by me. The species is closely allied to R. puellaris, and especially resembles the variety intensor in color. It differs in its smaller size, even or but slightly striate margin, broad lamellae and in the stem or flesh not becoming yellowish-spotted where touched.

Holotype: [USA, New York State] Port Jefferson, Suffolk Co., July, C. H. Peck (NYSf2526).

Spores broadly ellipsoid, (6.2-)6.5-6.9-7.3(-8.1) × (5-)5.3-5.6-5.9(-6.2) μm, Q = (1.15-)1.18-1.23-1.28(-1.32), ornamentation almost completely reticulated, composed of obtuse, fine, numerous [(7-)8-10 in a 3 μm diam. circle], amyloid warts, (0.3-)0.4-0.6 μm high, frequently connected by fine line connections [(1-)2-4(-6) in the circle], also frequently merged in chains or crests [(2-)3-6(-9) fusions in the circle], without isolated warts; suprahilar spot large, amyloid. **Basidia** (29-)30.5-33.5-36.5(-38) × 7.5-8.5-9(-10) μm, 4-spored, clavate; basidiola first cylindrical or ellipsoid, then clavate. **Hymenial cystidia** on sides of lamellae numerous, 1900-2300/mm², measuring (41-)47-55-63(-74) × (7-)8-9-10 μm, clavate or fusiform, apically obtuse, mainly with small, 1-3(-5) μm long appendages, thin-walled, contents banded, sometimes also crystalline or oleiferous, often strongly blackening in sulfovanillin, sometimes with yellow pigments; near the gill edge mainly clavate, rarely fusiform, measuring (22-)28.5-35.5-42.5(-48) × (6-)6.5-8-9(-11) μm, apically obtuse, often with 1-3 μm long appendages, partly or completely filled with granulose or banded contents. **Marginal cells** well-differentiated, very abundant and usually smaller than basidiola, mainly cylindrical and flexuous, some broadly clavate to subcapitate, measuring (11-)13.5-16.5-19.5(-22) × 2.5-4.5-6(-8.5) μm. **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from underlying sphaerocytes of the context, only 45-55 μm deep, two-layered; suprapellis 25-35 μm deep, of ascending, irregularly oriented, strongly gelatinized hyphae; subpellis 15-25 μm deep, of horizontally oriented, intricate, less gelatinized, 2-3 μm wide hyphae. Acidoresistant incrustations absent. Hyphal terminations near the pileus margin branched, often with lateral projections or flexuous, narrow, often densely septate and composed of up to 4 cells; terminal cells measuring (10-)13-20.5-27.5(-3) × (2-)2.5-3-4(-4.5) μm, subulate, attenuated or subcylindrical, slightly flexuous or moniliform, thin-walled, apically tapering to 1.5 μm; subterminal cells equally wide or wider, often branched, nodulose or flexuous, sometimes simply short and cylindrical. Pileipellis in the pileus center very similar, with terminal cells often longer and narrower, (14-)19.5-27-34.5(-41) × 2-2.5-3 μm. Pileocystidia near pileus margin abundant, small, usually originating in suprapellis, sometimes with one septum, those originating in subpellis often with three or more cells, with the terminal cell (10-)16.5-25.4-34.5(-45) × (3-)4-5-5.5(-6) μm, usually shortly cylindrical or clavate, thin-walled, with granulose or banded contents, turning slowly grayish in sulfovanillin. Pileocystidia near the pileus center similar, with terminal cells measuring 11-29-48(-102) × 4-5-5.5(-6) μm. Cystidioid hyphae frequent in subpellis, dispersed in trama of pileus and lamellae. **Clamp connections** absent in all parts.

Notes: Micromorphological characters, in combination with the small basidiomata, mild taste, and colored spore print suggest a placement in subg. *Tenellula*.

Because it has no odor, is not yellowing and has no yellow spore print, *R. pusilla* might fit in subsect. *Rhodellinae* (Romagn.) Bon. Singer (1932, 1942a)

first placed this species in subsect. *Puellarinae*, but later (Singer 1958, 1986) described a subsect. *Pussilinae* Singer based on Peck's species.

Singer (1958) synonymised *R. operta* Burl., *R. praepalustris* Murrill and *R. pinophila* Murrill with *R. pusilla*. Since then, Fatto (1996) proved that *R. operta* is a distinct species, while Looney (2015) showed with sequence data that *R. pinophila* is in *Xerampelinae*.

25. *Russula rugulosa* Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 54: 179. 1902.

Figs 49-50

Original description:

Pileus rather thin, fragile, convex, becoming nearly plane or centrally depressed, viscid when moist, roughened or uneven with small tubercles and rugae, even on the margin when young, becoming tuberculate striate with age, the viscid pellicle separable on the margin, flesh white, reddish under the cuticle, taste tardily acrid; lamellae rather close, adnate or slightly rounded behind, white; stem nearly equal, spongy within, white; spores white, rough, subglobose, .0003-.0004 of an inch broad, shining in transmitted light.

Woods. Floodwood. August. Edible. For description of the species see *Edible fungi*, p. 173.

The rugulose russula is closely related to the emetic russula, but differs from it in the uneven or rugulose surface of the cap, in the tardily acrid taste and in its closer adnate gills. Its cap is red, varying from pale red to dark red, viscid when moist, even on the margin when young but somewhat tuberculate and striate when old. Its surface is roughened by minute tubercles or pimples, which sometimes appear to run together and form short ridges. These are sometimes absent from the center of the cap. The viscid cuticle easily peels from the margin of the cap but not from the center. The flesh is white except just under the cuticle, where it is reddish. It is soft and fragile, and its taste is slowly and much less sharply acrid than in the emetic russula. Its gills are closely placed, attached to the stem and persistently white. The stem is brittle, soft and spongy within, smooth and white. The cap is 2-4 inches broad; the stem is 2-3 inches long, 4-8 lines thick.

It grows in woods among mosses and fallen leaves or on the bare ground and appears in August and September. It is an inhabitant of the Adirondack forests. Its slightly acrid flavor is destroyed in cooking and it affords a harmless, tender and agreeable food.

Lectotype (designated here): [USA, New York State] Floodwood, Franklin Co., Aug., C. H. Peck (NYSf2683); isotype: *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 24: pl. 72, figs 12-18.

Spores subglobose to broadly ellipsoid, (6.9-)7.1-7.4-7.7(-8.7) × 6.2-6.4-6.6(-7.2) μm, Q = (1.08-)1.11-1.15-1.19(-1.25); ornamentation subreticulate, composed of obtuse, distant [(2-)3-5 in a 3 μm diam. circle], amyloid warts, (0.3-)0.4-0.6 μm high, connected by frequent line connections [0-2(-3) in the circle], often fused in chains or crests [0-2(-4) fusions in the circle], with rare isolated warts; suprahilar spot irregular, amyloid. **Basidia** (42-)44-48-51(-55) × 12-13-14 (-14.5) μm, 2-4-spored, broadly clavate to subcapitate, pedicellate; basidiola first cylindrical, then clavate, 4-12 μm wide. **Hymenial cystidia** on sides of lamellae numerous, ca. 2100-2500/mm², measuring (52-)55.5-64-72.5(-90) × 8-9.5-11(-2) μm, clavate or fusiform, apically acute or obtuse, usually with 2-5 μm long appendages, thin-walled, contents heteromorphous, banded, hardly reacting in sulfovanillin; near gill edge measuring (26-)33-43.5-54(-74) × 7-8-9(-10) μm and often with 4-16 μ long appendages. **Marginal cells** well differentiated, very abundant and smaller than basidiola, clavate, cylindrical, measuring (12-)13.5-17.5-21.5(-25) × 3-4.5-5.5(-5.5) μm, occasionally moniliform, apically obtuse, but often constricted. **Pileipellis** orthochromatic in Cresyl blue, sharply delimited from underlying sphaerocytes of the context, 105-155 μm deep, obscurely two-layered; suprapellis

65-90 μm deep, of ascending, irregularly oriented, strongly gelatinized, near surface loose and downward gradually denser hyphae; subpellis 45-55 μm deep, of horizontally oriented and less gelatinized, 2-4 μm wide hyphae. Acidoresistant incrustations absent. Hyphal terminations near the pileus margin branched, narrow, with terminal cells of very variable length, measuring (12-)18-~~31~~-44.5(-61) \times (2-)2.5-~~3~~-4(-4.5) μm , mainly subulate and attenuated apically to 1.5 μm , flexuous and sometimes also moniliform near tip, occasionally some subcylindrical shorter ones, thin-walled; subterminal cells usually very branched and irregular, equally wide or wider, nodulose or with lateral extensions, usually flexuous. Hyphal terminations near the pileus center similar, terminal cells measuring (10-)18.5-~~28.5~~-38.5(-59) \times (2-)2.5-~~3~~-3.5(-4) μm . Pileocystidia in suprapellis dispersed, densely septate, with 2-5(-10) cells of variable length and width, thin-walled, with poor and often hardly visible contents that are granulose-banded and hardly react in sulfovanillin; terminal cells near the pileus margin measuring (10-)13.5-~~19~~-24(-32) \times (3-)4-~~5~~-6(-7) μm , ellipsoid or cylindrical, apically obtuse. Pileocystidia in subpellis very abundant, with more distant septa and usually longer terminal cells measuring (23-)31.5-~~55~~-78(-103) \times (3.5-)4.5-~~5.5~~-6.5(-7) μm , occasionally with lateral extensions or nodules, contents more differentiated, heteromorphous-banded, in sulfovanillin with grayish refringent inclusions. Dispersed cystidioid hyphae present in trama of pileus and lamellae. **Clamp connections** absent in all parts.

Notes: Both Peck (1902a) and Singer (1926, 1939) range this species close to *R. emetica*. The white spore print, red pileus with tuberculate-striate margin and tardily acrid taste agree with this classification. However, the weak reaction to sulfovanillin and rather limited number of dispersed pileocystidia in the suprapellis are not typical for this species group, but rather remind of *R. simillima* Peck, close to the *R. fellea* (Fr.) Fr. complex (see below).

26. *Russula simillima* Peck, *Ann. Rep. N.Y. St. Mus. Nat. Hist.* 24: 75. 1872.

Figs 51-52

Original description:

Pileus hemispherical or convex, then expanded, slightly depressed, at first or when moist viscid, the margin at length tuberculate-striate, pale ochraceous yellow, the disk usually a little brighter colored; lamellae subequal, reaching the stem, some of them forked behind, venose-connected, yellowish from the first; stem equal or slightly tapering upward, spongy within, rarely hollow, colored like the pileus, sometimes a little paler; spores 1/3000' in diameter; taste acrid.

Plant 2'-4' high, pileus 1'-3' broad, stem 4''-9'' thick. Ground in woods. Greig. September.

*Allied very closely to *R. foetens*, from which it differs by the absence of many marked color and the margin not so widely striate. I have never seen it caespitose not growing in cleared lands.*

Holotype: [USA, New York State] Greig, Lewis Co., Sept., *C. H. Peck* (NYSf2802).

Spores broadly ellipsoid, (7.1-)7.4-~~7.9~~-8.3(-8.8) \times (5.6-)6-~~6.4~~-6.7(-7) μm , $Q = (1.15-)$ 1.19-~~1.24~~-1.28(-1.35); ornamentation reticulate, composed of obtuse, relatively small and numerous [6-8(-9) in a 3 μm diam. circle], amyloid warts, (0.5-)0.7-0.8(-0.9) μm high, connected by frequent line connections [2-5(-6) in the circle], occasionally also fused in pairs or short ridges [1-5(-6) fusions in the circle], without isolated warts; suprahilar spot large, amyloid. **Basidia** (35-)36.5-~~40~~-43.5 (-45) \times (8-)9-~~10.5~~-11.5(-12.5) μm , 4-spored, clavate, pedicellate; basidiola first cylindrical, then narrowly clavate. **Hymenial cystidia** on sides of lamellae numerous, ca. 2200-2600/mm², measuring (50-)55.5-~~67~~-78.5(-103) \times 8.5-~~9.5~~-10.5(-11.5) μm ,

clavate or fusiform, apically easily collapsing, mainly obtuse, few mucronate or with small appendages, thin-walled, with heteromorphous contents that are moderately to weakly graying in sulfovanillin; near gill edge mainly fusiform, measuring (40-)43-49-55(-66) × 6.5-7.5-8.5(-10.5) μm, apically narrowing and with 2-5 μ long appendages, usually optically empty. **Marginal cells** not differentiated, similar to basidiola, measuring (9-)13.5-17-20(-23) × 3.5-4.9-6(-8.5) μm. **Pileipellis** orthochromatic in Cresyl blue, gradually passing to underlying sphaerocytes of the context, 120-150 μm deep, non-gelatinized, clearly two-layered; suprapellis 30-50 μm deep, a trichoderm of erect or ascending, near surface loose and downward gradually denser hyphal terminations; subpellis 80-110 μm deep, of horizontally oriented, dense, irregularly inflated, frequently branched, ca. 3.5-12 μm wide hyphae. Acidoresistant incrustations absent. Hyphal terminations near the pileus margin frequently branched, with terminal cells measuring (18-)19.5-24.5-30(-36) × 3-3.5-4(-5) μm, cylindrical, occasionally also attenuated, apically obtuse, flexuous-moniliform, thin-walled; subterminal cells frequently very branched and irregular, equally wide or irregularly inflated, often forming spider-like ramified structure. Terminal cells of hyphae in the pileus center similar but sometimes more irregular and moniliform, measuring (14-)20-26.5-33(-40) × 3-4-5(-6) μm. Pileocystidia abundant, mainly one or two-celled, some longer ones originating deep in subpellis and occasionally with three or more cells, clavate, near the pileus margin with terminal cells measuring (13-)24-33-41.5(-48) × (3.5-)4.5-6.5-8.5(-9.5) μm, narrowly clavate, cylindrical or ellipsoid, often short (especially when pluriseptate), apically obtuse, thin-walled, contents heteromorphous, weakly graying sulfovanillin; near the pileus center smaller, with terminal cells measuring (14-)19-31.5-44(-54) × 5-6-7(-8.5) μm. Cystidioid hyphae in subpellis very abundant, present also in trama of pileus and lamellae. **Clamp connections** absent in all parts.

Notes: This species has always been situated in species groups belonging to subg. *Ingratula* (sensu Romagnesi 1987). Shaffer (1970) studied the type and situated *R. simillima* in “subsect. *Felleinae*” (Melzer & Zvára) ined., thereby also following the opinion of Singer (1939 and onwards) who thinks that Peck’s species is merely a form of the European species (Singer 1986). Because of this high similarity to the European *R. fellea*, including its particular color and strict association with beech, Peck’s species can be readily identified in the field and seems to present no particular identification problems. Molecular data will elucidate whether or not these are separate species.

There exist few studies that illustrate the microscopy of *R. fellea*. The structure of the pileipellis of *R. simillima*, in particular the irregular and often inflated hyphae in the subpellis, are also reminiscent of subsect. *Violaceinae* (Romagn.) Sarnari.

27. *Russula subdepallens* Peck, *Bull. Torrey Bot. Club* 23: 412. 1896. **Figs 53-54**

Original description:

Pileus fleshy, at first convex and striate on the margin, then expanded or centrally depressed and tuberculate-striate on the margin, viscid, blood-red or purplish red, mottled with yellowish spots, becoming paler or almost white with age, often irregular, flesh fragile, white, becoming cinereous with age, reddish under the cuticle, taste mild; lamellae broad, subdistant, adnate, white or whitish, the interspaces venose; stem stout, solid but spongy within, persistently white; spores white, globose, rough, .0003 in. broad; pileus 3-6 in. broad; stem 1.5-3 in. long, 6-12 lines thick.

Under a hickory tree. Trexlertown, Pennsylvania. June. W. Herbst.

Closely related to Russula depallens, from which it differs in having the margin of the pileus striate at first and more strongly so when mature, also in the pileus being spotted at first, the lamellae more distant, the stem persistently white and the spores white.

Holotype: Trexlertown, Pa. [Pennsylvania], June, *Wm. Herbst* (NYSf3010).

Spores broadly ellipsoid, (7.1-)7.5-7.9-8.4(-8.4) × (5.4-)5.9-6.3-6.6(-7.1) μm, Q = (1.13-)1.21-1.28-1.33(-1.36); ornamentation composed of moderately distant, incompletely amyloid large, obtuse (5-7 in a 3 μm diam. circle) warts, 0.8-1(-1.1) μm high, connected by occasional, fine, low line connections (0-2 in the circle), often merged in distinctly prominent, short crests [(0-)2-4(-5) fusions in the circle], with few isolated spines; suprahilar spot not amyloid. **Basidia** (35-)42-48-54(-60) × 7.5-8.5-9.5(-10.5) μm, 4-spored, clavate; basidiola first cylindrical, then narrowly clavate. **Hymenial cystidia** on sides of lamellae abundant, 3500-4000/mm², measuring (53-)57-63.5-69(-71) × (7-)7.5-8.5-9.5(-10.5) μm, mainly clavate, apically obtuse-rounded, rarely tapering and with a 1-5 μm long appendage, thin-walled, easily collapsing; contents finely granulose-refracting in upper half, optically empty towards the basal septum, in sulfovanillin slowly turning to dark red-brown; near gill edge absent (or very rare?). **Marginal cells** similar to basidiola but smaller, measuring (6-)8.5-13-17(-23) × (3-)3.5-4.5-5.5(-6.5) μm. **Pileipellis** orthochromatic, but turning to a dark blue-green due to (yellow) pigmented cells walls and incrustations on gloeoplerous hyphae, sharply delimited from the underlying sphaerocytes of the context, very thick, strongly gelatinized, 250-320 μm deep, vaguely two-layered; suprapellis 95-140 μm deep, of loose, intricate, repent hyphae; subpellis ca. 70-100 μm deep, of parallel, horizontally oriented, dense, 1.5-4(-6) μm wide hyphae. Abundant acidoresistant incrustations present on gloeoplerous hyphae with refracting yellow contents. Hyphal terminations near the pileus margin very flexuous, often moniliform, branched, with terminal cells measuring ca. (12-)15.5-22-29(-41) × 3-4-4.5(-5.5) μm, often twisted, mainly cylindrical, apically obtuse, thin-walled; subterminal cells usually equally wide, branched and irregular, intricate, nodulose. Hyphal terminations near the pileus center less irregular, less branched and less flexuous, with terminal cells measuring (15-)18.5-28.5-38.5(-54) × (3-)3.5-4-4.5(-5.5) μm, narrowly clavate or cylindrical, rarely capitate; subterminal cells often not distinctly flexuous and not branched. Pileocystidia ill-differentiated, more reminiscent of gloeoplerous (cystidioid) hyphae, with terminal cells very variable in length, often exceeding 100 μm, but sometimes very short – especially those near the surface of pileipellis, ca. 3-6 μm thick, thin-walled, cylindrical and often apically subcapitate, contents yellow, refracting, very slowly (!) turning grey in sulfovanillin, having yellowish incrustations in Congo red or Cresyl blue. **Clamp connections** absent in all parts.

Notes: Peck's observation relating this species to the group of greying or blackening species has been interpreted as the major feature by all later authors (Burlingham 1915, Singer 1926 and onwards). As a result, *R. subdepallens* has always been placed in *Decolorantes* (sensu Singer comprising both *R. decolorans* (Fr.) Fr. group and *R. vinosa* Lindblad group). More recently, Peck's species is also interpreted as a very close relative to *R. exalbicans* (see under that name in <https://www.mycocquebec.org>), again principally because of the mention of a greying stipe. However, we rather situate *R. subdepallens* in *Ochroleucinae* (= *Viscidinae*) considering the thick glutinous pileipellis, striate margin, ill-differentiated pileocystidia as yellowish gloeoplerous hyphae, presence of yellow incrustations in pileipellis, irregular subcylindrical hyphal terminations near the pileus margin, white spore print, no distinct acidity, purple, red and yellow pileus colours.

It was, therefore, quite a surprise to discover that the type specimen has spores without an amyloid suprahilar spot, a feature that immediately excludes all of the abovementioned interpretations of Peck's species. Suddenly, there seems to be no other alternative than a placement in subg. *Ingratula*. Although this might at first sight not seem very plausible, we think *R. subdepallens* could indeed be a close, but mild, relative to species such as *R. mutabilis* Murrill the thick glutinous pileipellis, striate margin, ill-differentiated pileocystidia as yellowish gloeoplerous hyphae, presence of yellow incrustations in pileipellis, irregular subcylindrical hyphal terminations near pileus margin and white spore print are also typical for this species. Furthermore, we have found *R. mutabilis*, a species with an orange brown pileus, at moments that it was exuding abundant blood red droplets that color the tissues of lamellae and stipe, and it has also distinct yellow tinges (in this case more on the lower stipe). Finally, in the herbarium, the lengthwise sectioned young basidiomata have a distinctly cavernose-pitted stipe, typical for *Foetentinae*.

28. *Russula viridella* Peck, *Bull. New York State Mus. Nat. Hist.* 105: 41. 1906.

Figs 55-56

Original description:

Pileus firm, subglobose, hemispheric or very convex, becoming nearly plane or centrally depressed, sometimes nearly funnelform, even on the margin, dry, soon minutely squamulose or furfuraceous, specially toward the margin, pale grayish green, generally smooth and paler or subochraceous in the center; flesh white, taste acrid; lamellae thin, narrow, close, some of them forked, occasionally anastomosing at the base, a few short ones intermingled, white; stem equal or nearly so, even, solid or spongy within, white; spores white tinged with yellow, globose or subglobose, .00024-.0003 of an inch long, nearly as broad; cystidia subfusiform, .0025-.003 of an inch long, .0006 broad.

*The pale green russula is related to the greenish russula, *Russula virescens*, and has nearly the same colors, but it may be separated from the greenish russula by the minute squamules or fragments of the epidermis of the cap, the thinner and closer gills and by its acrid taste. When the cap is viewed in a certain light it has a pruinose appearance. The white gills are closely placed side by side and are sometimes connected with each other by transverse branches near the base. The stem is nearly cylindrical, solid and white. It is very susceptible to the attacks of insect larvae and is often found perforated by them even in young plants. The acrid flavor of the fresh mushroom is destroyed by cooking.*

*The cap is 2.5-4 inches broad, the stem 2-3 inches long, and 5-8 lines thick. This species grows under hemlock trees and appears in July. It is gregarious and Horicon is at present the only locality where it has been found. It belongs to the section *Rigidae*. It is a fine addition to our mycological flora and to our list of edible mushrooms.*

Lectotype (designated here): Horicon, Warren co. [Warren County, New York], 22 July 1905, C. H. Peck (NYSF3395); isotype: Bull. New York State Mus. Nat. Hist. 105: pl. 100, figs 1-7. 1906.

Spores ellipsoid, (6.8-)~~7.2-7.7~~-8(-8.5) × (4.9-)~~5.1-5.4~~-5.6(-6) μm, Q = (1.28-)~~1.34-1.41~~-1.47(-1.51); ornamentation subreticulate, composed of small, numerous [7-10(-12) in a 3 μm diam. circle], amyloid warts, 0.2-0.3 μm high, connected by frequent line connections [(1-)~~2-4~~(-5) in the circle] and frequently fused in short or long chains [(1-)~~2-5~~(-8) fusions in the circle], without isolated warts; suprahilar spot small, smooth, not amyloid. **Basidia** 39-~~42.5~~-45(-48) × (8-)~~8.5-9-9.5~~(-10) μm, 4-spored, narrowly clavate; basidiola first cylindrical then clavate. **Hymenial cystidia** on sides of lamellae widely dispersed to dispersed 300-500/mm², measuring (57-)~~70-82~~-94.5(-105) × (8.5-)~~11-12~~-13.5(-14.5) μm, mainly fusiform, occasionally clavate, pedunculate, apically acute to acute-pointed, usually with 3-10(-14) μm long, globose appendage, thin-walled, contents heteromorphous-

crystalline, strongly graying in sulfovanillin; near gill edge measuring (45-)58.5-71-83(-91) \times (8.5-)9.5-10.5-11.5(-12.5) μm , usually with one, 2-6 μm long or two globose appendages. **Marginal cells** not differentiated, measuring (12-)15-21-27 (-40) \times (4.5-)5.5-6.5-7(-7.5) μm , apically obtuse. **Pileipellis** orthochromatic in Cresyl blue (or weakly metachromatic?), sharply delimited from underlying sphaerocytes of the context, 460-550 μm deep, obscurely two-layered; suprapellis 60-100 deep, of erect, not gelatinized, dense hyphal terminations; subpellis ca. 400-450 μm deep, of strongly gelatinized, irregularly oriented, loose, intricate, 3-5 μm wide hyphae, gradually more dense and horizontally oriented towards the pileus trama. Acidoresistant incrustations absent. Hyphal terminations near the pileus margin forming a trichoderm to almost hymeniderm, but disrupting into smaller patches (similar as in *R. virescens*), composed usually of 2-3(-4) unbranched cells, with terminal cells measuring (16-)24-31.5-39(-42) \times (3.5)4-5-6.5(-8) μm , cylindrical, often also narrowly lageniform, apically obtuse, thin-walled; subterminal cells usually equally wide but distinctly shorter, ellipsoid to cylindrical, mainly unbranched, measuring (10-)11.5-17-22(-32) \times (3.5-)4-5.5-6.5(-8) μm . Pileipellis near the pileus center continuous, hyphal terminations with terminal cells more irregular in shape, often inflated, measuring (11-)15-23.5-32(-43) \times (4-)4.5-6.5-8(-11.5) μm , lageniform, utriform, pyriform, clavate or cylindrical, thin-walled, apically obtuse; subterminal cells more frequently branched, often flexuous and with lateral nodules or projections. Pileocystidia numerous, very voluminous and conspicuous, one-celled, near the pileus margin measuring 33-72-114(>150) \times (7-)8.5-10-11.5(-13) μm , fusiform, longer ones originating in the subpellis, apically mucronate, with one or two globose, small appendages, thin-walled, contents granular to crystalline, turning dark gray to black in sulfovanillin. Cystidioid hyphae frequent in subpellis near the trama, dispersed in the trama of pileus and lamellae. **Clamp connections** absent in all parts.

Notes: A trichodermous to almost hymenidermous structure of the suprapellis, disrupting toward the pileus margin, a very thick, gelatinized subpellis, oblong spores with subreticulate ornamentation without amyloid suprahilar spot, are all typical features of this species, suggesting a placement in subg. *Heterophyllidia*. Although Peck (1906) compares his species to *R. virescens*, a placement also accepted by Singer (1942a-b), his species cannot be placed in that subsection because of the enormous pileocystidia and untypical suprapellis structure. For the moment, we would rather suggest a placement near *Griseinae*.

CONCLUSION

With this contribution we finished the revision of all available type-specimens of the 46 *Russula* taxa described by Peck (Table 1). Two types could not be studied because they were either missing or completely eaten by insects. For these species (*R. nigrodisca* Peck and *R. pulverulenta* Peck), a new representative collection should be selected based on the original description.

Table 1. Alphabetical list of all russulas described by C. H. Peck with their classifications and reference to descriptions. The bold numbers in the last column corresponds to the number of the description provided in this study

<i>Protologue</i>	<i>Taxon</i>	<i>Latest classification</i>	<i>Proposed classification (this study)</i>	<i>References to our revisions (in bold this study)</i>
Peck 1902a	<i>R. abietina</i>	<i>Sphagnophilinae</i>	<i>Laricinae?</i>	1
Peck 1900	<i>R. aeruginascens</i>	<i>Cyanoxanthinae</i>	<i>Cyanoxanthinae</i>	2
Peck 1897	<i>R. albella</i>	<i>Lepidinae</i>	<i>Emeticinae or Citrinae</i>	3
Peck 1887	<i>R. albida</i>	<i>Roseinae</i>	<i>Roseinae</i>	Adamčík & Buyck 2012
Peck 1898	<i>R. albidula</i>	<i>Sanguininae</i>	<i>Sanguininae</i>	4
Peck 1897	<i>R. anomala</i>	<i>Citrinae</i>	<i>Citrinae?</i>	5
Peck 1888	<i>R. atropurpurea</i>	<i>Xerampelinae</i>	<i>Xerampelinae</i>	Adamčík & Buyck 2011a
Peck 1913	<i>R. ballouii</i>	<i>Fistulosinae</i>	<i>Ochroleucinae</i>	6
Peck 1885	<i>R. basifurcata</i>	<i>Griseinae</i>	<i>Griseinae?</i>	7
Peck 1910	<i>R. blackfordiae</i>	<i>Sphagnophilinae</i>	<i>Subg. Tenellula</i>	8
Peck 1890	<i>R. brevipes</i>	<i>Lactarioides</i>	<i>Lactarioides</i>	Buyck & Adamčík 2013
Peck 1879	<i>R. compacta</i> Frost in Peck	<i>Crassotunicatae</i>	<i>Pseudocompactae</i>	9
Peck 1886	<i>R. crustosa</i>	<i>Virescentinae</i>	<i>Virescentinae</i>	10
Peck 1904b	<i>R. densifolia</i> var. <i>paxilloides</i>	<i>Nigricantinae</i>	<i>Polyphyllae</i>	Adamčík & Buyck 2014
Peck 1903	<i>R. earlei</i>	<i>Archeinae</i>	<i>Archaeinae</i>	11
Peck 1911	<i>R. eccentrica</i>	<i>Nigricantinae</i>	<i>Polyphyllae</i>	12
Peck 1900	<i>R. flaviceps</i>	<i>Integrae</i>	<i>Chamaeleontinae</i>	Adamčík et al. 2013
Peck 1879	<i>R. flavida</i>	<i>Lepidinae</i>	<i>Auratinae?</i>	13
Peck 1886	<i>R. (foetens</i> var.) <i>granulata</i>	<i>Subvelatae</i>	<i>Foetentinae</i>	14
Peck 1907b	<i>R. foetentula</i>	<i>Foetentinae</i>	<i>Foetentinae</i>	Adamčík et al. 2013
Peck 1903	<i>R. granulata</i> var. <i>leptoides</i>	<i>Foetentinae</i> (cf <i>R. ochroleuca</i>)	<i>Foetentinae</i>	15
Peck 1902a	<i>R. (integra</i> var.) <i>rubrotincta</i> (Peck) Burl.	= <i>R. paludosa</i>	<i>Xerampelinae?</i>	16
Peck 1904b	<i>R. luteobasis</i>	<i>Lepidinae</i>	<i>Messapicae?</i>	17
Peck 1903	<i>R. magnifica</i>	<i>Polyphyllinae</i>	<i>Polyphyllinae</i>	18
Peck 1872	<i>R. mariae</i>	<i>Amoeninae</i>	<i>Amoeninae</i>	19
Peck 1907b	<i>R. modesta</i>	<i>Modestinae</i>	<i>Modestinae</i>	Adamčík et al. 2013
Peck 1906a	<i>R. nigrescentipes</i>	<i>Decolorantinae</i>	<i>Roseinae</i>	Adamčík & Buyck 2012
Macoun 1899	<i>R. nigrodisca</i>	<i>Emeticinae</i>	eaten by insects	–
Peck 1897	<i>R. ochrophylla</i>	<i>Olivaceinae</i>	<i>Olivaceinae</i>	20
Peck 1897	<i>R. ochrophylla</i> var. <i>albipes</i>	<i>Olivaceinae</i>	<i>romellii</i> group	21

<i>Protologue</i>	<i>Taxon</i>	<i>Latest classification</i>	<i>Proposed classification (this study)</i>	<i>References to our revisions (in bold this study)</i>
Peck 1900	<i>R. palustris</i>	<i>Exalbicantinae</i>	<i>Foetentinae</i>	22
Singer 1943	<i>R. peckii</i>	<i>Roseinae</i>	<i>Exalbicantinae</i>	Adamčík & Buyck 2012
Peck 1907a	<i>R. pectinatoides</i>	<i>Foetentinae</i>	<i>Foetentinae</i>	Adamčík et al. 2013
Peck 1898	<i>R. polyphylla</i>	<i>Polyphyllinae</i>	<i>Polyphyllinae</i>	23
Write 1902	<i>R. puellaris</i> var. <i>umbonata</i>	<i>Puellarinae</i>	nomen nudum	–
Peck 1902b	<i>R. pulverulenta</i>	<i>Subvelatae</i>	missing	–
Peck 1897	<i>R. pusilla</i>	<i>Puellarinae</i>	<i>Rhodellinae</i> or <i>Puellarinae</i>	24
Peck 1902a	<i>R. rugulosa</i>	<i>Emeticinae?</i>	<i>Felleinae?</i>	25
Peck 1910	<i>R. serissima</i>	<i>Olivaceinae/Decolorantes</i>	<i>Xerampelinae</i>	Adamčík & Buyck 2011a
Peck 1872	<i>R. simillima</i>	<i>Felleinae</i>	<i>Felleinae</i>	26
Peck 1873	<i>R. sordida</i>	<i>Nigricantinae</i>	<i>Nigricantinae</i>	Adamčík & Buyck 2014
Peck 1907b	<i>R. squalida</i>	<i>Xerampelinae</i>	homotypic syn of <i>R. atropurpurea</i> Peck	–
Peck 1896	<i>R. subdepallens</i>	<i>Integroidinae</i>	<i>Foetentinae?</i>	27
Peck 1906b	<i>R. subsordida</i>	<i>Nigricantinae</i>	<i>Nigricantinae</i>	Adamčík & Buyck 2014
Peck 1906	<i>R. subvelutina</i>	<i>Xerampelinae</i>	<i>Rhodellinae</i> or <i>Puellarinae</i>	Buyck & Adamčík 2013
Peck 1887	<i>R. uncialis</i>	<i>Lilacinae</i>	<i>Lilacinae</i>	Adamčík et al. 2013
Peck 1902b	<i>R. ventricosipes</i>	<i>Foetentinae</i>	<i>Foetentinae</i>	Adamčík et al. 2013
Peck 1906b	<i>R. viridella</i>	<i>Virescentinae</i>	<i>Griseinae?</i>	28
Peck 1891	<i>R. viridipes</i> <i>Banning in Peck</i>	<i>(Lactarius cf necator)</i>	No type specimen	–

For the majority of the 44 revised taxa, our type studies confirmed the latest suggested placements in the classification of the genus (Table 1, second column), although there are some notable exceptions. Indeed, on the basis of microscopic features, 8 species (19%) changed subgenus (*sensu* Romagnesi 1987):

<i>R. ballouii</i>	<i>Fistulosinae (Ingratula)</i>	<i>to Ochroleucinae (Incrustatula)</i>
<i>R. compacta</i>	<i>Crassotunicatae (-)</i>	<i>to Pseudocompactae (Malodora)</i>
<i>R. flaviceps</i>	<i>Integrae (Polychromidia)</i>	<i>to Chamaeleontinae (Incrustatula)</i>
<i>R. nigrescentipes</i>	<i>Decolorantinae (Polychromidia)</i>	<i>to Roseinae (Incrustatula)</i>
<i>R. palustris</i>	<i>Exalbicantinae (Russula)</i>	<i>to Foetentinae (Ingratula)</i>
<i>R. peckii</i>	<i>Roseinae (Incrustatula)</i>	<i>to Exalbicantinae (Russula)</i>
<i>R. rugulosa</i>	<i>Emeticinae?(Russula)</i>	<i>to Felleinae?(Ingratula)</i>
<i>R. subdepallens</i>	<i>Integroidinae (Polychromidia)</i>	<i>to Foetentinae? (Ingratula)</i>

In the above list, *R. compacta* is a bit special as it belongs to a group that is not represented in Europe and appears now even to be the unique representative in North America of a subgenus that has a predominantly tropical distribution.

It is also remarkable that some subgenera are very well represented among the species described by Peck, e.g. subg. *Ingratula* and *Compactae* (sensu Romagnesi 1987), account for seven and eight species respectively, while our analyses suggest that for *Ingratula*, there may actually be three more species among Peck's taxa (see Table 1). Also for *Compactae* our results are interesting as they suggest, for example, that instead of a single species traditionally placed in *Polyphyllinae*, there are probably already four taxa assigned to this group based on morphological characters: *R. magnifica*, *R. polyphylla*, *R. eccentrica* and *R. densifolia* var. *paxilloides* Peck.

Several other species changed subsection, but these new placements remain to be confirmed in many cases based on new collections (as also indicated by question marks in Table 1). Several type collections are represented by more than 1 fruiting body and might represent mixed collections as suggested by Melera *et al.* (2017). For this reason we labelled the single basidiomata within each type specimen.

Acknowledgements. Mss Lorinda Leonardi, collection manager at NYS, is acknowledged for assistance with type material during our visit. S. Adamčík and S. Jančovičová were funded for this study by Slovak national grant (APVV 15-0210). Travel to US herbaria was funded by an EDIT Research Integration Grant (JPA 5 – IRG, PI Buyck).

REFERENCES

- ADAMČÍK S. & BUYCK B., 2010 — Re-instatement of *Russula levyana* Murrill as a good and distinct American species of *Russula* section *Xerampelinae*. *Cryptogamie, Mycologie* 31(2): 119-135.
- ADAMČÍK S. & BUYCK B., 2011a — The species of *Russula* subsection *Xerampelinae* described by C.H. Peck and Miss G.S. Burlingham. *Cryptogamie, Mycologie* 32(1): 63-81.
- ADAMČÍK S. & BUYCK B., 2011b — Type- studies in American *Russula* (Russulales, Basidiomycota): species of subsection *Decolorantinae* described by H.C. Beardslee, G.S. Burlingham and W.A. Murrill. *Cryptogamie, Mycologie* 33(3): 323-329.
- ADAMČÍK S. & BUYCK B., 2012 — In and out of *Russula* subsection *Roseinae*. *Nova Hedwigia* 94(3-4): 413- 428.
- ADAMČÍK S. & BUYCK B., 2014 — Type studies in *Russula* subsection *Nigricantes* from the Eastern United States. *Cryptogamie, Mycologie* 35 (3): 291-307.
- ADAMČÍK S., CAI L., CHAKRABORTY D., CHEN X-H, COTTER H. Van T., DAI D-Q, DAI Y-C, DAS K., DENG C., GHOBAD-M. , D. HYDE K.D., LANGER E., LATHA K.P.D., LIU F., LIU S-L, LIU T., Wei LV W., Shu-Xia LV, Alexandre R. MACHADO, PINHO D.B., PEREIRA O.L., PRASHER I.B., ROSADO A.W.C., QIN J., QIN W.M., VERMA R.K., WANG Q., YANG Z.-L., YU X.-D., ZHOU L.-W. & B. BUYCK. 2015a — Fungal Biodiversity Profiles 1-10. *Cryptogamie, Mycologie* 36(2): 121-166.
- ADAMČÍK S., CARTERET X. & BUYCK, B., 2013 — Type studies on some *Russula* species described by C.H. Peck. *Cryptogamie, Mycologie* 34(4): 367- 391.
- ADAMČÍK S., JANČOVIČOVÁ S. & BUYCK B., 2015b — Type- studies in *Russula* subsection *Decolorantes* (Russulales, Basidiomycota) in America, part II. *Phytotaxa* 231.3.3.
- ADAMČÍK S. & MARHOLD K., 2000 — Taxonomy of the *Russula xerampelina* group. I. Morphometric study of the *Russula xerampelina* group in Slovakia. *Mycotaxon* 76: 463-479.
- ADAMČÍK S., MITCHELL D. & BUYCK B., 2010 — *Russula ochrifloridana* sp. nov., a new yellowish fishy *Russula* from Florida and its comparison with *R. grundii*. *Cryptogamie, Mycologie* 31(4): 363-372.
- ARORA D. & NGUYEN N.H., 2014 — A new species of *Russula* subgenus *Compactae* from California. *North American Fungi* 9 (8): 1-7.
- BAZZICALUPO A.L., BUYCK B., SAAR I., VAURAS J., CARMEAN D. & BERBEE M.L., 2017 — Troubles with mycorrhizal mushroom identification where morphological differentiation lags behind barcode sequence divergence. *Taxon* 66 (4): 791-810.
- BEARDSLEE H.C., 1914 — Notes on a few Asheville fungi. *Mycologia* 6: 88-92.
- BILLS G.F. & MILLER O.K., Jr., 1984 — Southern Appalachian russulas. I. *Mycologia* 76: 975- 1002.
- BILLS G.F., 1984 — Southern Appalachian russulas. II. *Mycotaxon* 21: 491- 517.

- BILLS G.F., 1985 — Southern Appalachian russulas. III. The identity of *Russula eccentrica* and *R. morgani* (Russulaceae). *Brittonia* 37: 360-365.
- BON M., 1987 — Espèces et combinaisons nouvelles (addenda et corrigenda). *Documents Mycologiques* 18 (69): 35-36.
- BURLINGHAM G.S., 1915 — *Russula* Pers. *North American Flora* 9 (4): 201-236.
- BURLINGHAM G.S., 1921 — Some new species of *Russula*. *Mycologia* 13 (3): 129-134.
- BURLINGHAM G.S., 1944 — Studies in North American Russulae. *Mycologia* 36 (1): 104-120.
- BURNHAM S.H., 1919 — Charles Horton Peck. *Mycologia* 11: 33-39.
- BUYCK B., 1988 — Etude microscopique de spécimens types de *Russules* tropicales de la sous-section *Diversicolores*. *Mycotaxon* 33: 57-70.
- BUYCK B., 1992 — Checklist of tropical *Russulae* and their type specimens. *Russulales New, Special issue* 1: 1-99.
- BUYCK B., 1989 — Valeur taxonomique du bleu de crésyl pour le genre *Russula*. *Bulletin de la Société Mycologique France* 105: 1-6.
- BUYCK B., 1998 — Revision of *Russula* section *Archaeinae*. *Belgian Journal of Botany* 131: 116-126.
- BUYCK B., 2004a — Précisions sur *Russula virescens* et sur quelques *Griseinae* leucosporées. *Bulletin mensuel de la Société mycologique de France* 120 (1-4): 385-401.
- BUYCK B., 2004b — Short diagnoses and descriptions for some exotic *Russula* (Basidiomycotina). *Cryptogamie, Mycologie* 25 (2) : 127-128.
- BUYCK B., 2007 — An introduction to the study of *Russula* in the eastern United States. *Pagine di Micologia* 27: 81-86.
- BUYCK B. & ADAMČÍK S., 2011a — Type studies in *Russula* subgenus *Heterophyllidia* from the eastern United States. — *Cryptogamie, Mycologie* 32 (2):151-169.
- BUYCK B. & ADAMČÍK S., 2011b — Type studies of the *Russula* species described by W.A. Murrill, 2. *R. roseiisabellina*, *R. sericella* and *R. obscuriformis*. *Mycotaxon* 115: 131-144.
- BUYCK B. & ADAMČÍK S., 2011c — Type studies in *Russula* subsection *Decolorantinae* from the eastern United States. *Cryptogamie, Mycologie* 32 (3): 323-339.
- BUYCK B. & ADAMČÍK S., 2013a — The *Russula xerampelina* complex (Russulales, Agaricomycotina) in North America. *Scripta Botanica Belgica* 51: 121-135.
- BUYCK B. & ADAMČÍK S., 2013b — Type studies in *Russula* subsection *Lactarioideae* from North America and a tentative key to North American species. *Cryptogamie, Mycologie* 34(3): 259-279.
- BUYCK B., ADAMČÍK S. & LEWIS D., 2008a — *Russula* section *Xerampelinae* in Texas. *Cryptogamie-Mycologie* 29 (1): 13-27.
- BUYCK B., BESSETTE A. & ADAMČÍK S., 2011 — *Russula hixsonii* Murrill, a rare and intriguing southern species of uncertain systematic position, rediscovered in Georgia, USA. *Cryptogamie, Mycologie* 32 (4): 403-412.
- BUYCK B. & HALLING R., 2004 — Two new *Quercus*-associated *Russula*'s from Costa Rica and their relation to some very rare North American species. *Cryptogamie, Mycologie* 25 (1): 3-13.
- BUYCK B., HOFSTETTER V., EBERHARDT U., VERBEKEN A. & KAUF F., 2008b — Walking the thin line between *Lactarius* and *Russula* (Russulaceae, Basidiomycotina): the dilemma of subsect. *Ochricompactae*. *Fungal Diversity* 28: 15-40.
- BUYCK B., JANČOVIČOVA S. & ADAMČÍK S., 2015 — The study of *Russula* in the Western United States. *Cryptogamie, Mycologie* 36 (2): 193-211.
- BUYCK B. & MITCHELL D., 2003 — *R. lentiginosa* spec. nov. from West Virginia, USA, a probable link between tropical and temperate *Russula*-groups. *Cryptogamie, Mycologie* 24 (4) : 317-325.
- BUYCK B., MITCHELL D. & PARRENT J., 2006 — *Russula parvovirescens* sp. nov., a common but ignored species in the eastern United States. *Mycologia* 98 (4): 612-615.
- BUYCK B., OLARIAGA I., LOONEY B., JUSTICE J. & HOFSTETTER V., 2016 — Wisconsin chanterelles revisited and first indications for very wide distributions of *Cantharellus* species in the United States East of the Rocky Mountains. *Cryptogamie, Mycologie* 37 (3): 345-366.
- BUYCK B., DUHEM B., DAS K., JAYAWARDENA R.S., NIVEIRO N., PEREIRA O.L., PRASHER I.B., ADHIKARI S., ALBERTO E.O., BULGAKOV T.S., CASTAÑEDA-RUIZ R.F., HEMBROM M.E., HYDE K.D., LEWIS D.P., MICHLIG A., NUYTINCK J., PARIHAR A., POPOFF O.F., RAMIREZ N.A., DA SILVA M., VERMA R.K. & HOFSTETTER V., 2017 — Fungal Biodiversity Profiles 21-30. *Cryptogamie, Mycologie* 38 (1): 101-146.
- BUYCK B., ZOLLER S. & HOFSTETTER V., 2018 — Walking the thin line... ten years later: the dilemma of above- versus below-ground features to support phylogenies in the Russulaceae (Basidiomycota). *Fungal Diversity* (online first), doi.org/10.1007/s13225-018-0397-5.

- CABOŇ M., EBERHARDT U., LOONEY P.B., HAMPE F., KOLAŘÍK M., JANČOVIČOVÁ S., VERBEKEN A. & ADAMČÍK S., 2017 — New insights in *Russula* subsect. *Rubrinae*: phylogeny and the quest for synapomorphic characters. *Mycological Progress* 16 (9): 877-892.
- DAS K., GHOSH A., BHATT R.P., CHAKRABORTY D., HOFSTETTER V. & BUYCK B., 2017a — Fungal Biodiversity Profiles 41-50. *Cryptogamie, Mycologie* 38 (4): 527-547.
- DAS K., GHOSH A., CHAKRABORTY D., LI J., QIU L., BAGHELA A., HALAMA M., HEMBROM M.E., MEHMOODT, PARIHARA., PENCAKOWSKI B., BIELECKA M., RECZYŃSKA K., SASIELA D., SINGH U., SONG Y., ŚWIERKOSZ K., SZCZEŚNIAK K., UNIYAL P., ZHANG J. & BUYCK B., 2017b — Fungal Biodiversity Profiles 31-40. *Cryptogamie, Mycologie* 38(3): 353-406.
- FATTO R.M., 1996b — Notes on three small red-capped *Russulas*. *Mycotaxon* 59: 37-41.
- HESLER L.R., 1960a — A study of *Russula* Types. *Memoirs of the Torrey Botanical Club* 21: 1-59.
- HESLER L.R., 1960b — A study of *Russula* types II. *Mycologia* 53 (6): 605-625.
- HONGSANAN S., HYDE K.D., BAHKALIA.H., CAMPORESI E., CHOMNUNTI P., EKANAYAKA H., GOMES A.M., HOFSTETTER V., JONES E.B.G., PINHO D.B., PEREIRA O.L., TIAN Q., WANASINGHE D.N., XU J.-C. & BUYCK B., 2015 — Fungal Biodiversity Profiles 11-20. *Cryptogamie, Mycologie* 36 (3): 355-380.
- HYDE K.D., NORPHANPHOUN C., BAZZICALUPO A., KARUNARATHNA A., EKANAYAKA A.H., DISSANAYAKE A.J., SOARES M.A., PHUKHAMSAKDA A., WANASINGHE D.N., TENNAKON D.S., ABDEL-AZIZ F.A., LEE H., SIEDLECKI I., SENANAYAKE I.C., MANAWASINGHE I.S., KUŠAN I., YANG J., LI J., CHETHANA K.W.T., THAMBUGALA K.M., HE M.-Q., MAPOOK A., CLERICUZIO M., DAYARATHNE M.C., LIU N.-G., TIAN Q., PHOOKAMSAK R., JAYAWARDENA R.S., TIBPROMMA S., HUANG S.-K., HONGSANAN S., KONTA S., JAYASIRI S.C., ABREU V.P., LI W.-J., ZENG X.-Y., XIA Y.-P., LUO Z.-L., DARANAGAMA D.A., DE SILVA N.I., SHANG Q.-J., PERERA R.H., VIZZINI A., BAHKALI A.H., ROMERO A.I., MEŠIĆ A., BUYCK B., MILLER D., CAMPORESI E., DOVANA F., PLAUTZ H.L., PROMPUTTHA I., SU H.-Y., BHAT D.J., GARETH JONES E.B., MCKENZIE E.H.C., KANG J.-C., LIU J.-K., XU J.-C., PAWŁOWSKA J., RYVARDEN L., JADAN M., WRZOSEK M., BERBEE M.L., DOILOM M., ABDEL-WAHAB M.A., KIM N.K., MATOČEC N., PEREIRA O.L., CHOMNUNTI P., ZHAO Q., CASTAÑEDA-RUIZ R.F., JEEWON R., ZHAO R.I., LUMYONG S., MAHARACHCHIKUMBURA S.N., KARUNARATHNA S.C., BOONMEE S., SUETRONG S., GIBERTONI T.B., WEN T.C., LIM Y.W., TKALČEC Z., LIU Z.-Y. & MORTIMER P.E., 2017 — Fungal diversity notes 603-716: taxonomic and phylogenetic notes on genera and species. *Fungal Diversity* 87 (1): 1-235.
- KAUFFMAN C.H., 1909 — Unreported Michigan fungi for 1908, with a monograph of the *Russulas* of the State. *Reports of the Michigan Academy of Science* 11: 55-91.
- KAUFFMAN C.H., 1918 — The Agaricaceae of Michigan, Vol. I, II. — *Michigan Geological and Biological Surveys, Publ. 26, Biological Series* 5, 1-924.
- KIBBY G. & FATTO R.M., 1990 — *Keys to the species of Russula in northeastern North America*, 3rd ed. Somerville, Kibby-Fatto Enterprises, 61 p.
- KONG A., CIFUENTES J., ESTRADA TORRES A., GUZMÁN-DÁVALOS L., GARIBAY-ORIJEL R.G. & BUYCK B., 2015 — Russulaceae associated with mycoheterotroph *Monotropa uniflora* (Ericaceae) in Tlaxcala, Mexico: a phylogenetic approach. *Cryptogamie, Mycologie* 36 (4): 479-512.
- LIU J.K., HYDE K.D., JONES E.B.G., ARIYAWANSA H.A., BHAT D.J., BOONMEE MAHARACHCHIKUMBURA S.S.N., MCKENZIE E.H.C., PHOOKAMSAK R., PHUKHAMSAKDA C., SHENOY B.D., ABDEL-WAHAB M.A., BUYCK B., CHEN J., CHETHANA K.W.T., SINGTRIPOP C., DAI D.Q., DAI Y.C., DARANAGAMA D.A., DISSANAYAKE A.J., DOLIOM M., D'SOUZA M.J., FAN X.L., GOONASEKARA I.D., HIRAYAMA K., HONGSANAN S., JAYASIRI S.C., JAYAWARDENA R.S., KARUNARATHNA S.C., LI W.J., MAPOOK A., NORPHANPHOUN C., PANG K.L., PERERA R.H., PERŠOH D., PINRUAN U., SENANAYAKE I.C., SOMRITHIPOL S., SUETRONG S., TANAKA K., THAMBUGALA K.M., TIAN Q., TIBPROMMA S., UDAYANGA D., WIJAYAWARDENE N.N., WANASINGHE D., WISITRASSA-MEEWONG K., ABDEL-AZIZ F.A., ADAMČÍK S., BAHKALI A.H., BOONYUEN N., BULGAKOV T., CALLAC P., CHOMNUNTI P., GREINER K., GREINER K., HASHIMOTO A., HOFSTETTER V., KANG J.C., LEWIS D., LI X.H., LIU X.X., LIU Z.Y., MATUMURA M., MORTIMER P.E., RAMBOLD G., RANDRIANJOHANY E., SATO G., SRI-INDRASUTDHI V., TIAN C.M., VERBEKEN A., VON BRACKEL W., WANG Y.,

- WEN T.C., XU J.C., YAN J.Y., ZHAO R.L. & CAMPORESI E., 2015 — Fungal Diversity Notes 1-110: Taxonomic and phylogenetic contributions to fungal species. *Fungal diversity* 72: 1-197.
- LOONEY B.P., 2015 — Molecular annotation of type species of *Russula* described by W.A. Murrill from the southeast United States. *Mycotaxon* 129 (2): 255-268.
- LOONEY B.P., RYBERG M., HAMPE F., SANCHEZ-GARCÍA M. & MATHENY P.B., 2016 — Into and out of the tropics: global diversification patterns in a hyper-diverse clade of ectomycorrhizal fungi. *Molecular Ecology* 25: 630-647.
- MELERA S., OSTELLARI C., ROEMER N., AVIS P.G., TONOLLA M., BARJA F. & NARDUZZI-WICHT B., 2016 — Analysis of morphological, ecological and molecular characters of *Russula pectinatoides* Peck and *Russula praetervisa* Sarnari, with a description of the new taxon *Russula recondita* Melera & Ostellari. *Mycological Progress* 16 (2): 117-134.
- MACOUN J.M., 1899 — XIII. A list of the plants of the Pribilof islands, Bering sea, with notes on their distribution. *The Fur seals and Fur-seal islands of the North Pacific ocean* 3: 559-587.
- MURRILL W.A., 1940 — Additions to Florida fungi II. *Buletin of the Torrey Botanical Club* 67 (1): 57-66.
- MURRILL W.A., 1943 — More new fungi from Florida. *Lloydia* 6 (3): 207-228.
- PECK C.H., 1872 — Report of the botanist. *Annual Report of the New York State Museum of Natural History* 24: 27-135.
- PECK C.H., 1873 — Descriptions of new species of fungi. *Bulletin of the Buffalo Society of Natural Sciences* 1: 41-72.
- PECK C.H., 1879 — Report of the Botanist. *Annual Report of the New York State Museum of Natural History* 32: 2-72.
- PECK C.H., 1885 — Report of the Botanist. *Annual Report of the New York State Museum of Natural History* 38: 77-138.
- PECK C.H., 1886 — Report of the Botanist. *Annual Report of the New York State Museum of Natural History* 39: 30-73.
- PECK C.H., 1887 — New species of New York fungi. *Bulletin of the New York State Museum* 1(2): 5-24.
- PECK C.H., 1888 — Report of the Botanist. *Annual Report of the New York State Museum of Natural History* 41: 49-122.
- PECK C.H., 1890 — Report of the Botanist. *Annual Report of the New York State Museum of Natural History* 43: 5-47.
- PECK C.H., 1891 — Annual Report of the State Botanist. *Annual Report of the New York State Museum of Natural History* 44: 5-75.
- PECK C.H., 1896 — New species of fungi. *Bulletin of the Torrey Botanical Club* 23: 411-420.
- PECK C.H., 1897 — Report of the State Botanist. *Annual Report of the New York State Museum of Natural History* 50: 77-159.
- PECK C.H., 1898 — New species of Alabama fungi. *Bulletin of the Torrey Botanical Club* 25: 368-372.
- PECK C.H., 1900 — Report of the State botanist 1899. *Annual Report of the New York State Museum of Natural History* 53: 823-867.
- PECK C.H., 1902a — Report of the State botanist 1900. *Annual Report of the New York State Museum of Natural History* 54: 131-195.
- PECK C.H., 1902b — New species of fungi. *Bulletin of the Torrey Botanical Club* 29: 69-74.
- PECK C.H., 1903 — Report of the State botanist 1902. *Bulletin of the New York State Museum* 67: 3-194.
- PECK C.H., 1904a — New species of fungi. *Bulletin of the Torrey Botanical Club* 31: 177-182.
- PECK C.H., 1904b — Species not before reported. *Bulletin of the New York State Museum* 75: 12-22.
- PECK C.H., 1906a — New species of fungi. *Bulletin of the Torrey Botanical Club* 33: 213-221.
- PECK C.H., 1906b — Edible fungi. *Bulletin of the New York State Museum* 105: 36-44.
- PECK C.H., 1907a — Edible fungi. *Bulletin of the New York State Museum* 116: 38-45.
- PECK C.H., 1907b — New York species of *Russula*. *Bulletin of the New York State Museum of Natural History* 116: 67-98.
- PECK C.H., 1910 — New species of extralimital fungi. *Bulletin of the New York State Museum* 139: 42-48.
- PECK C.H., 1911 — New species and varieties of extralimital fungi. *Bulletin of the New York State Museum* 150: 50-65.
- PECK C.H., 1913 — Species not before reported. *Bulletin of the New York State Museum* 167: 23-33.
- PEGLER D.N. & R. SINGER, 1980 — New taxa of *Russula* from the Lesser Antilles. *Mycotaxon* 12: 92-96.

- PETERSEN R.H., 1980 — Charles Horton Peck. In: Vogelenzang L. (ed.), Annual Report of the State Botanist 1868-1912. Leiden, Boerhaave Press, pp. 1-25.
- QUÉLET L., 1881 — Quelques espèces critiques ou nouvelles de la flore mycologique de France. *Compte Rendu de l'Association Française Pour l'Avancement des Sciences* 9: 661-675.
- ROMAGNESI H., 1967 — *Les Russules d'Europe et d'Afrique du Nord*. Paris, Bordas, 998 p.
- ROMAGNESI H., 1985 — *Les Russules d'Europe et d'Afrique du Nord*. Reprint with supplement. Vaduz, J. Cramer, 1030 p.
- ROMAGNESI H., 1987 — Status et noms nouveaux pour les taxa infragénériques dans le genre *Russula*. *Documents Mycologiques* 18: 39-40.
- SARNARI M., 1998 — *Monografia illustrata del Genere Russula in Europa*, Vol. 1. Vicenza, A.M.B. Fondazione centro studi micologici, 799 p.
- SARNARI M., 2005 — *Monografia illustrata del Genere Russula in Europa*, Vol. 2. Trento, Fondazione Centro Studi Micologici, 768 p.
- SHAFFER R.L., 1970 — Notes on the subsection *Crassotunicatae* and other species of *Russula*. *Lloydia* 33: 49-96.
- SHAFFER R.L., 1972 — North American *Russulas* of the subsection *Foetentinae*. *Mycologia* 64 (5): 1008-1053.
- SINGER R., 1926 — Monographie der Gattung *Russula*. *Hedwigia* 66: 163-260.
- SINGER R., 1932 — Monographie der Gattung *Russula*. *Beihefte zum Botanischen Centralblatt* 49 (2): 205-380.
- SINGER R., 1935 — Sur la classification des Russules. *Bulletin de la Société Mycologique France* 51: 281-304.
- SINGER R., 1938 — Contribution à l'étude des Russules (1). 3. Quelques Russules américaines et asiatiques. *Bulletin de la Société Mycologique France* 54: 132-177.
- SINGER R., 1939 — Contribution à l'étude des Russules 4. Quelques Russules américaines et asiatiques. *Bulletin de la Société Mycologique France* 55: 226-283.
- SINGER R., 1942a — Das system der Agaricales. II. *Annales Mycologici* 40: 1-108.
- SINGER R., 1942b — Type studies on Basidiomycetes. I. *Mycologia* 34: 64-93.
- SINGER R., 1943 — Type studies on Basidiomycetes II. *Mycologia* 35: 142-163.
- SINGER R., 1947 — Type studies on Basidiomycetes III. *Mycologia* 39: 171-179.
- SINGER R., 1951 — The Agaricales (mushrooms) in modern taxonomy. *Lilloa* 22: 5-832.
- SINGER R., 1958 — New and interesting species of Basidiomycetes V. *Sydowia* 11: 141-272.
- SINGER R., 1975 — *The Agaricales in Modern Taxonomy*. 3rd ed. Vaduz, Gartner Verlag, 912 p.
- SINGER R., 1986 — *The Agaricales in modern taxonomy*. 4rd ed. Koeltz Scientific Books, Königstein, 981 p.
- SINGER R., ARAUJO I. & IVORY M.H., 1983 — The ectotrophically mycorrhizal fungi of the neotropical lowlands, especially central Amazonia. Litter decomposition and ectomycorrhiza in Amazonian forests 2. Part. 2. *Beihefte Nova Hedwigia* 77: 1-352.
- THIERS B., (continuously updated) Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium [online]. Available at <http://sweetgum.nybg.org/ih/>.
- WHITE V.S., 1902 — Some Mt. Desert fungi. *Bulletin of the Torrey Botanical Club* 29: 552-562.
- ZHANG J.B., LI J.W., LI F. & QIU L.H., 2017 — *Russula dinghuensis* sp. nov. and *R. subpallidirosea* sp. nov., two new species from Southern China supported by morphological and molecular evidence. *Cryptogamie, Mycologie* 38 (2): 1-13.

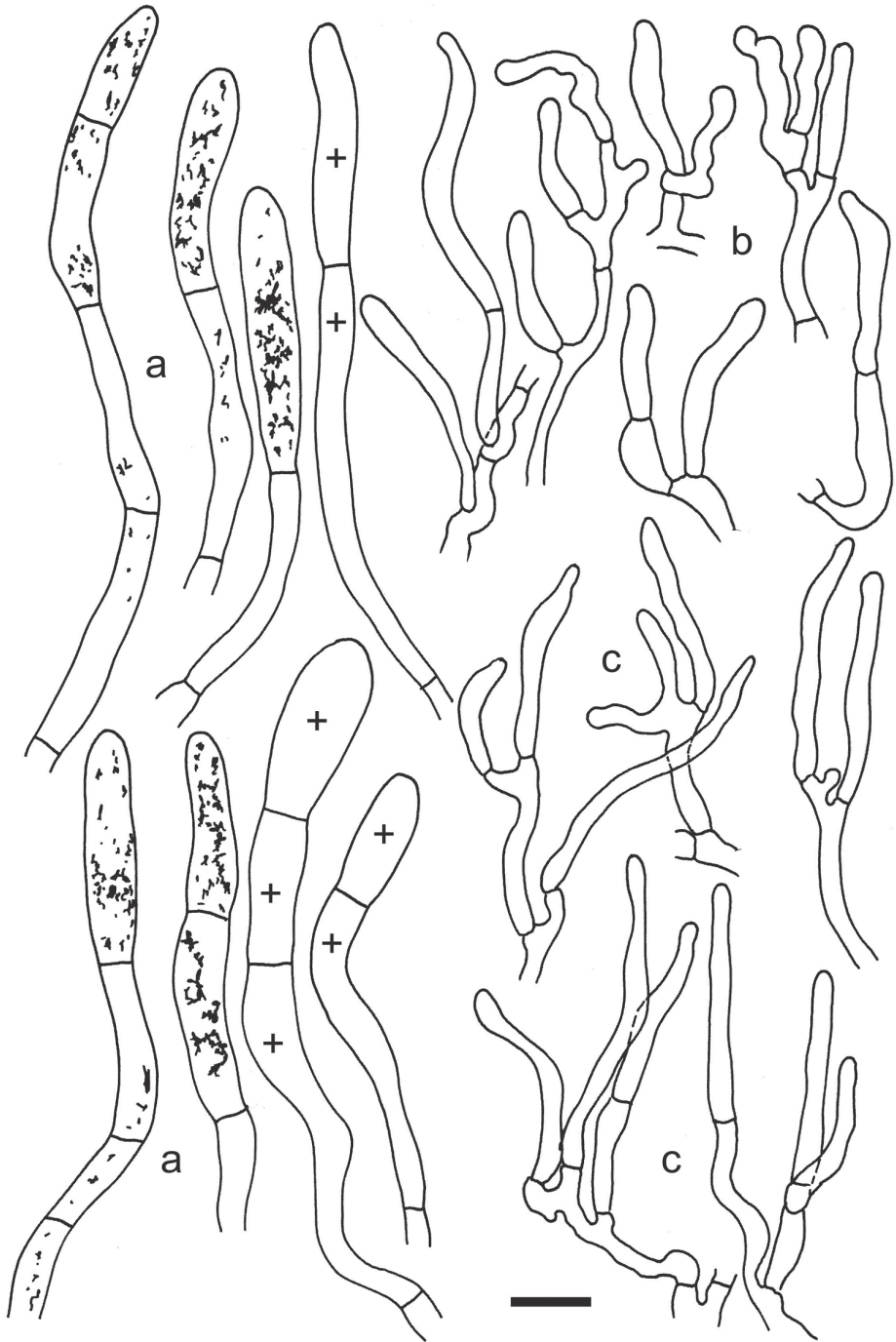


Fig. 1. *Russula abietina* (lectotype). **a.** Pileocystidia near the pileus margin. **b.** Hyphal terminations near the pileus center. **c.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red, but some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m.

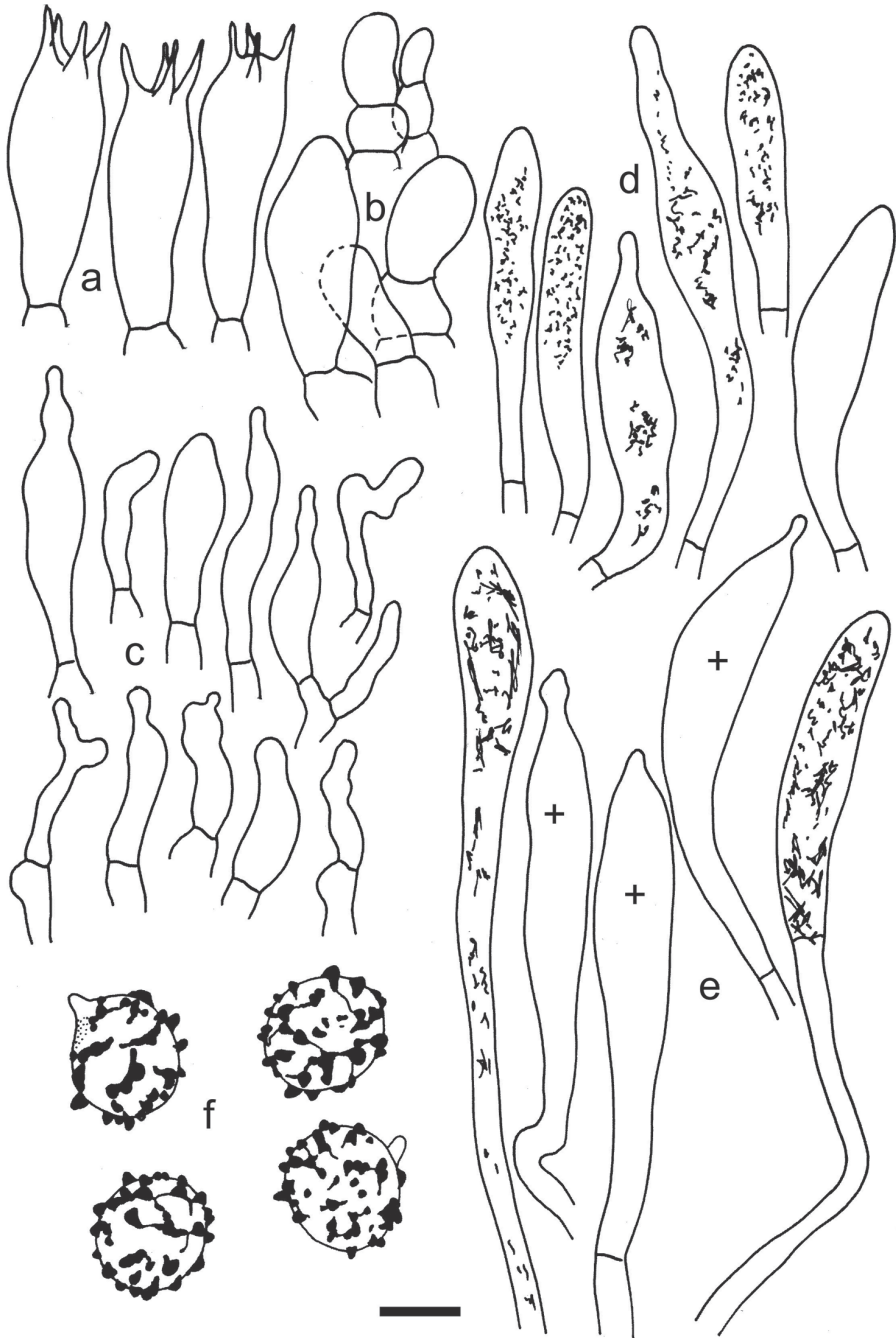


Fig. 2. *Russula abietina* (lectotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on edges of the lamellae. **e.** Hymenial cystidia on sides of the lamellae. **f.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μm , but only 5 μm for spores.

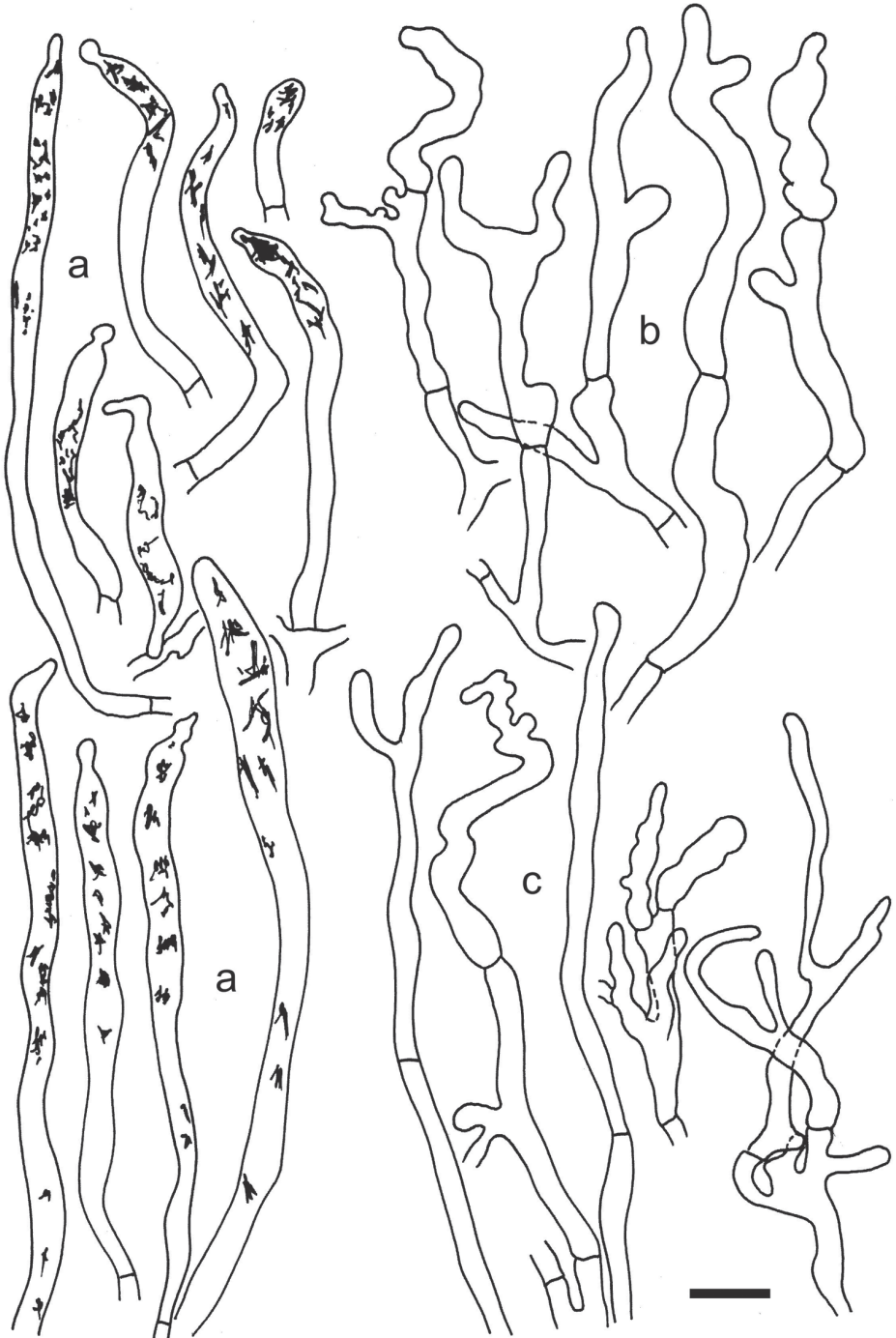


Fig. 3. *Russula aeruginascens* (holotype). **a.** Pileocystidia near the pileus margin. **b.** Hyphal terminations near the pileus center. **c.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

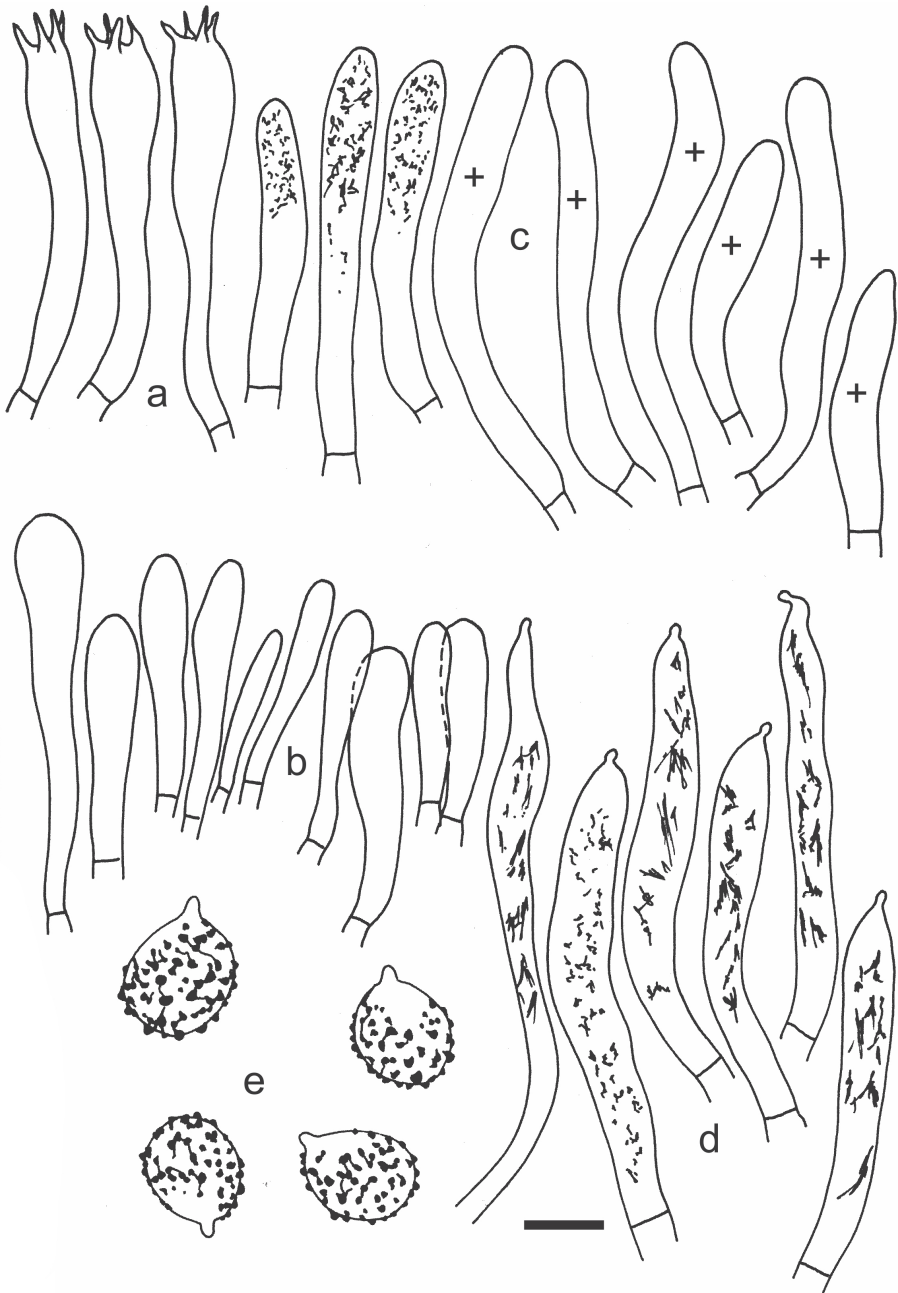


Fig. 4. *Russula aeruginascens* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Hymenial cystidia on edges of the lamellae. **d.** Hymenial cystidia on sides of the lamellae. **e.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μm , but only 5 μm for spores.

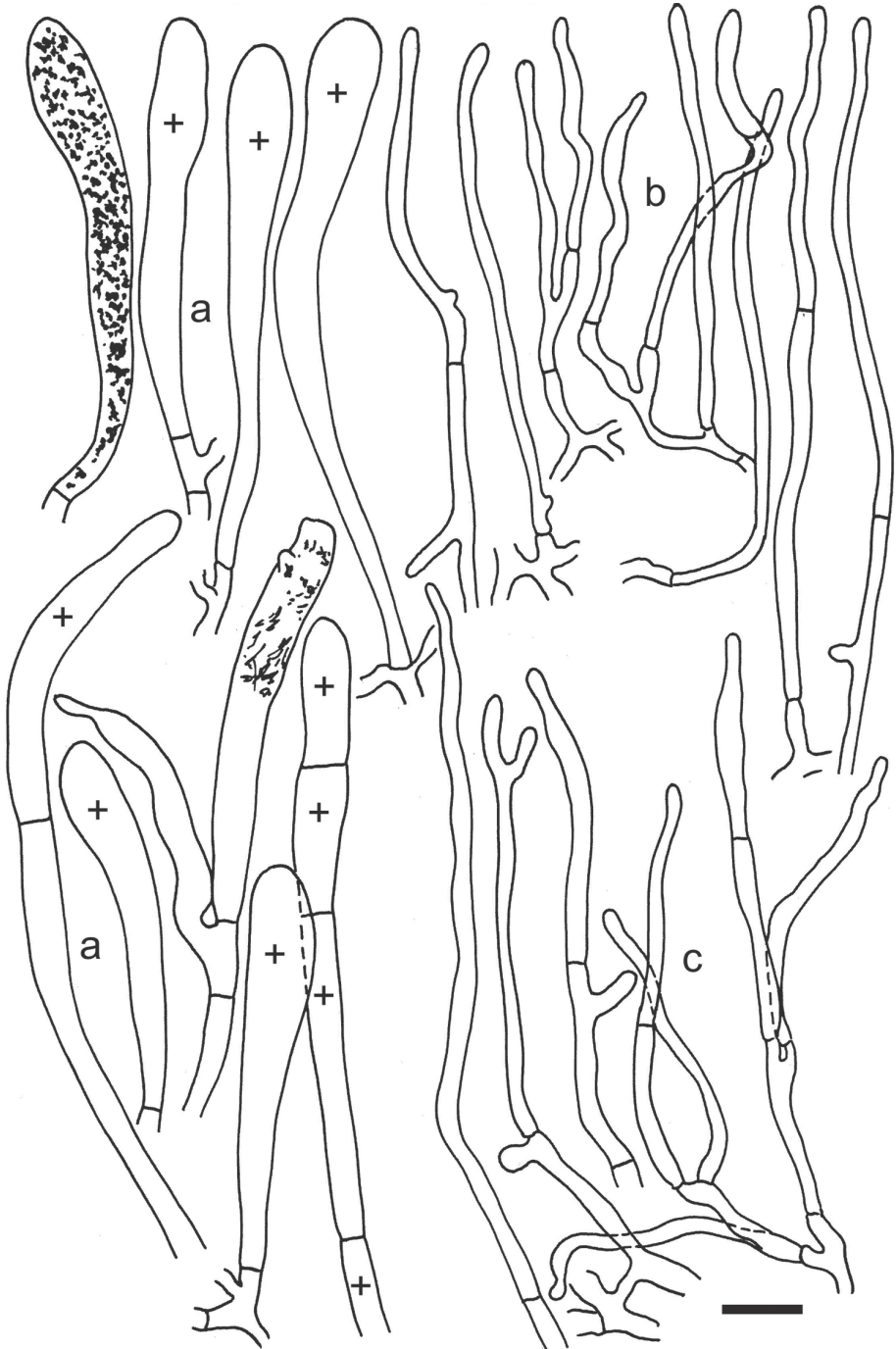


Fig. 5. *Russula albella* (holotype). **a.** Pileocystidia near the pileus margin. **b.** Hyphal terminations near the pileus center. **c.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red, but some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m.

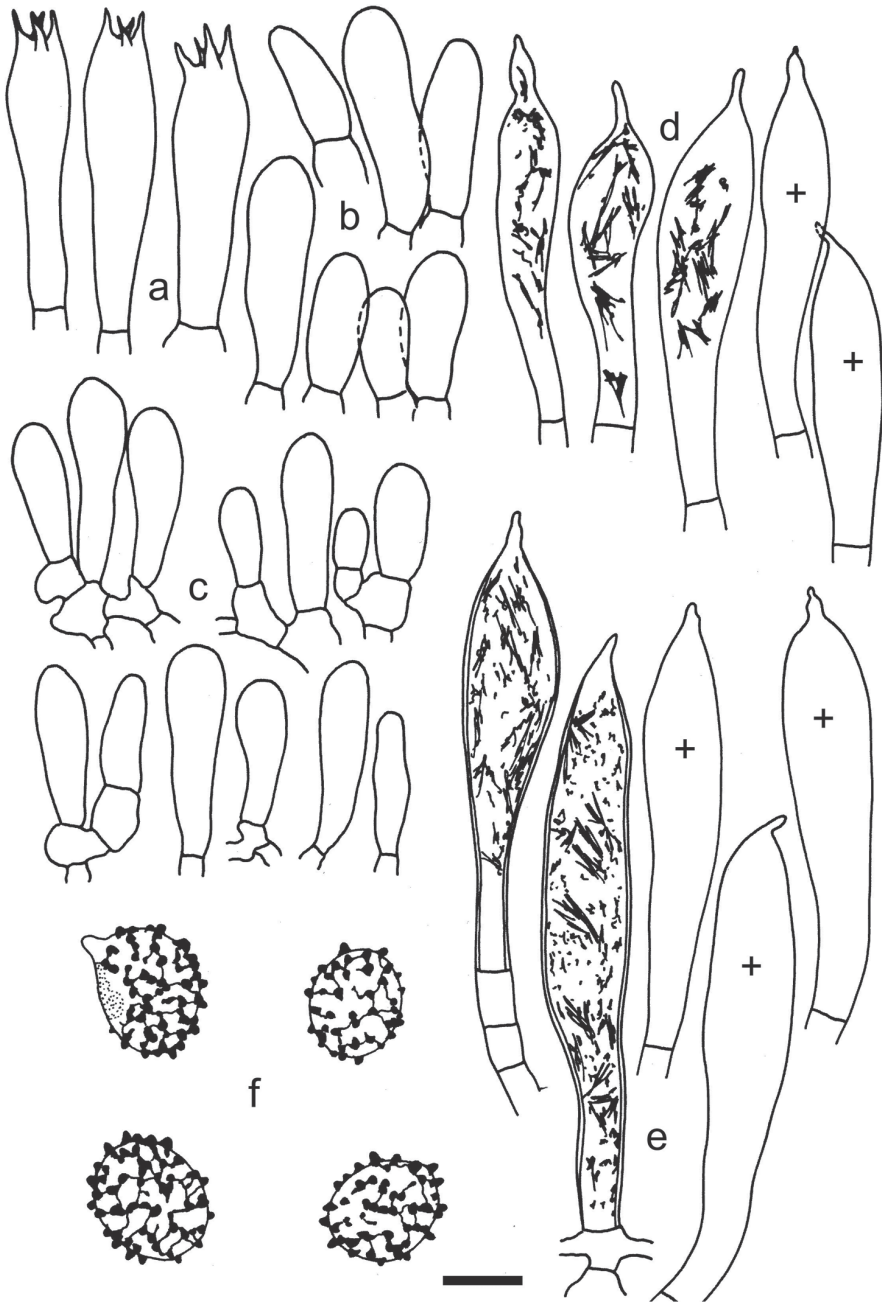


Fig. 6. *Russula albella* (holotype). a. Basidia. b. Basidiola. c. Marginal cells on edges of the lamellae. d. Hymenial cystidia on edges of the lamellae. e. Hymenial cystidia on sides of the lamellae. f. Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m, but only 5 μ m for spores.

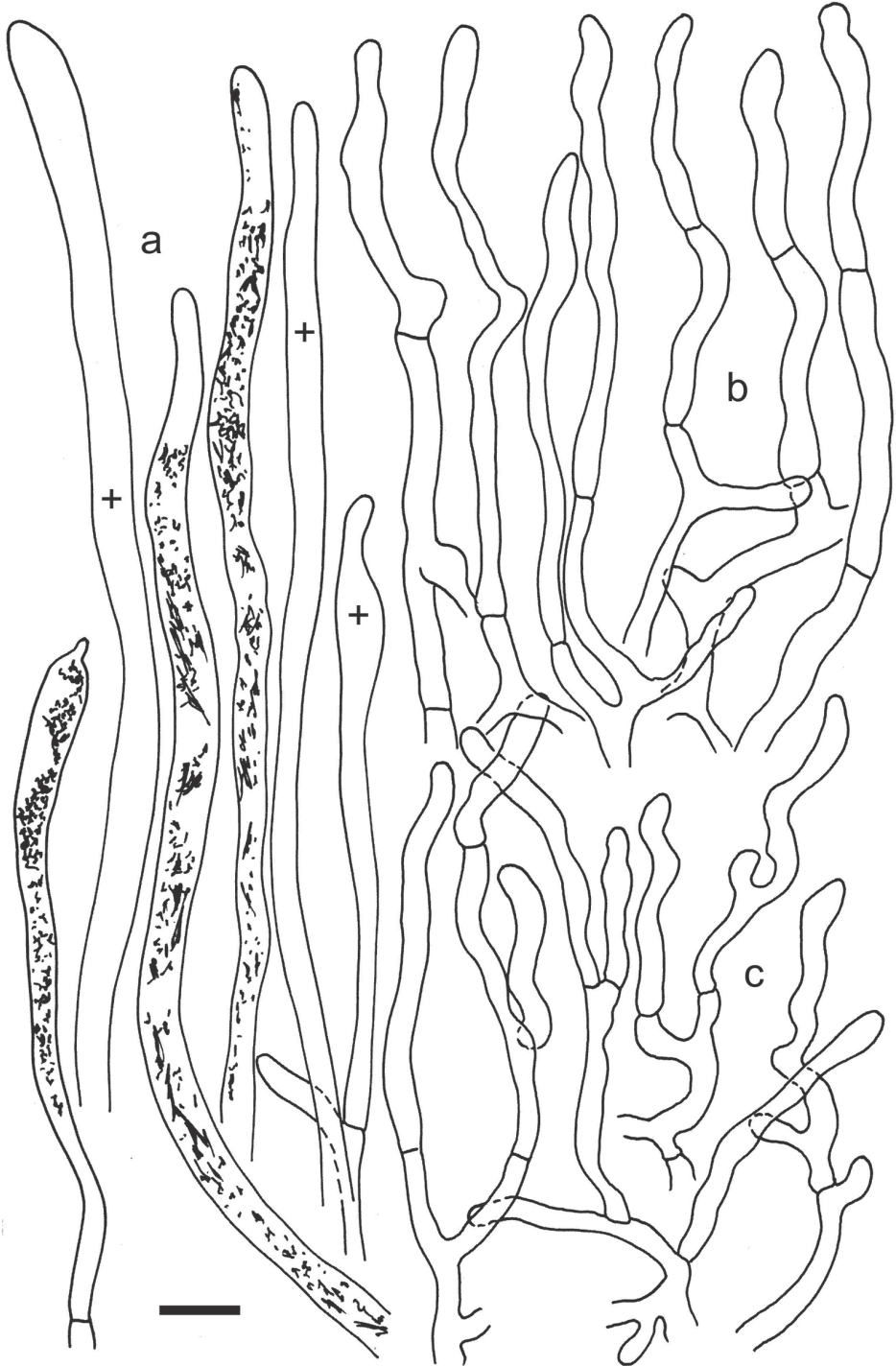


Fig. 7. *Russula albidula* (holotype). **a.** Pileocystidia near the pileus margin. **b.** Hyphal terminations near the pileus center. **c.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red, but some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m.

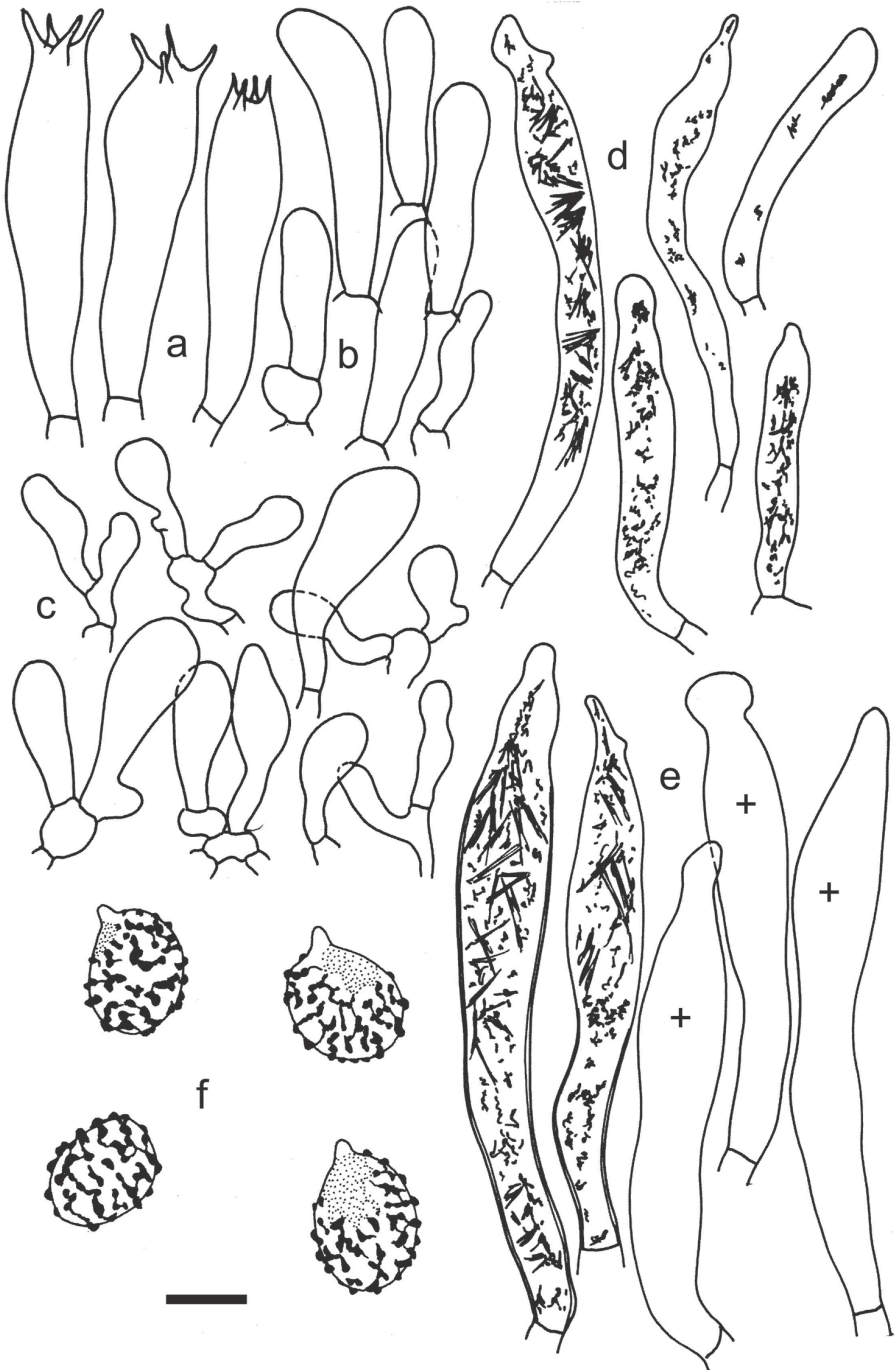


Fig. 8. *Russula albidula* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on edges of the lamellae. **e.** Hymenial cystidia on sides of the lamellae. **f.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μm , but only 5 μm for spores.

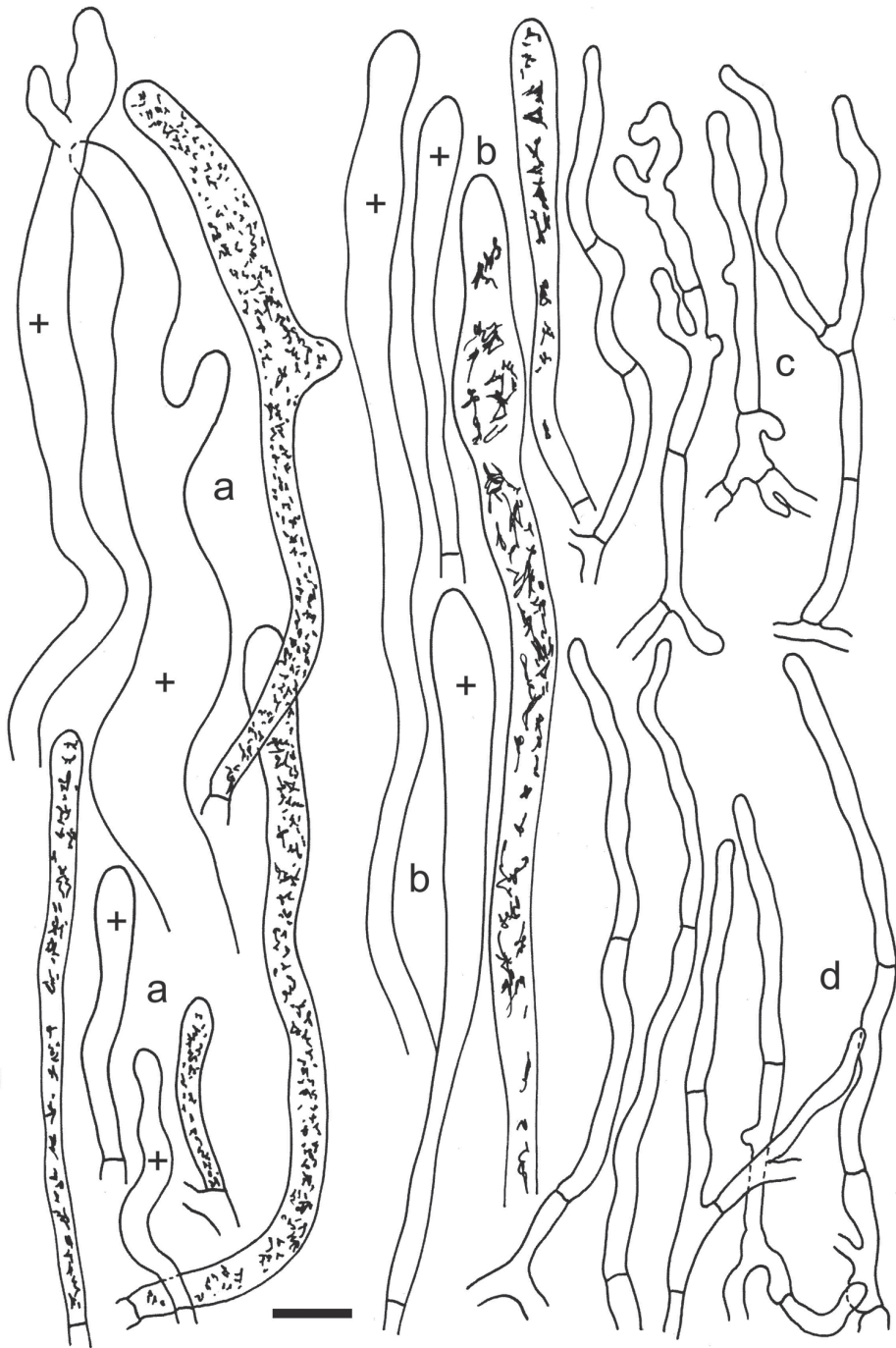


Fig. 9. *Russula anomala* (holotype). a. Pileocystidia near the pileus centre. b. Pileocystidia near the pileus margin. c. Hyphal terminations near the pileus center. d. Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red, but some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m.

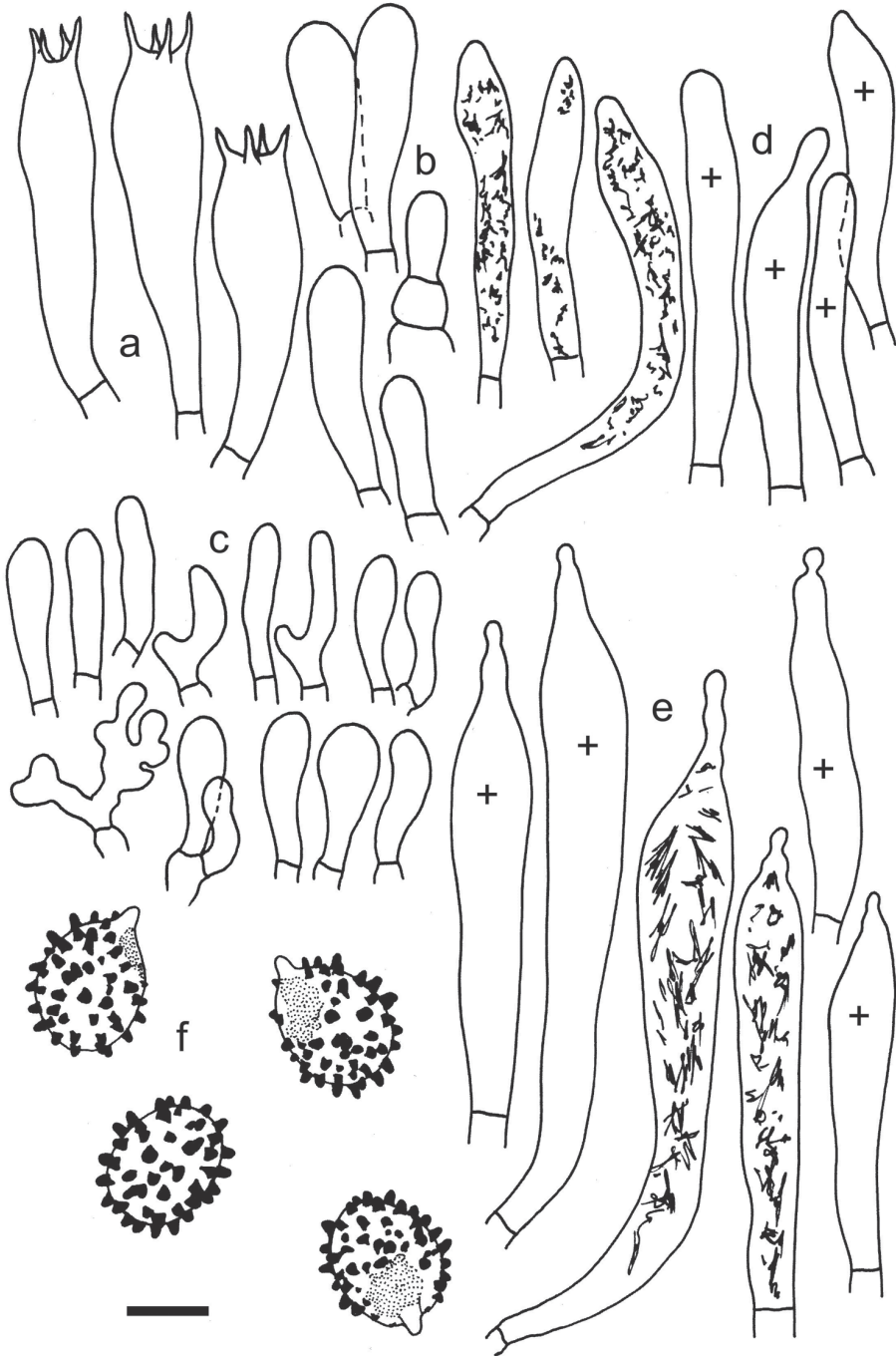


Fig. 10. *Russula anomala* (holotype). a. Basidia. b. Basidiola. c. Marginal cells on edges of the lamellae. d. Hymenial cystidia on edges of the lamellae. e. Hymenial cystidia on sides of the lamellae. f. Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m, but only 5 μ m for spores.

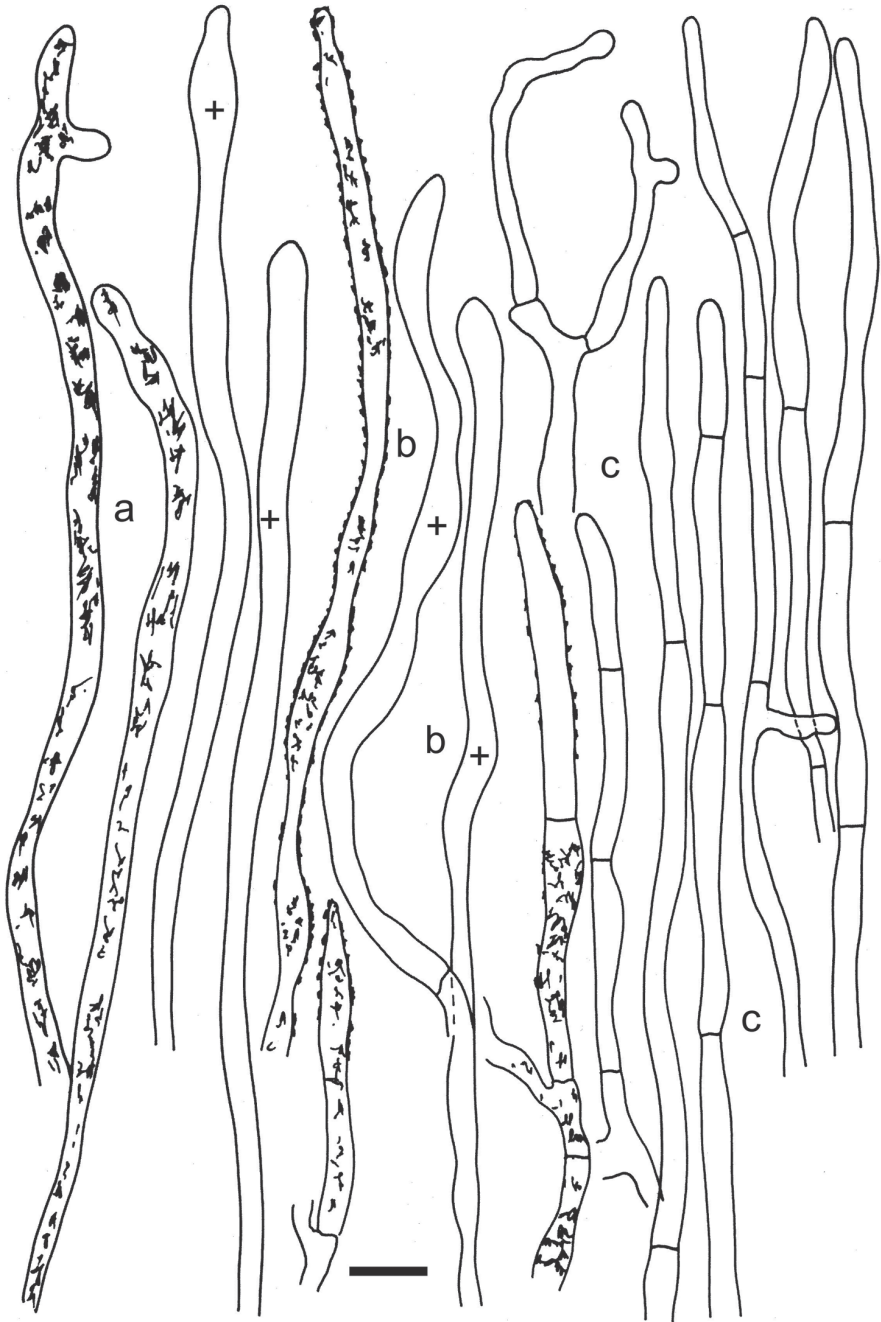


Fig. 11. *Russula ballouii* (holotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red, but some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m.

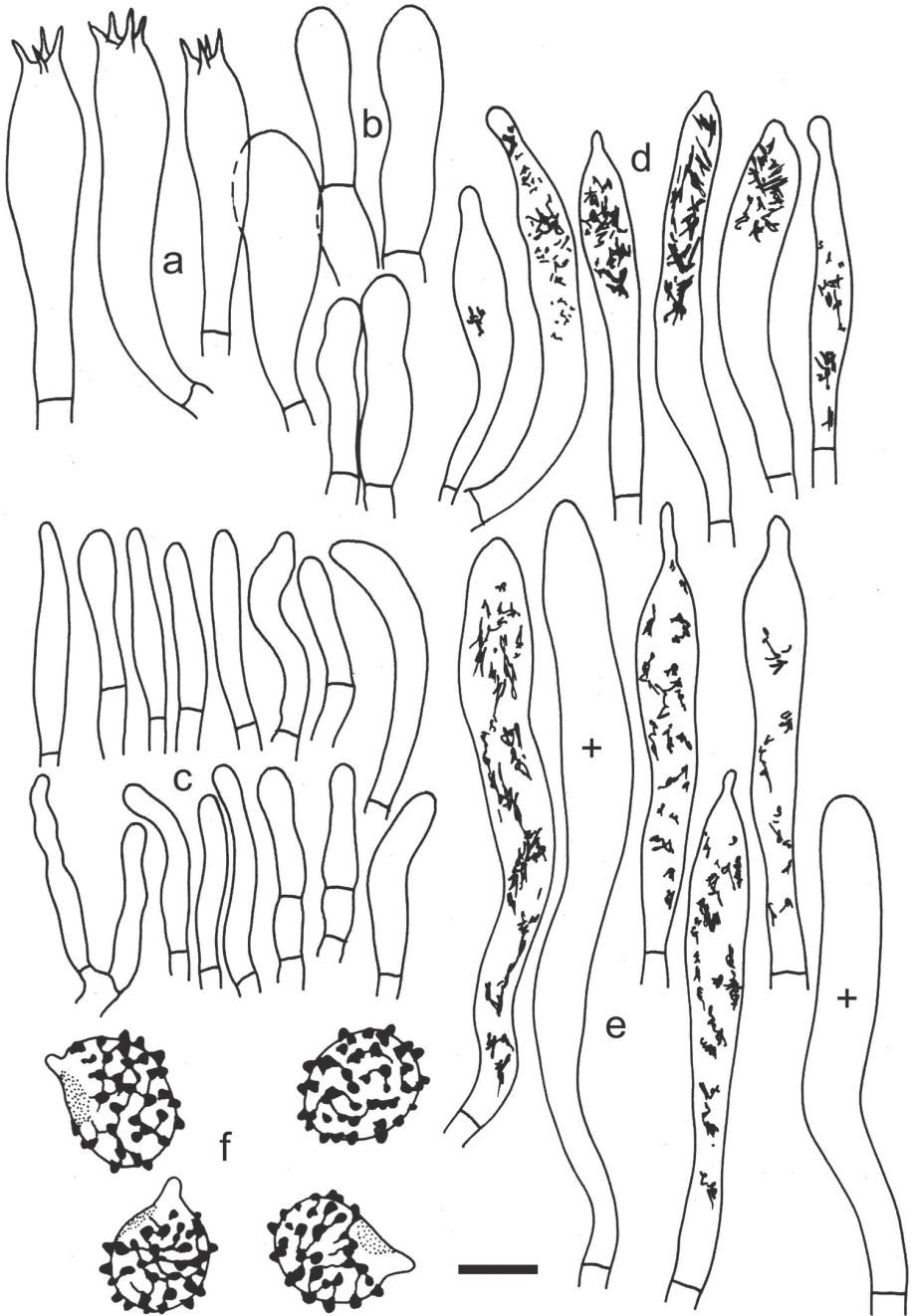


Fig. 12. *Russula ballouii* (holotype). a. Basidia. b. Basidiola. c. Marginal cells on edges of the lamellae. d. Hymenial cystidia on edges of the lamellae. e. Hymenial cystidia on sides of the lamellae. f. Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μm , but only 5 μm for spores.

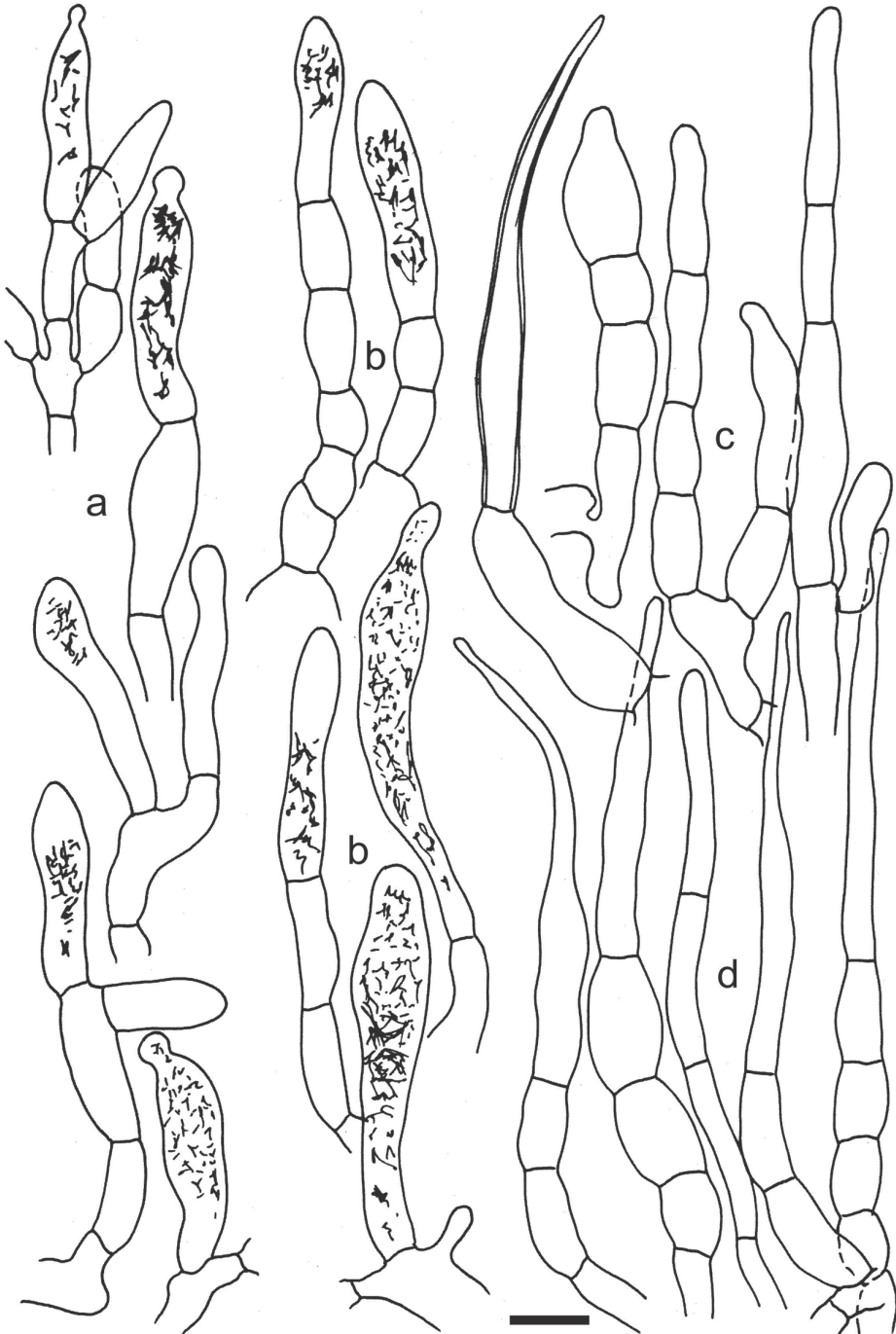


Fig. 13. *Russula basifurcata* (holotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

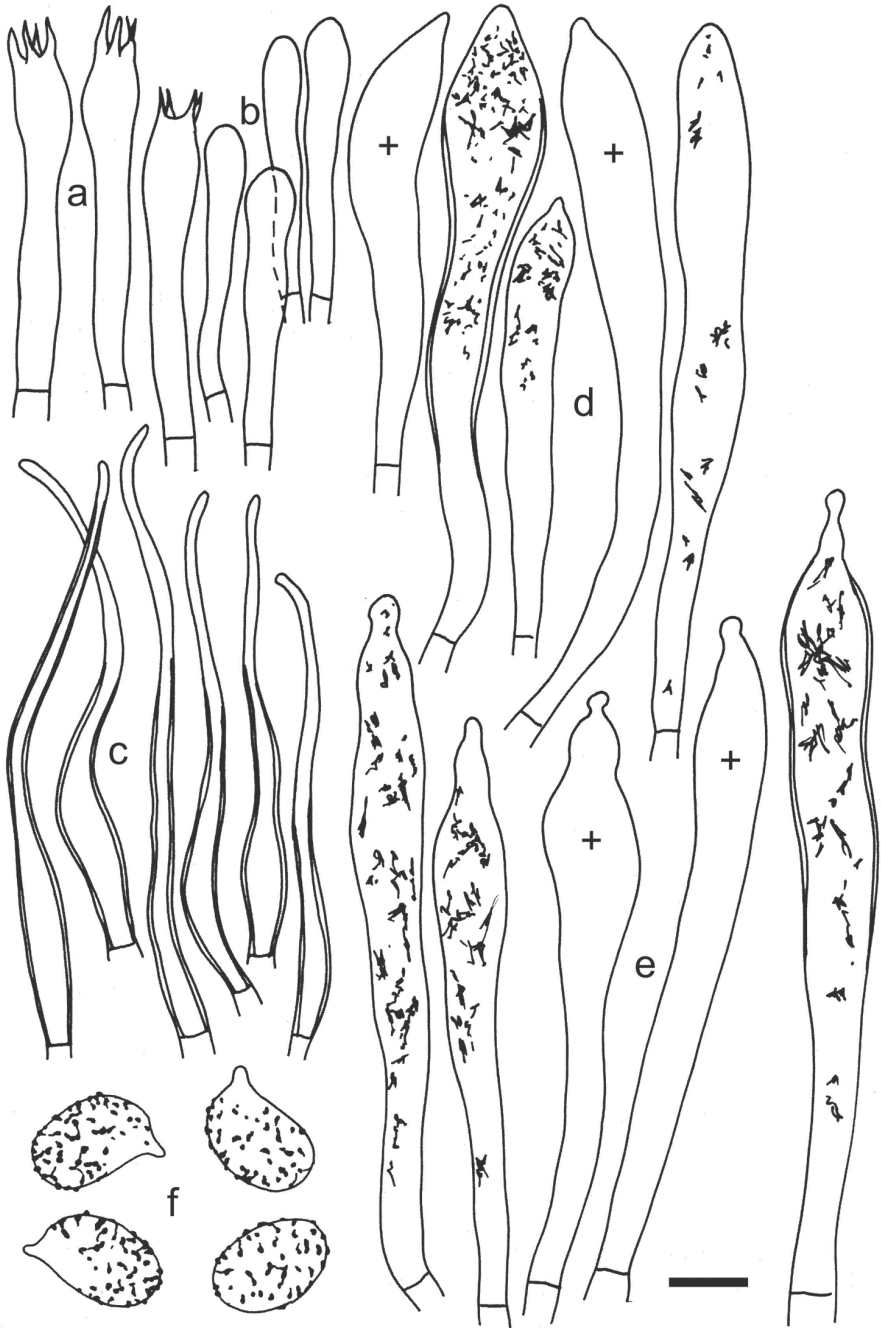


Fig. 14. *Russula basifurcata* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on edges of the lamellae. **e.** Hymenial cystidia on sides of the lamellae. **f.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μm , but only 5 μm for spores.

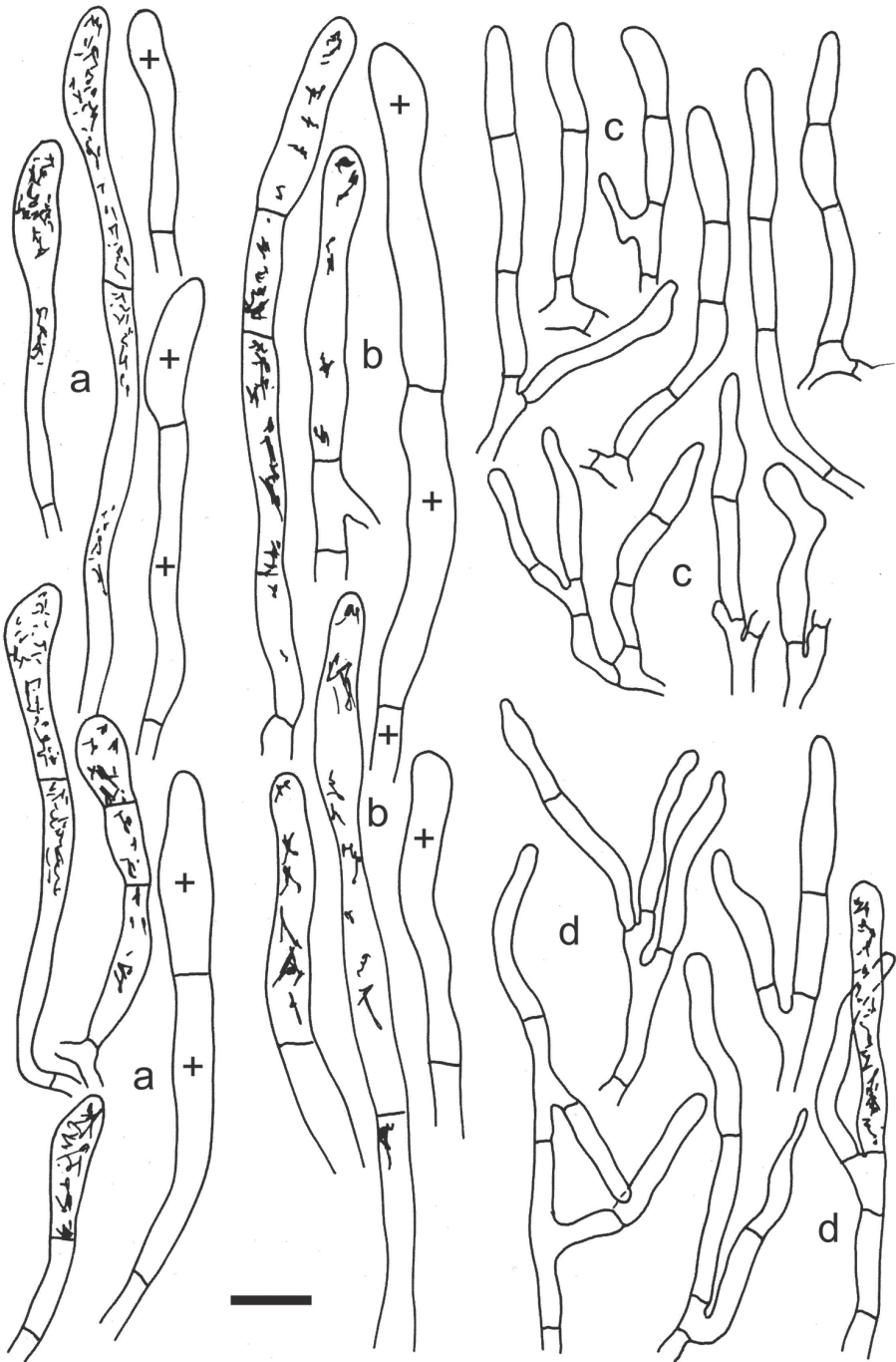


Fig. 15. *Russula blackfordiae* (holotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red, but some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m.

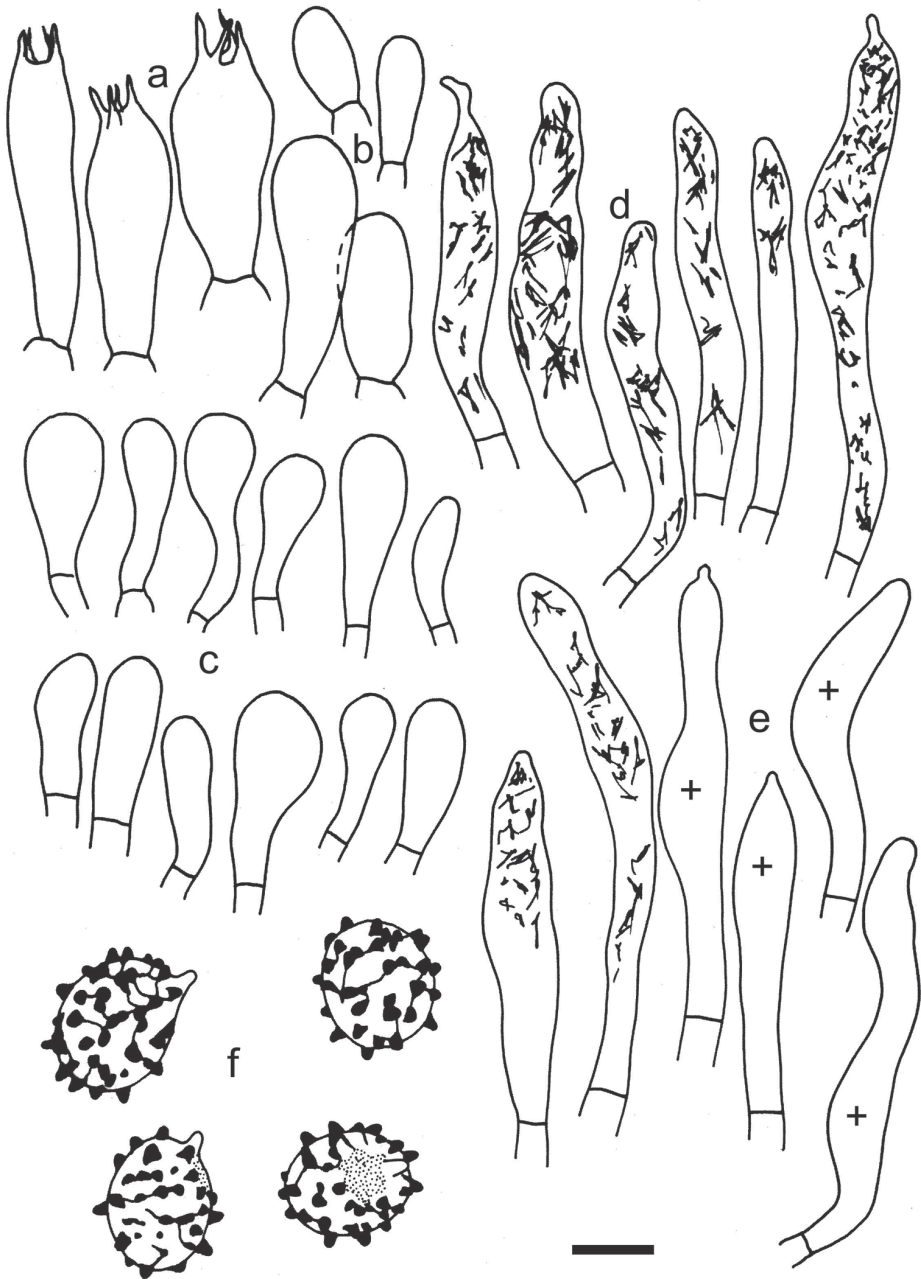


Fig. 16. *Russula blackfordiae* (holotype). a. Basidia. b. Basidiola. c. Marginal cells on edges of the lamellae. d. Hymenial cystidia on edges of the lamellae. e. Hymenial cystidia on sides of the lamellae. f. Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μm , but only 5 μm for spores.

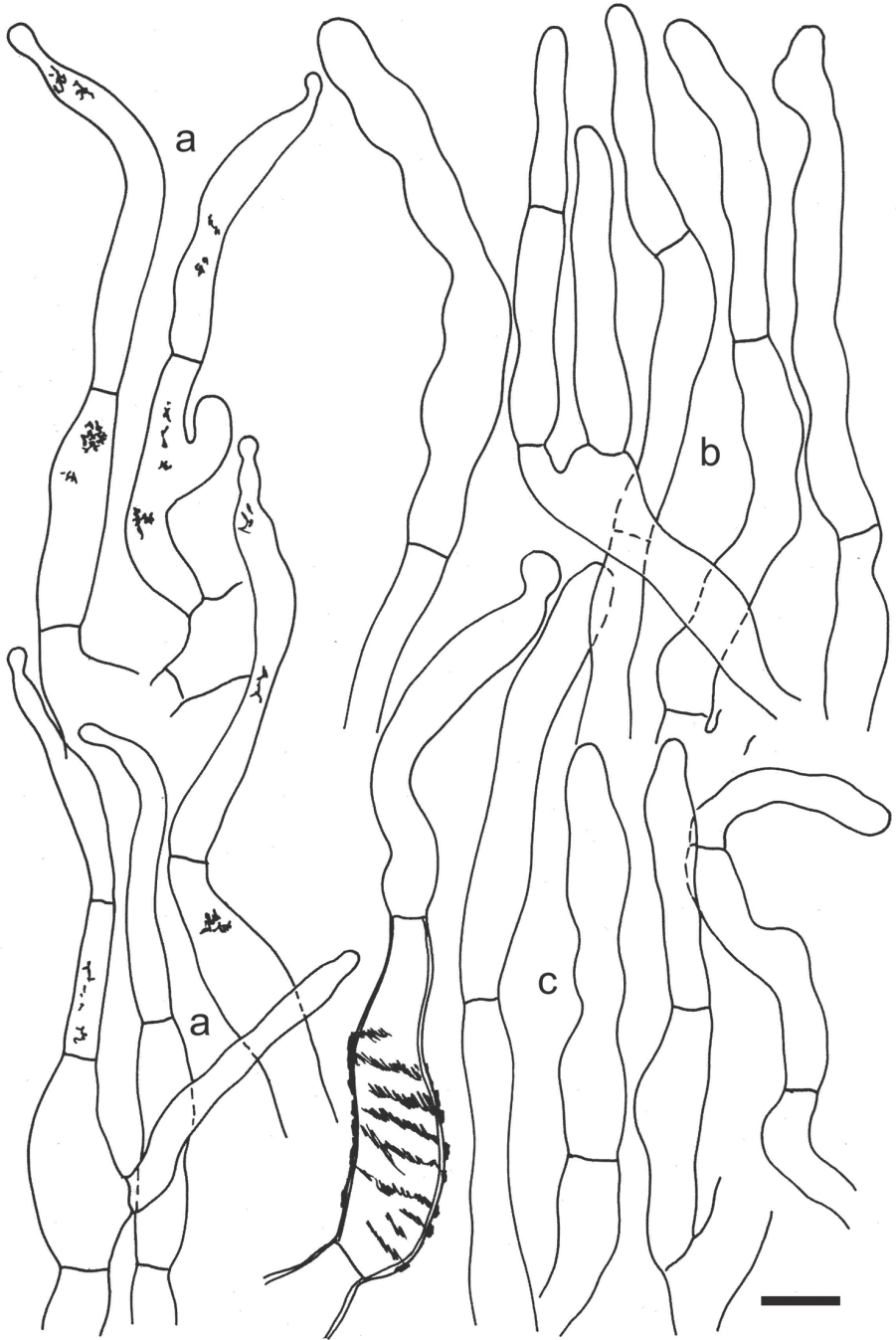


Fig. 17. *Russula compacta* (lectotype). **a.** Pileocystidia near the pileus margin. **b.** Hyphal terminations near the pileus center. **c.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

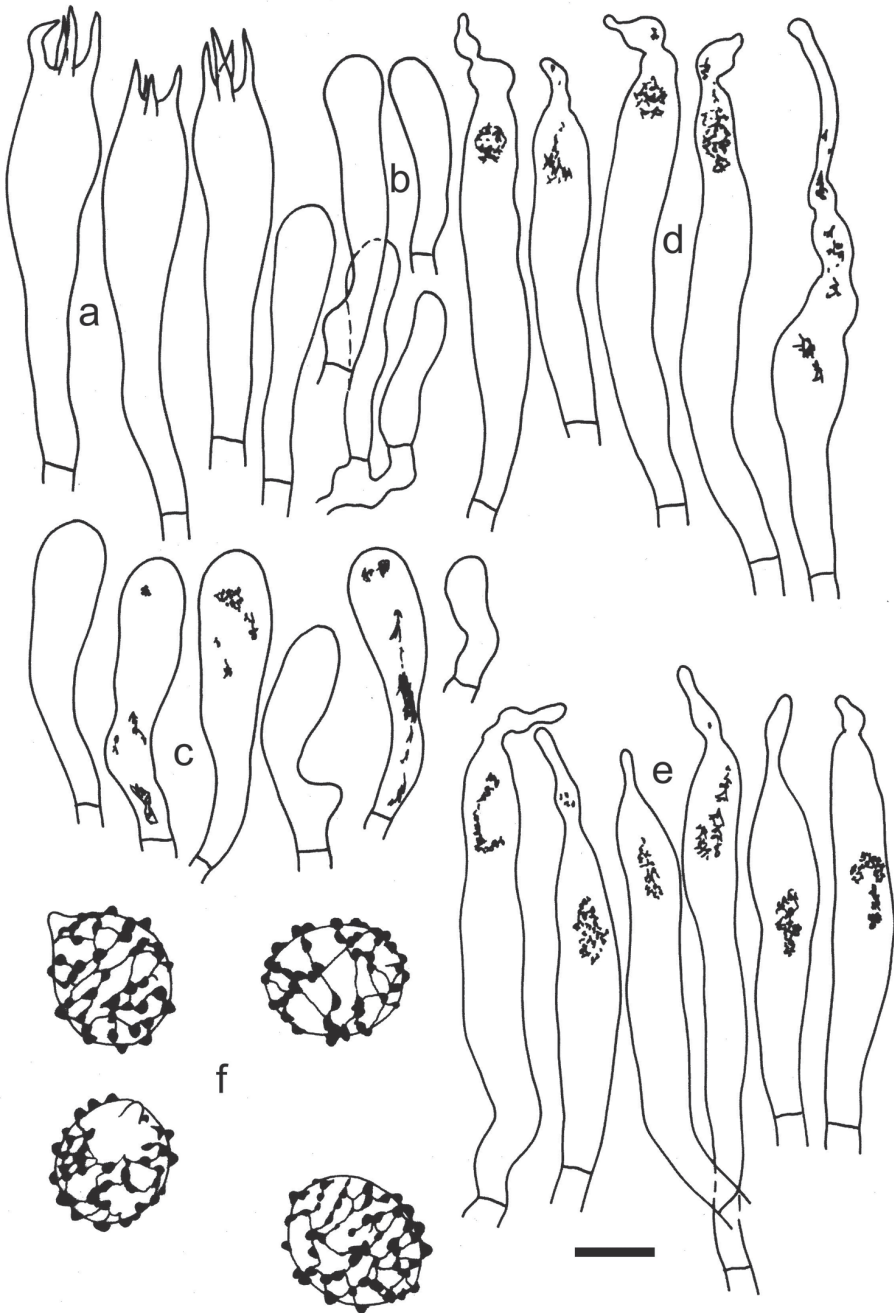


Fig. 18. *Russula compacta* (lectotype). a. Basidia. b. Basidiola. c. Marginal cells on edges of the lamellae. d. Hymenial cystidia on edges of the lamellae. e. Hymenial cystidia on sides of the lamellae. f. Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red. Scale bar = 10 μm , but only 5 μm for spores.

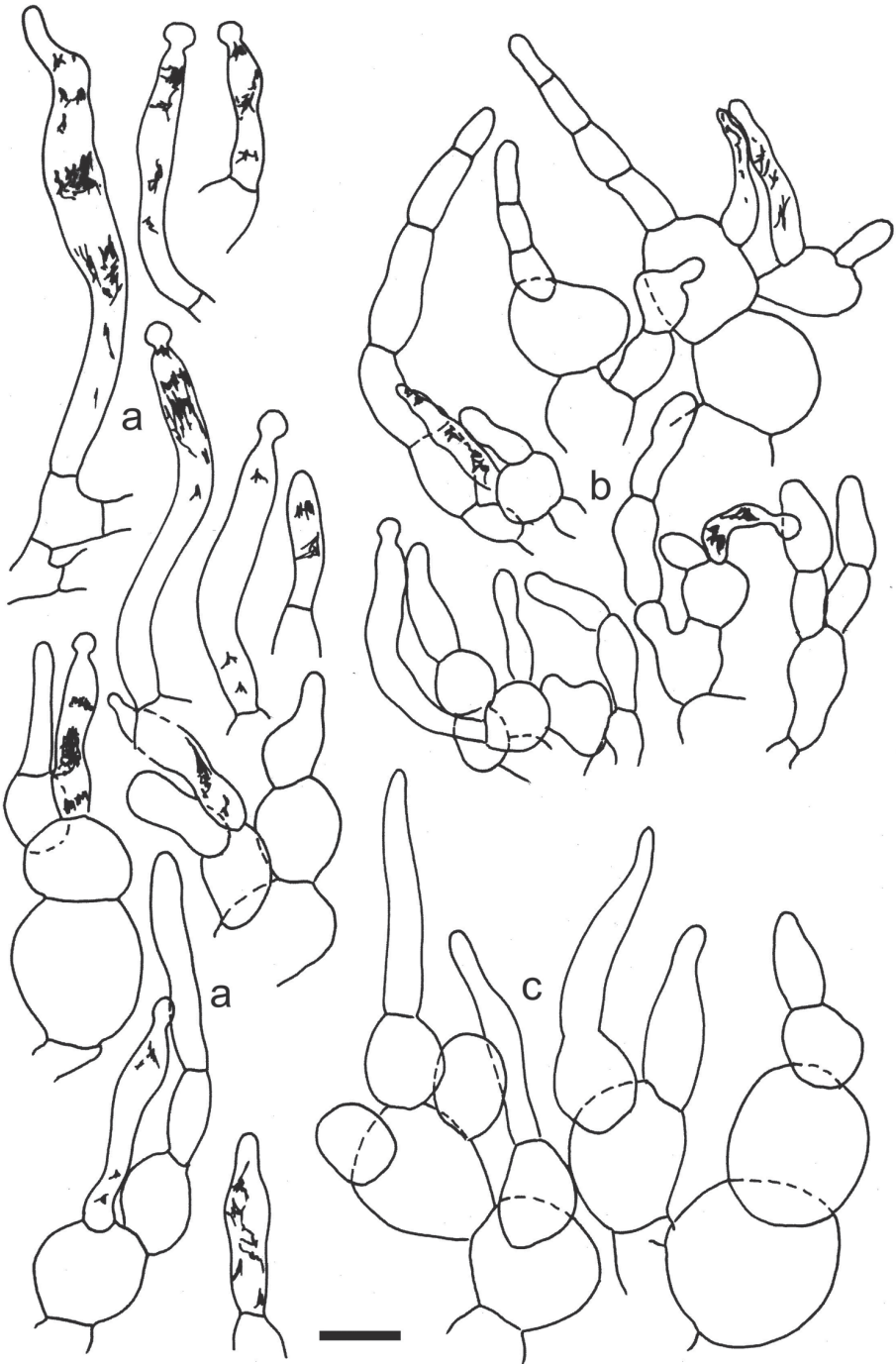


Fig. 19. *Russula crustosa* (holotype). a. Pileocystidia near the pileus margin. b. Hyphal terminations and pileocystidia near the pileus center. c. Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

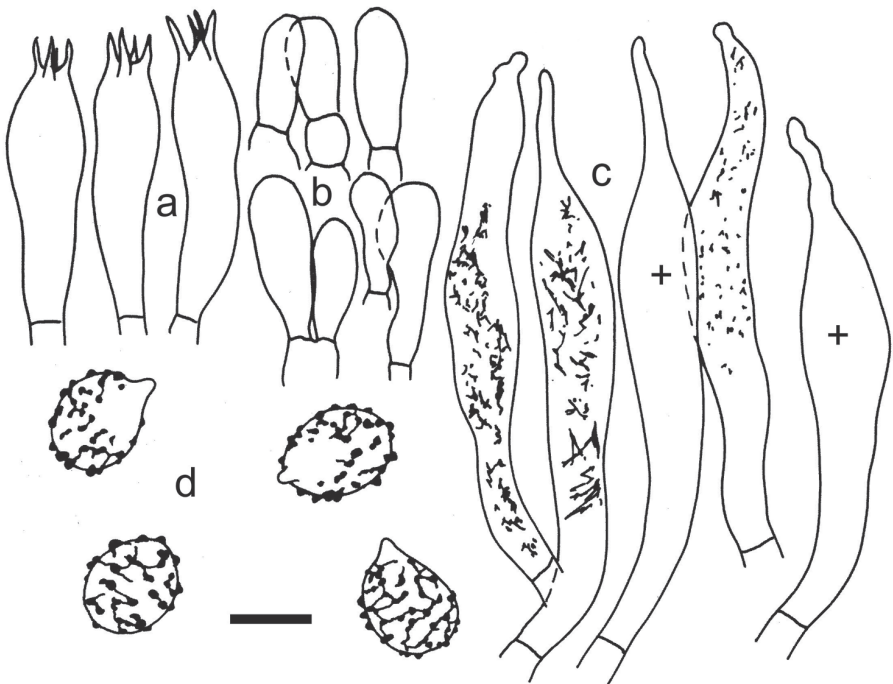


Fig. 20. *Russula crustosa* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Hymenial cystidia on sides of the lamellae. **d.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μm , but only 5 μm for spores.

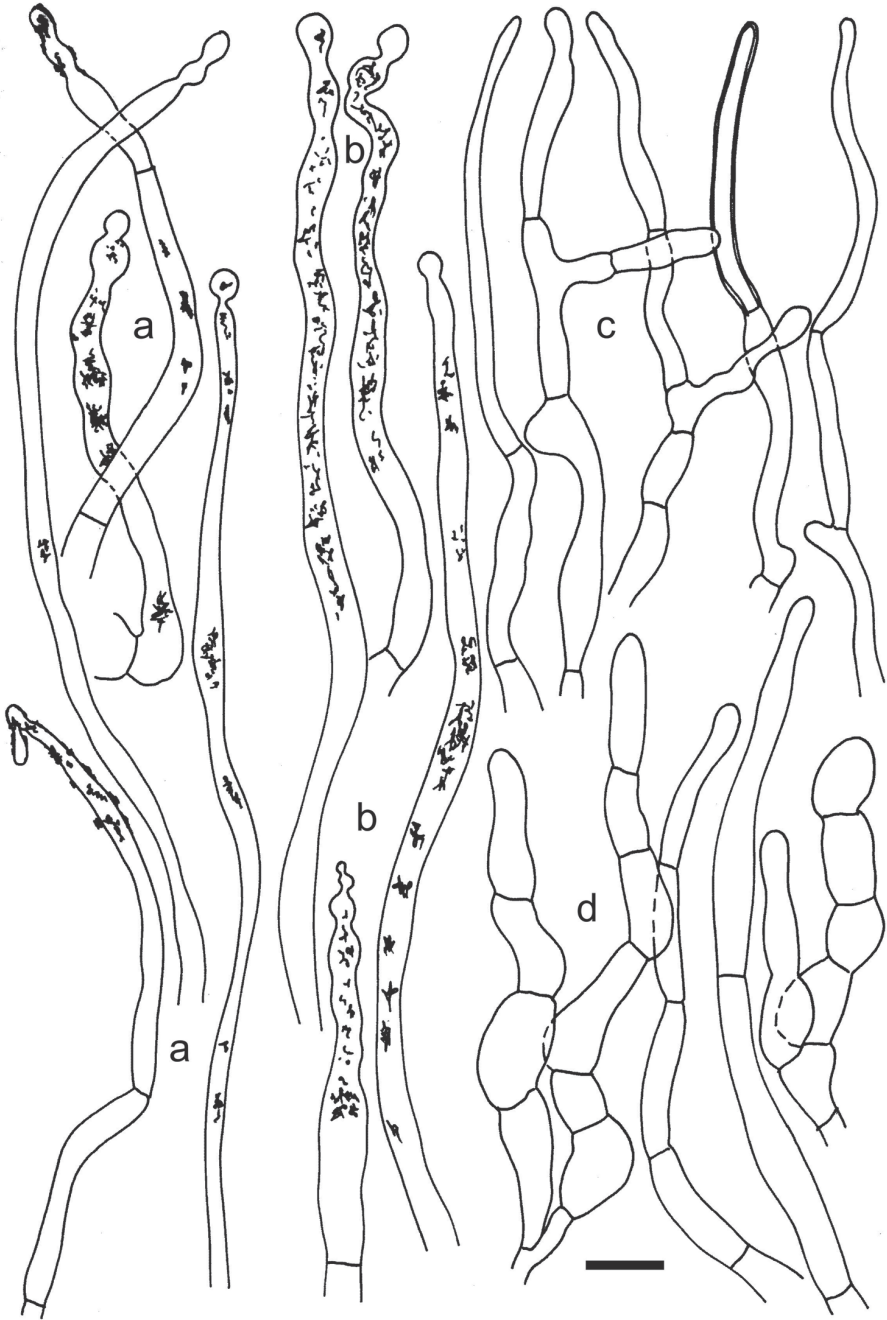


Fig. 21. *Russula earlei* (holotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

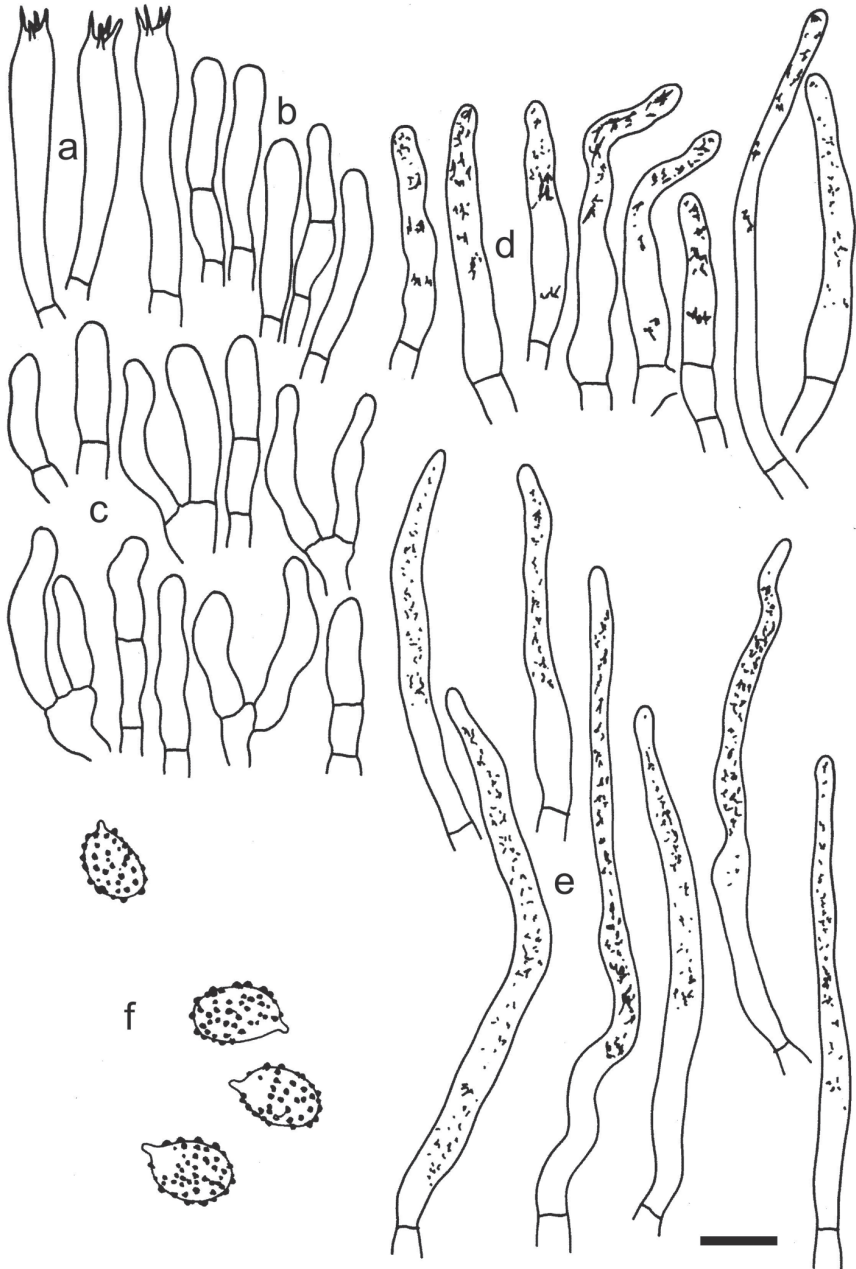


Fig. 22. *Russula earlei* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on edges of the lamellae. **e.** Hymenial cystidia on sides of the lamellae. **f.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red. Scale bar = 10 μ m, but only 5 μ m for spores.

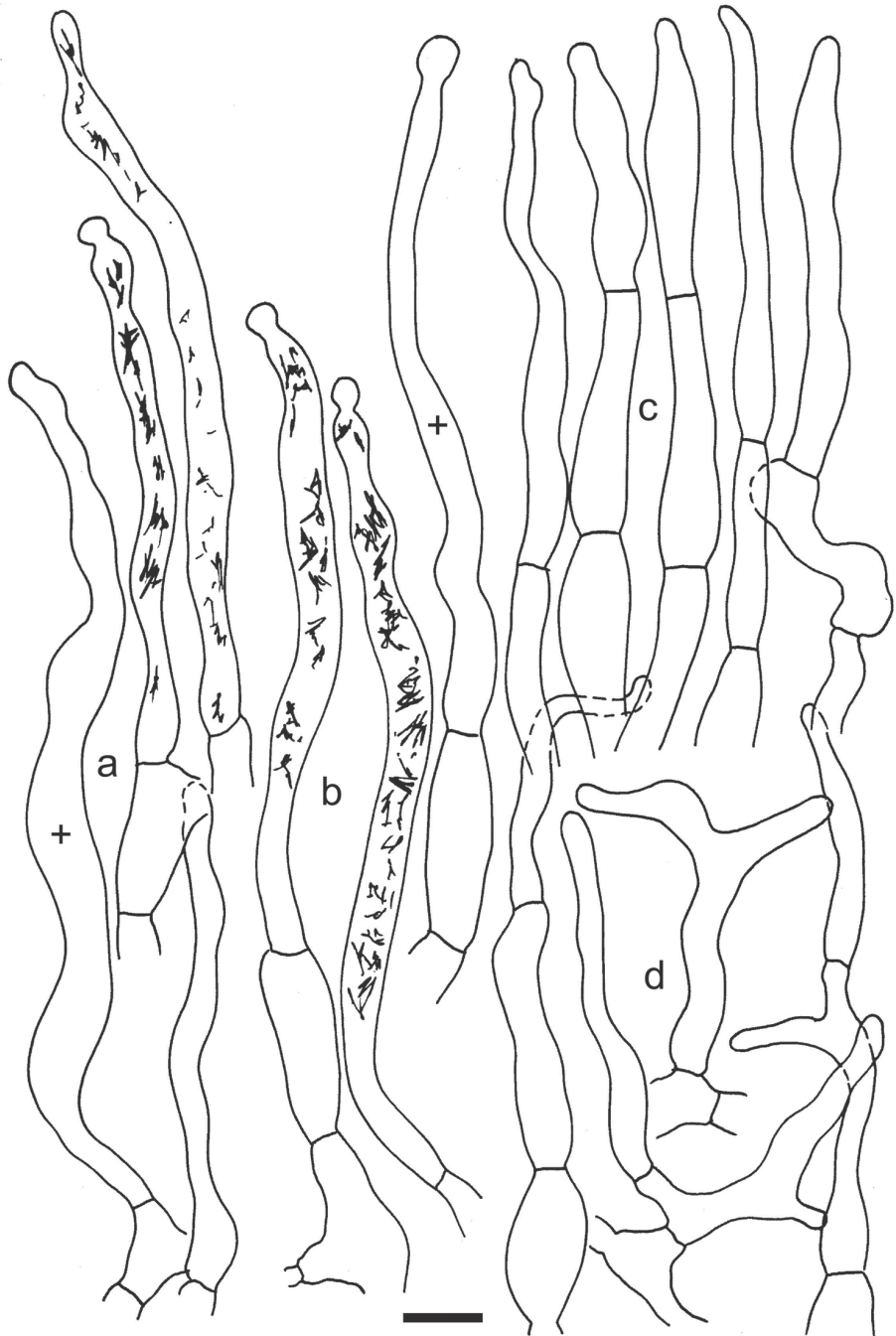


Fig. 23. *Russula eccentrica* (holotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red, but some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m.

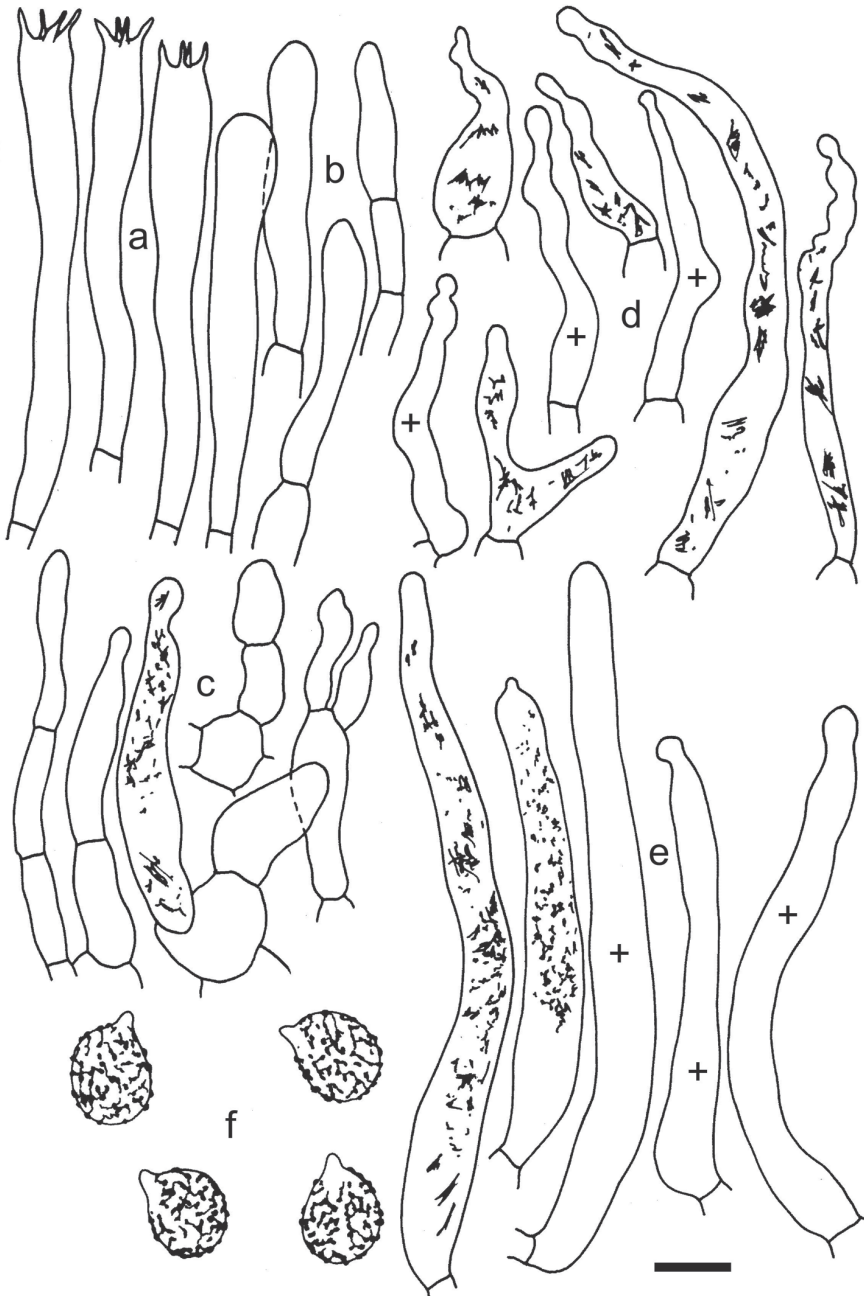


Fig. 24. *Russula eccentrica* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on edges of the lamellae. **e.** Hymenial cystidia on sides of the lamellae. **f.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μm , but only 5 μm for spores.

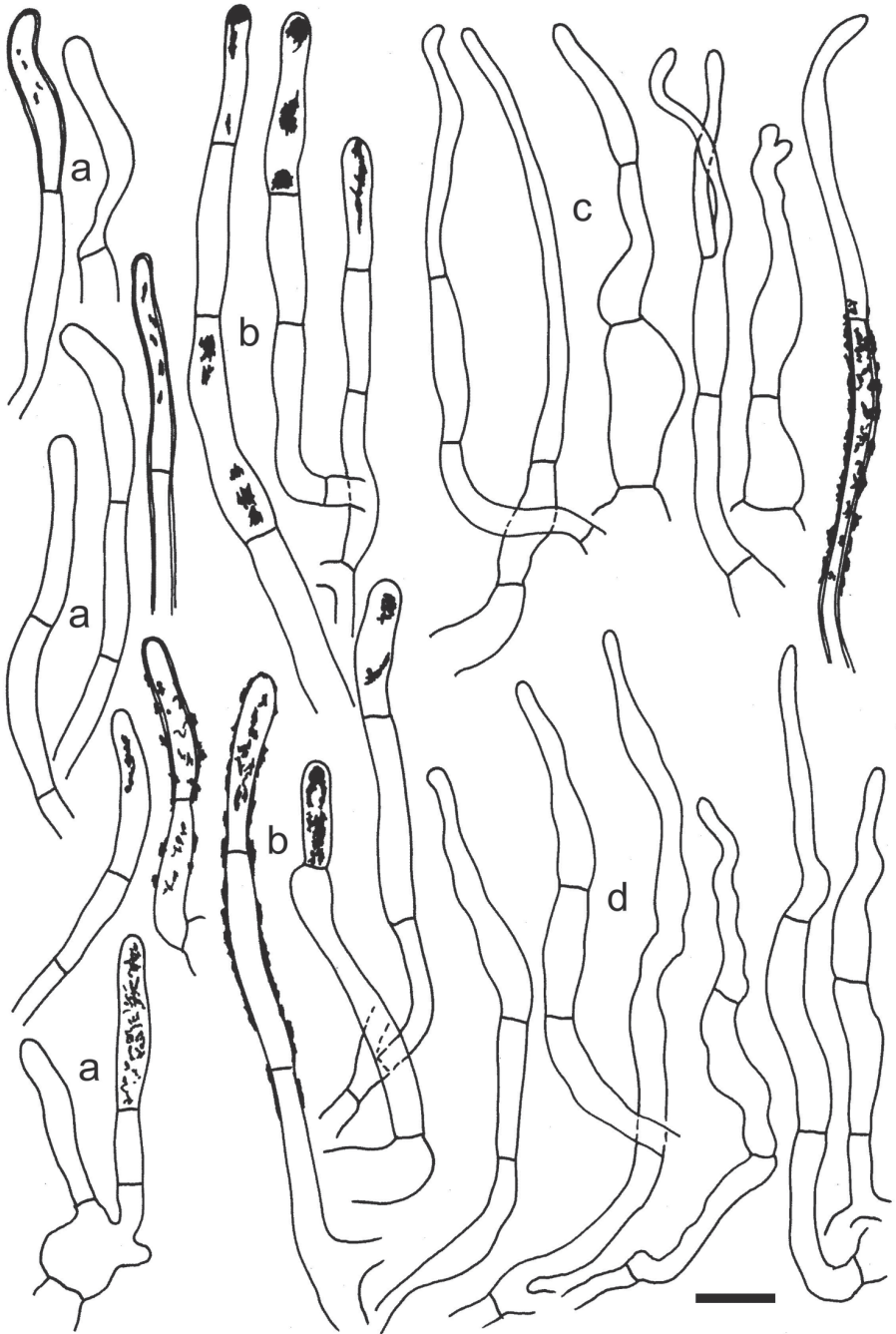


Fig. 25. *Russula flavida* (holotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

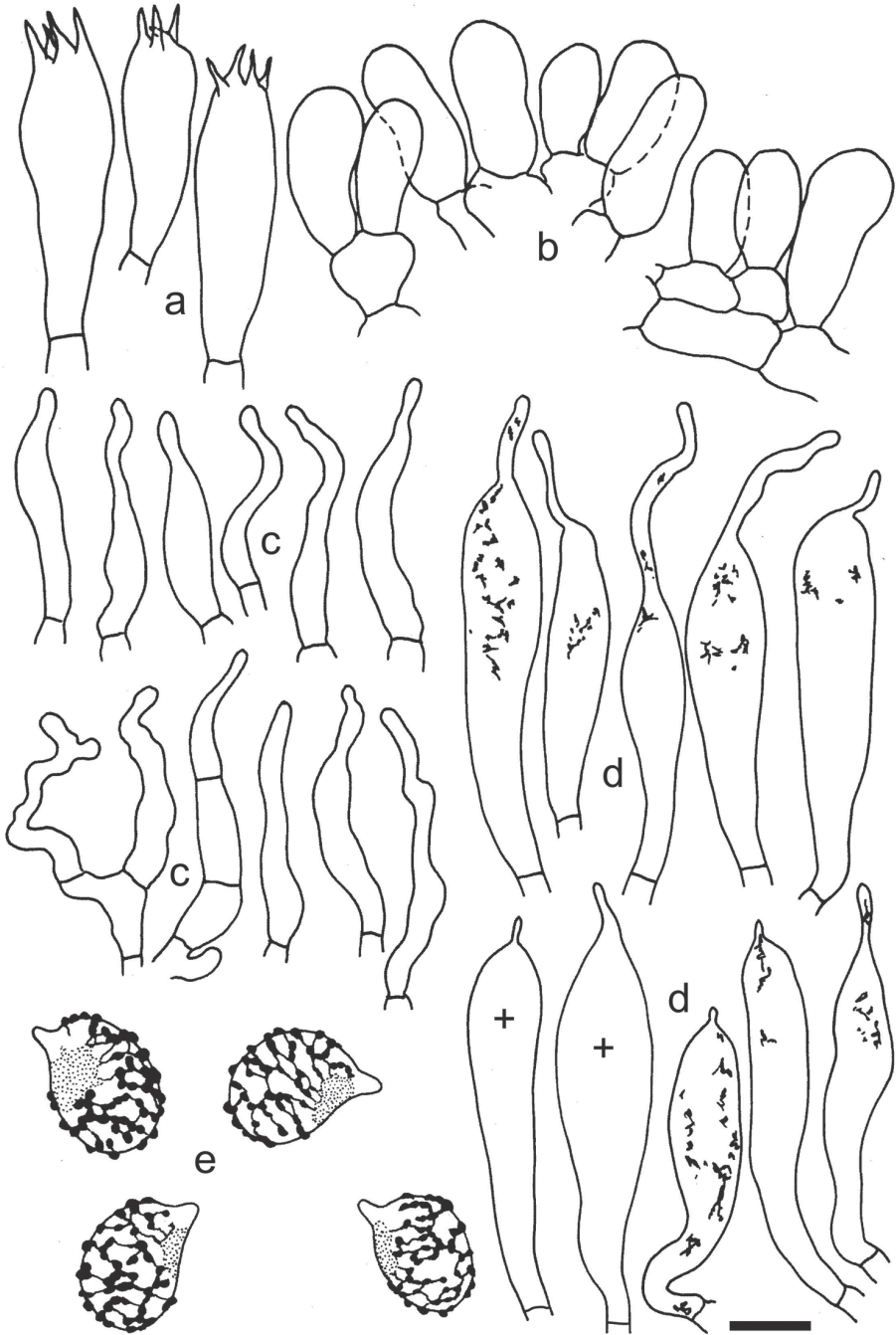


Fig. 26. *Russula flavida* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia near edges of the lamellae. **e.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m, but only 5 μ m for spores.

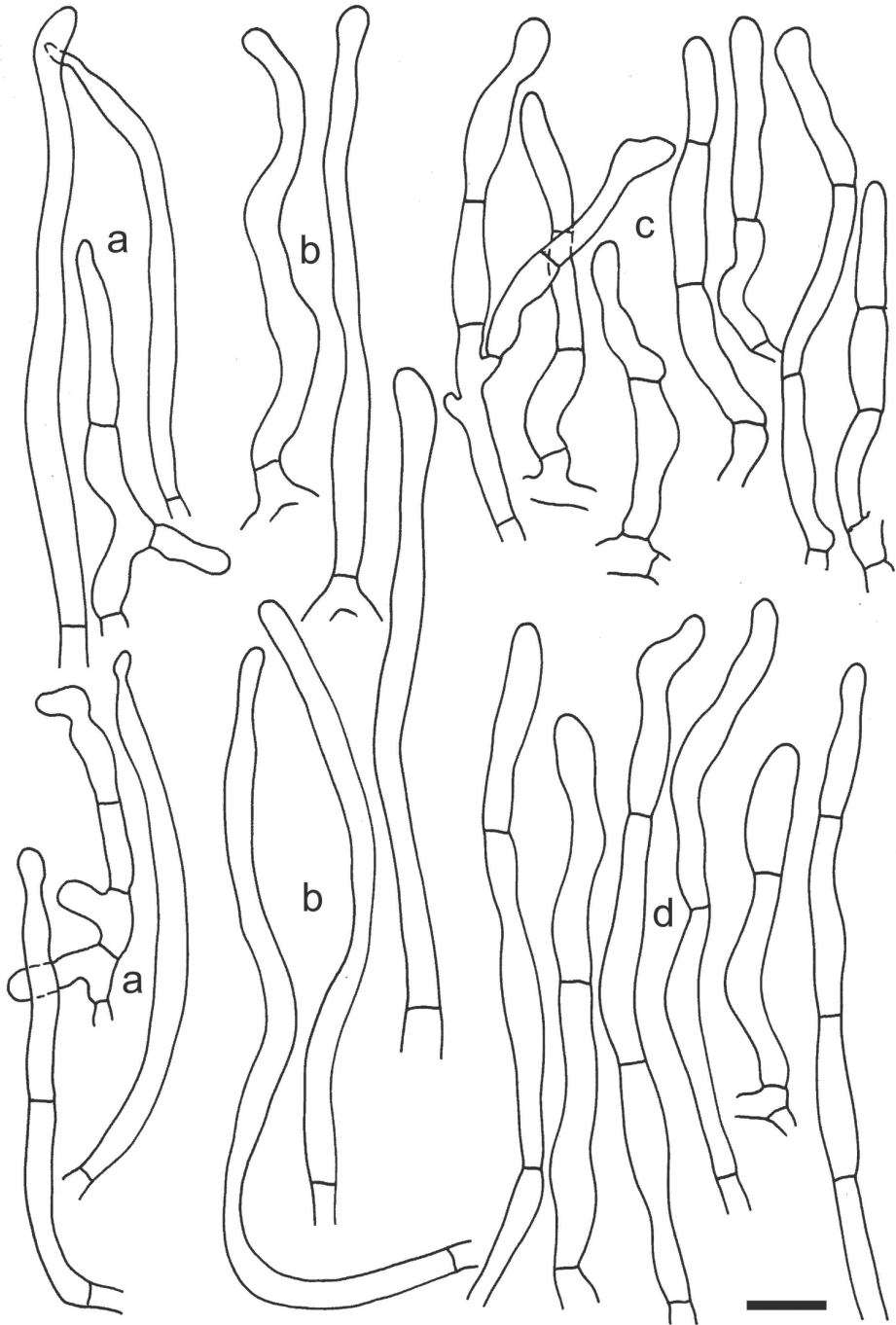


Fig. 27. *Russula granulata* (holotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

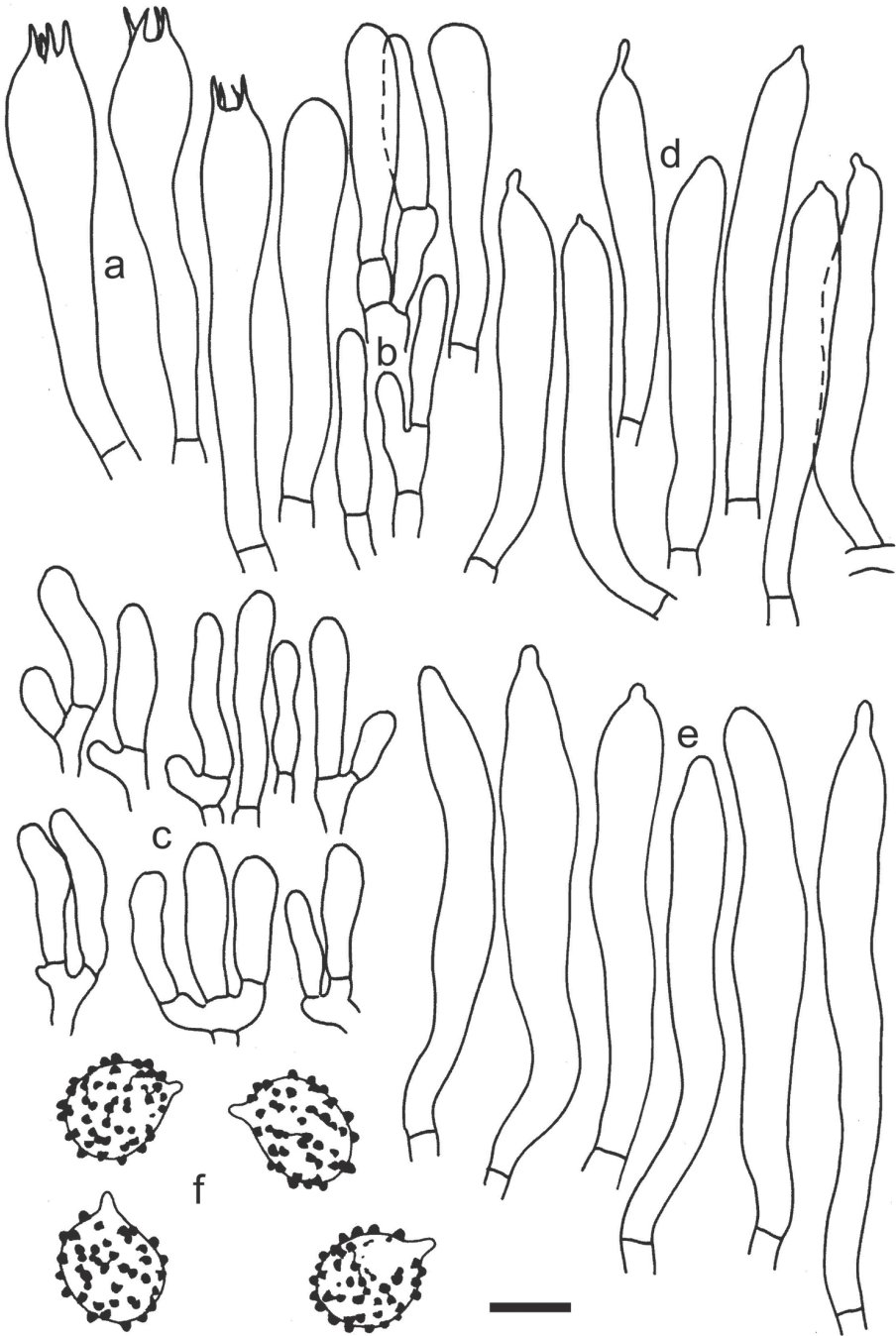


Fig. 28. *Russula granulata* (holotype). a. Basidia. b. Basidiola. c. Marginal cells on edges of the lamellae. d. Hymenial cystidia on edges of the lamellae. e. Hymenial cystidia on sides of the lamellae. f. Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red. Scale bar = 10 μ m, but only 5 μ m for spores.

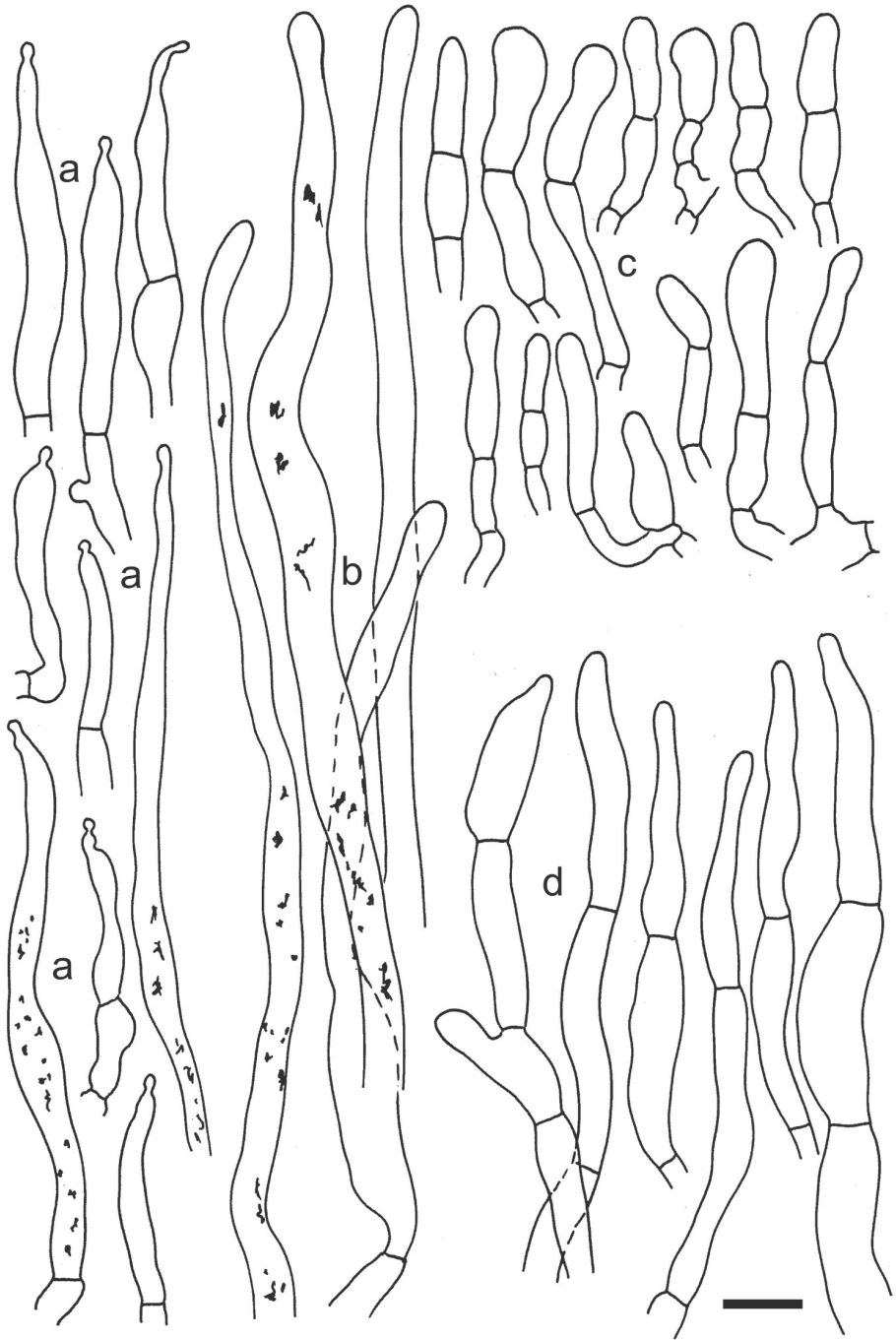


Fig. 29. *Russula granulata* var. *leptotoides* (holotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

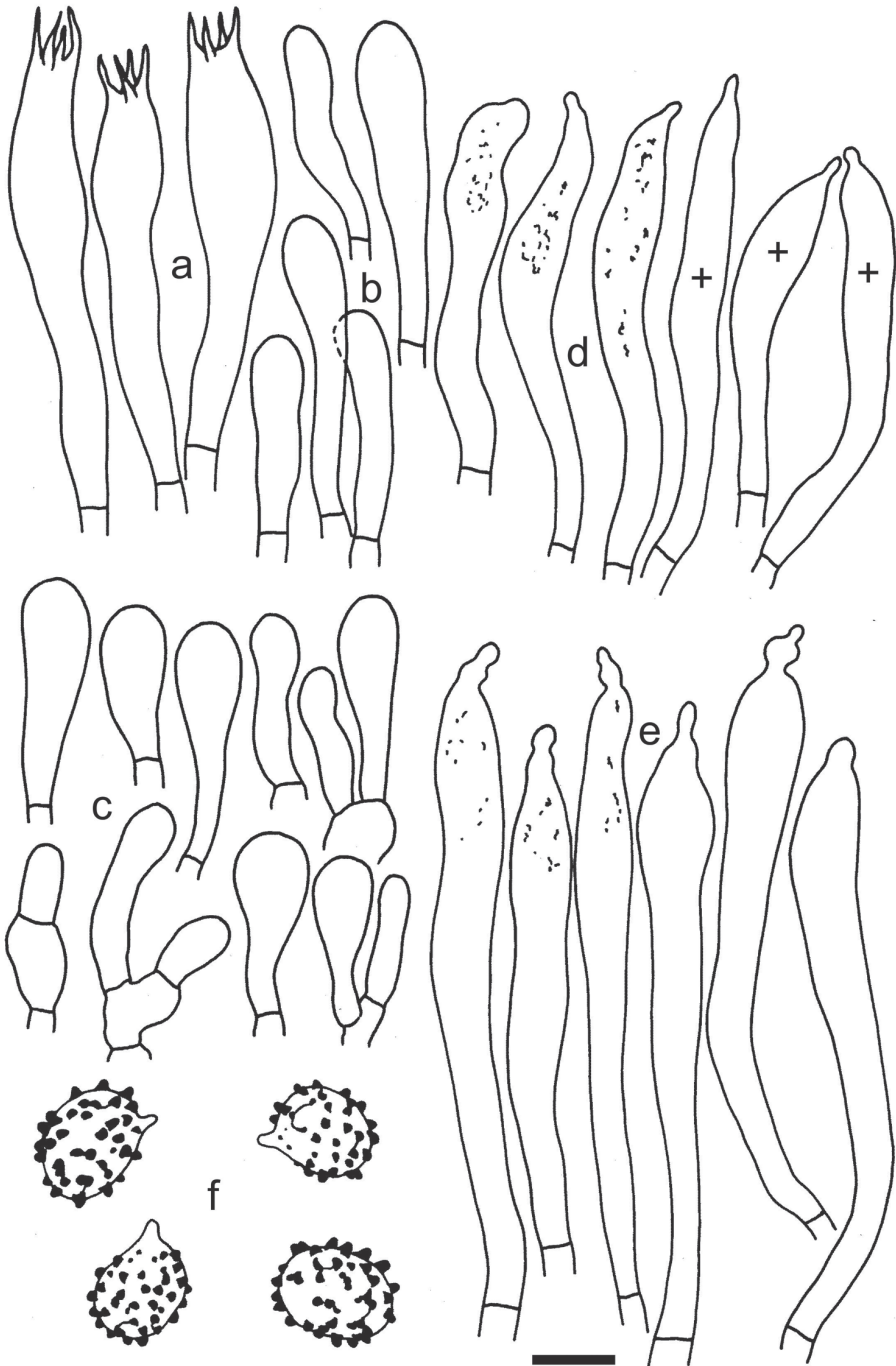


Fig. 30. *Russula granulata* var. *lepiotoides* (holotype). a. Basidia. b. Basidiola. c. Marginal cells on edges of the lamellae. d. Hymenial cystidia on edges of the lamellae. e. Hymenial cystidia on sides of the lamellae. f. Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with heteromorphous contents indicated schematically by a plus sign (+). Scale bar = 10 μm , but only 5 μm for spores.

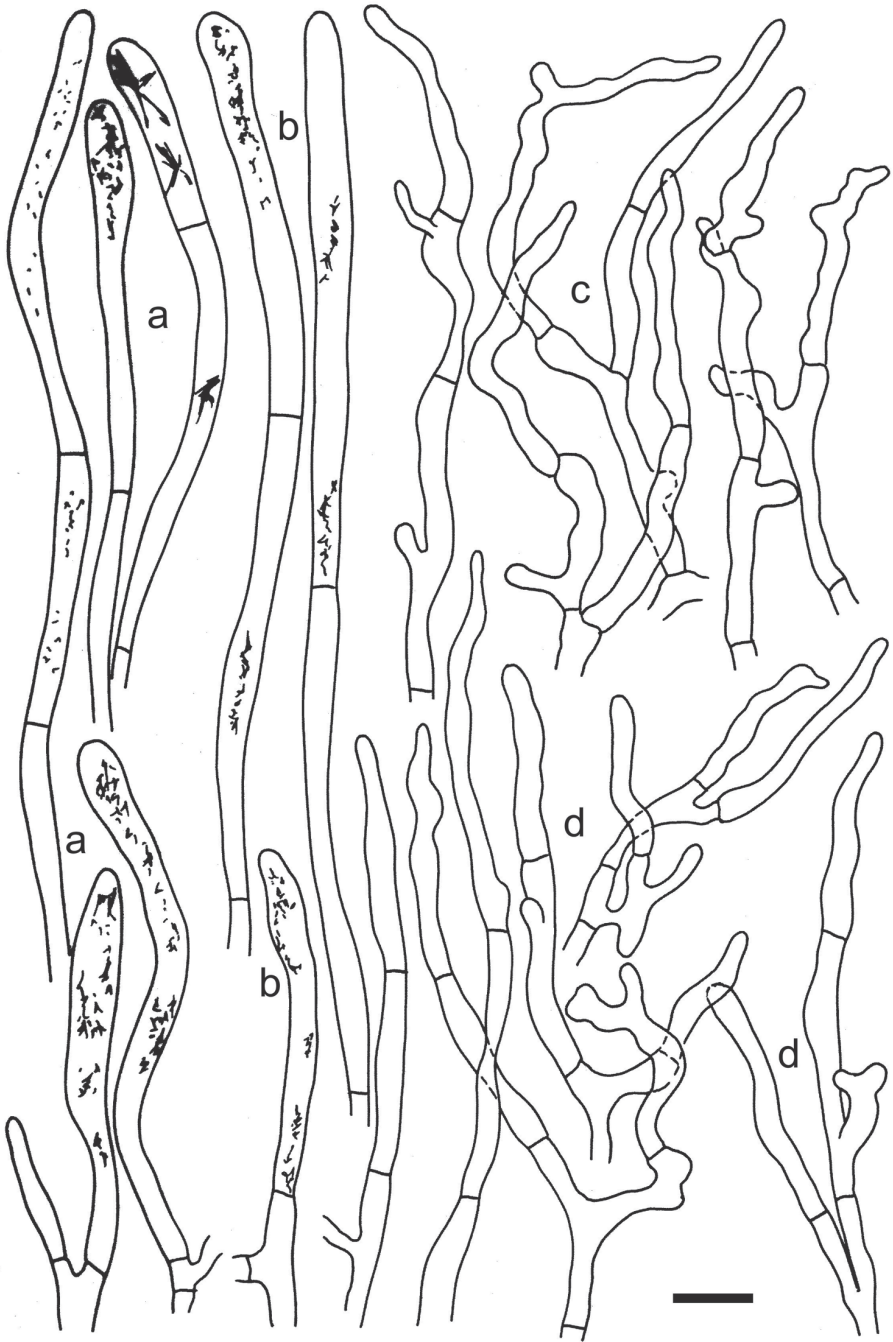


Fig. 31. *Russula integra* var. *rubrotincta* (holotype). a. Pileocystidia near the pileus centre. b. Pileocystidia near the pileus margin. c. Hyphal terminations near the pileus center. d. Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

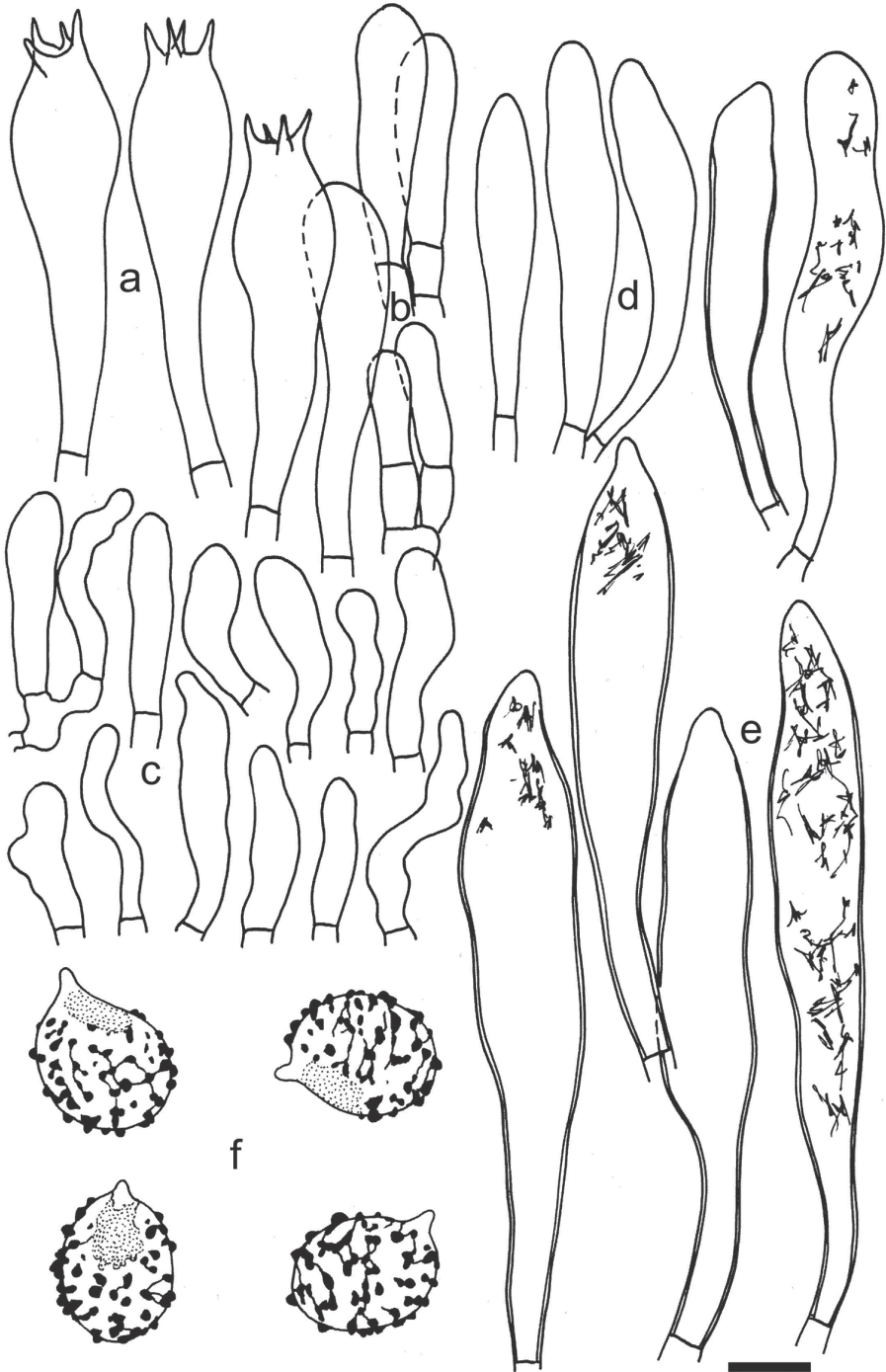


Fig. 32. *Russula integra* var. *rubrotincta* (holotype). a. Basidia. b. Basidiola. c. Marginal cells on edges of the lamellae. d. Hymenial cystidia on edges of the lamellae. e. Hymenial cystidia on sides of the lamellae. f. Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red. Scale bar = 10 μm , but only 5 μm for spores.

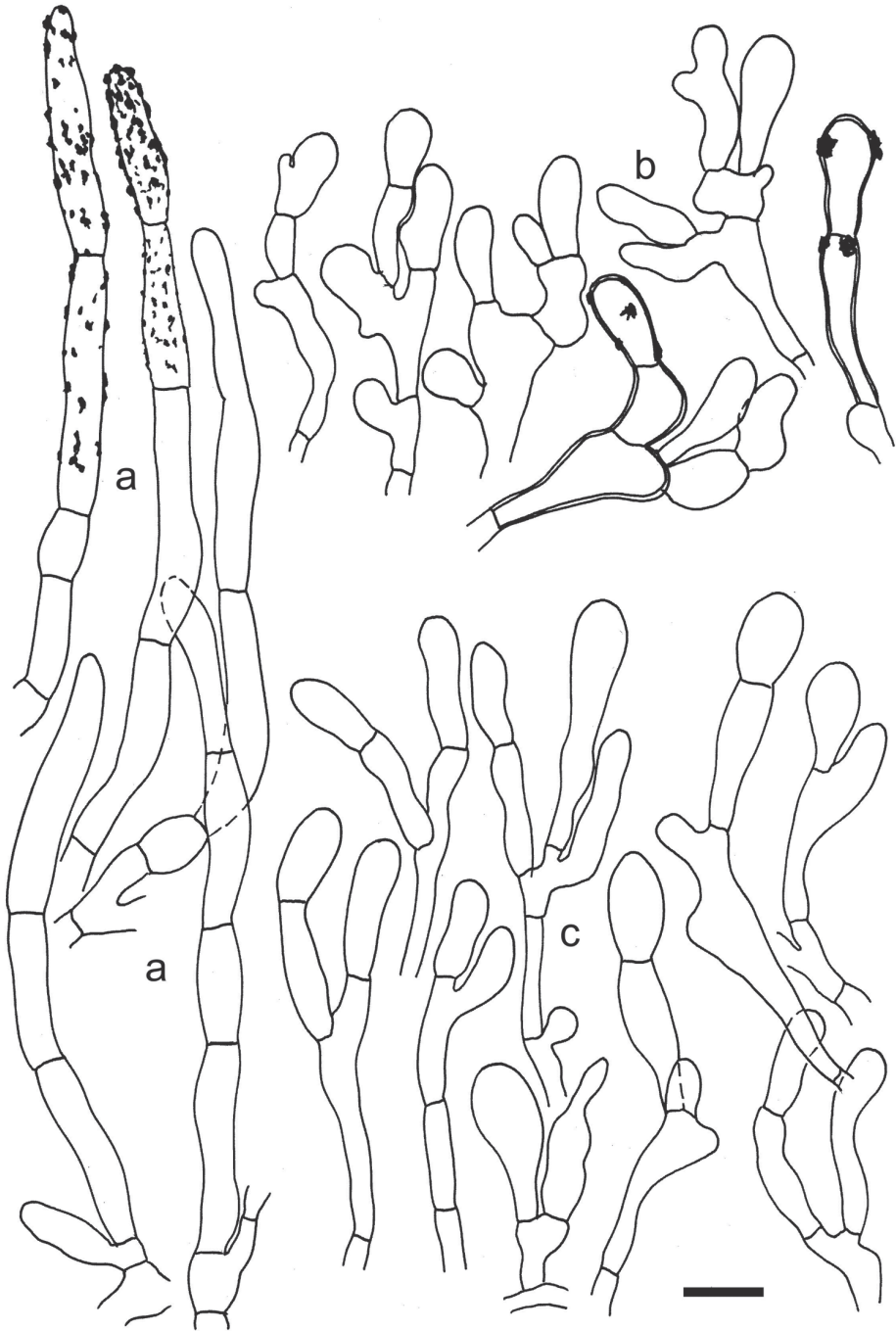


Fig. 33. *Russula luteobasis* (holotype). **a.** Pileocystidia near the pileus margin. **b.** Hyphal terminations and pileocystidia near the pileus center. **d.** Hyphal terminations and near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

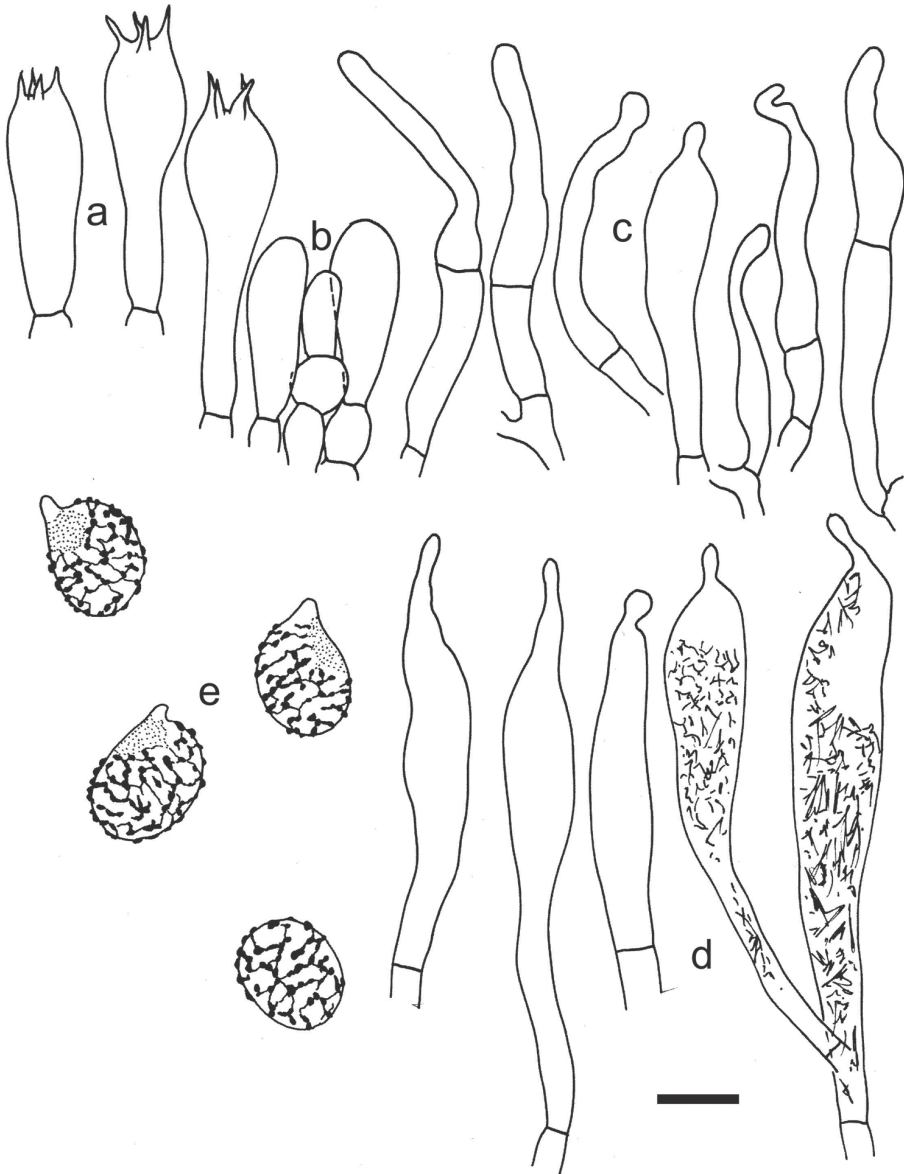


Fig. 34. *Russula luteobasis* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on sides of the lamellae. **e.** Spores as seen in Melzer's reagent. **f.** Cystidia with contents as observed in Congo Red. Scale bar = 10 μm , but only 5 μm for spores.

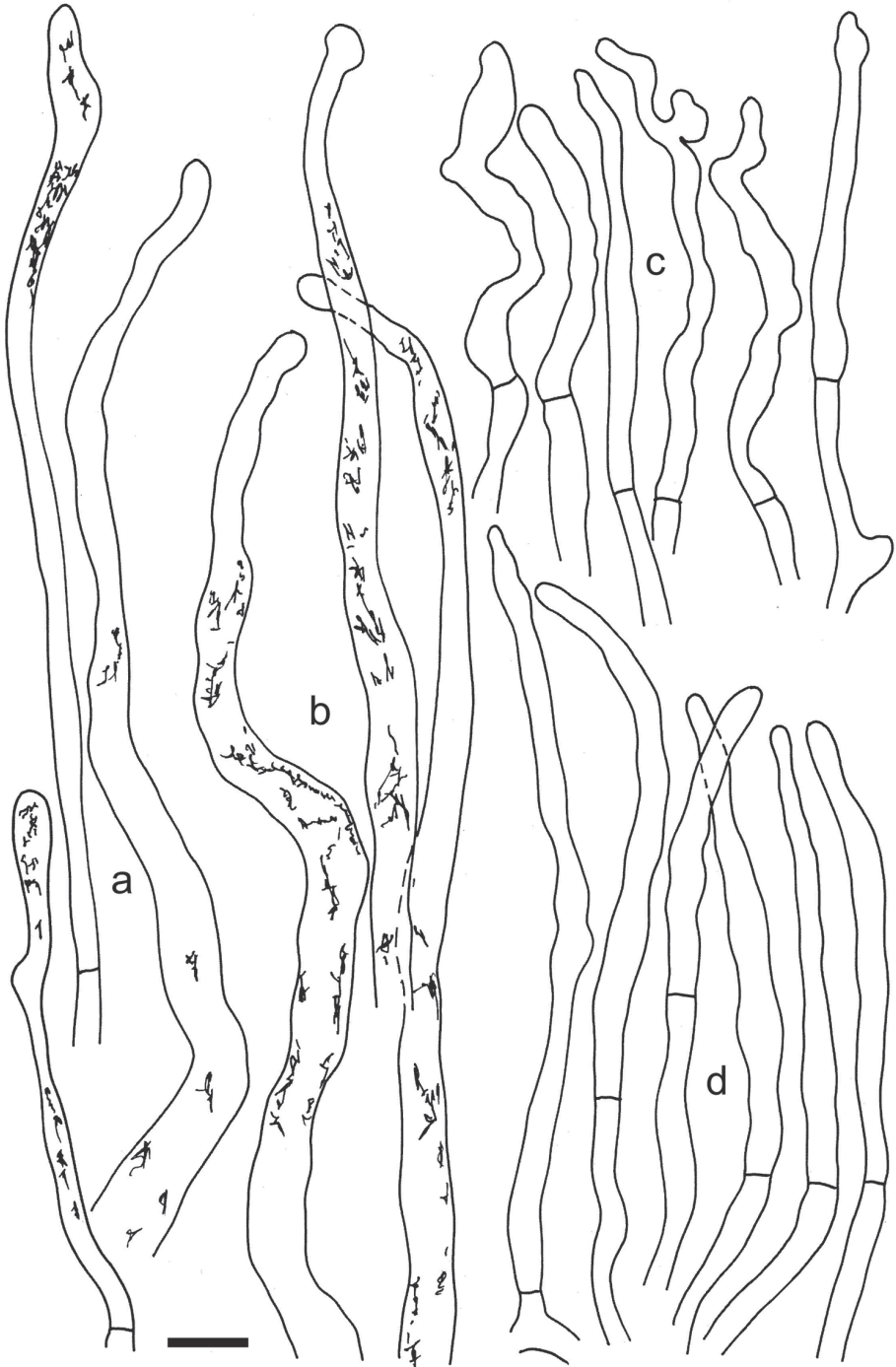


Fig. 35. *Russula magnifica* (lectotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

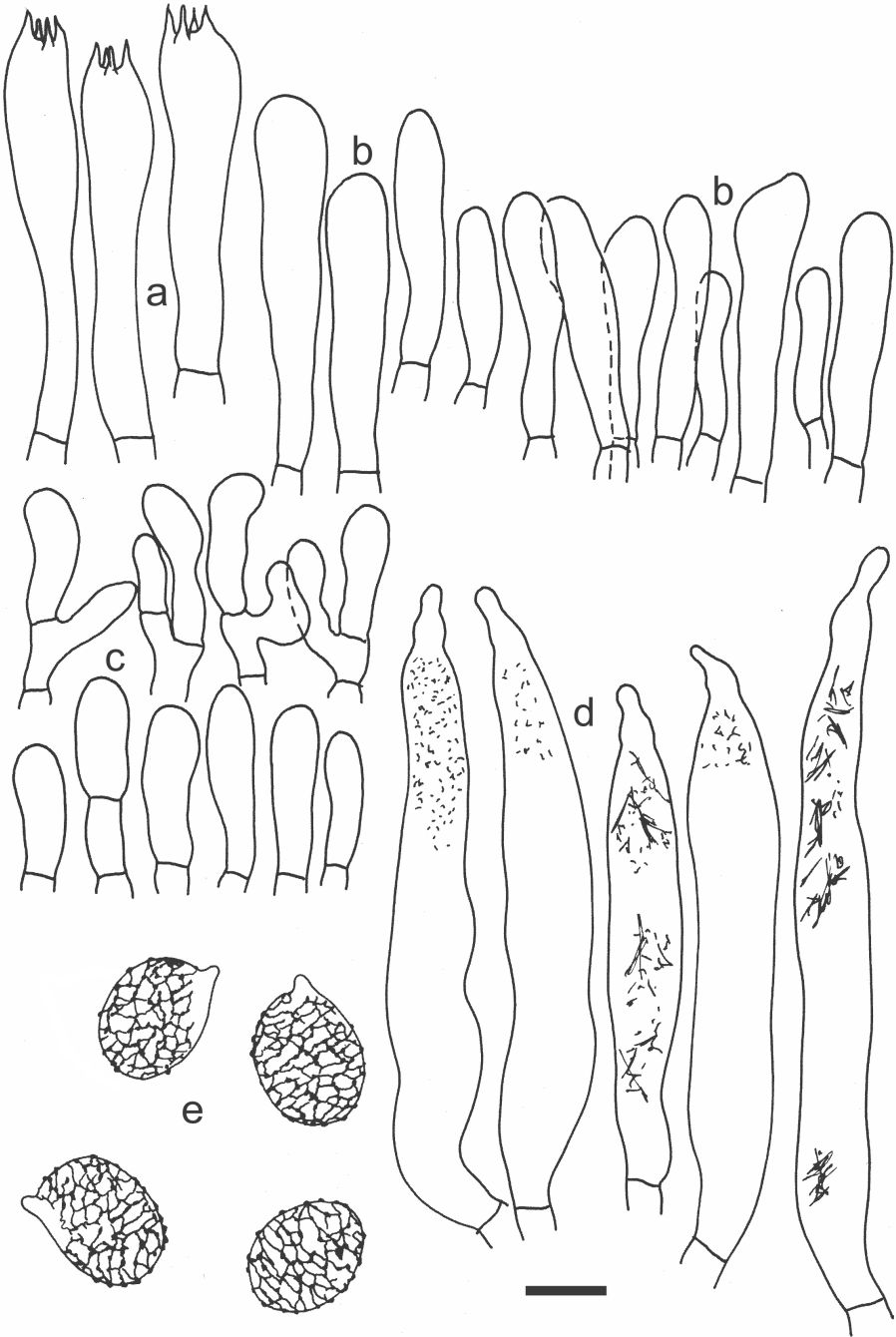


Fig. 36. *Russula magnifica* (lectotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on sides of the lamellae. **e.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red. Scale bar = 10 μ m, but only 5 μ m for spores.

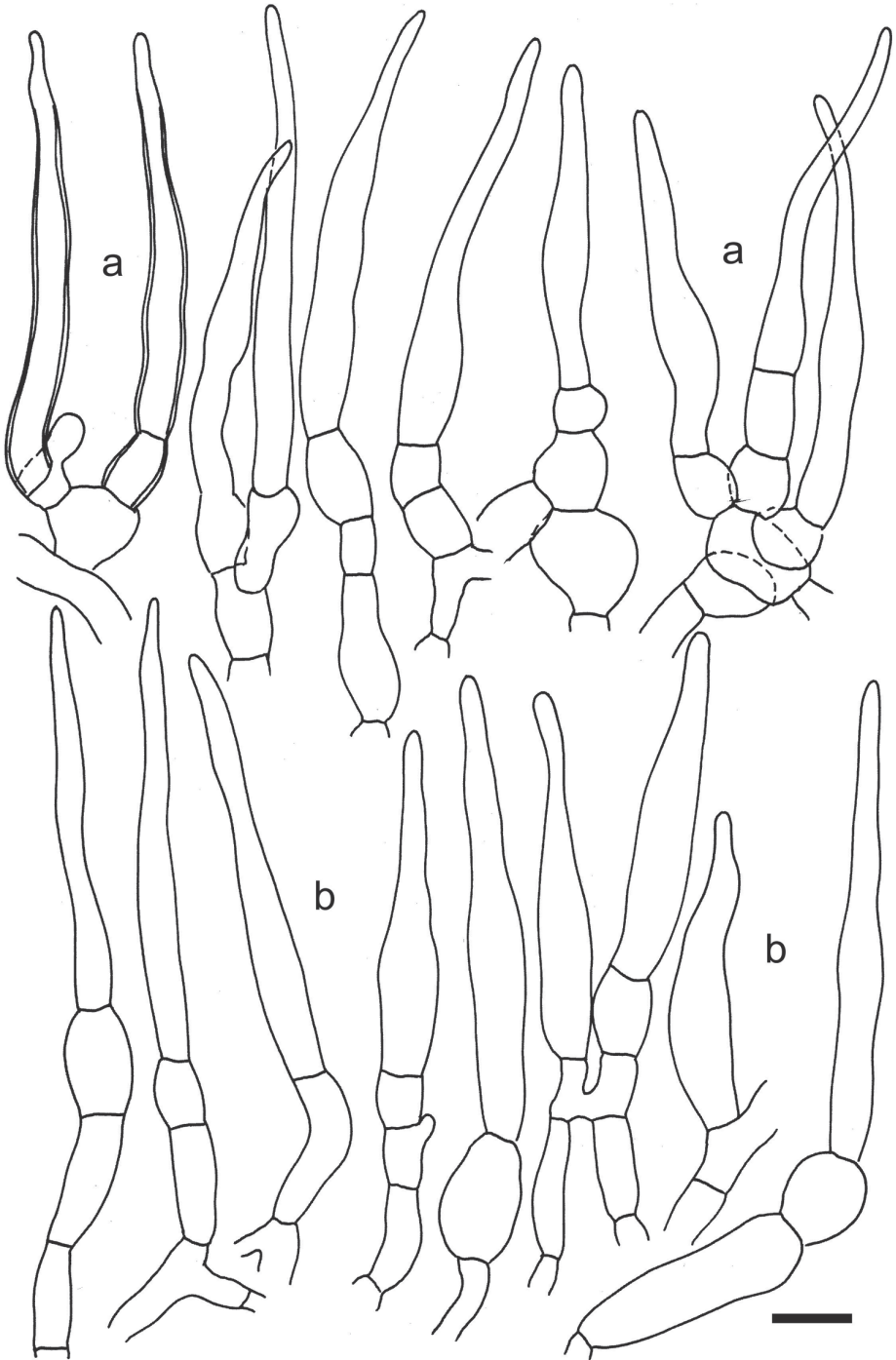


Fig. 37. *Russula mariae* (holotype). **a.** Hyphal terminations near the pileus center. **b.** Hyphal terminations near the pileus margin. Scale bar = 10 μ m.

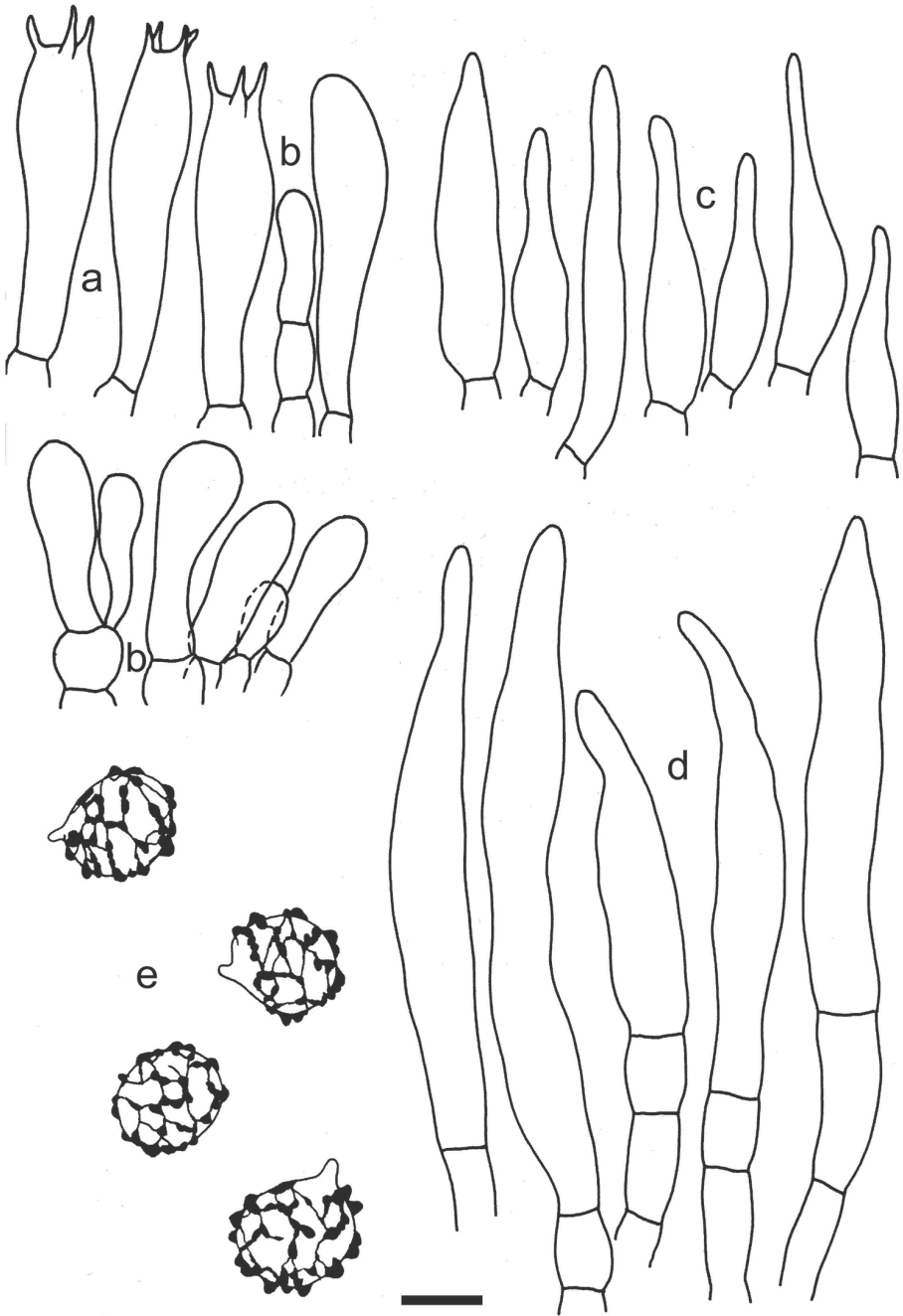


Fig. 38. *Russula mariae* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Hymenial cystidia on edges of the lamellae. **d.** Hymenial cystidia on sides of the lamellae. **e.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red. Scale bar = 10 μm , but only 5 μm for spores.



Fig. 39. *Russula ochrophylla* (holotype). **a.** Hyphal terminations near the pileus center. **b.** Hyphal terminations near the pileus margin. Scale bar = 10 μ m.

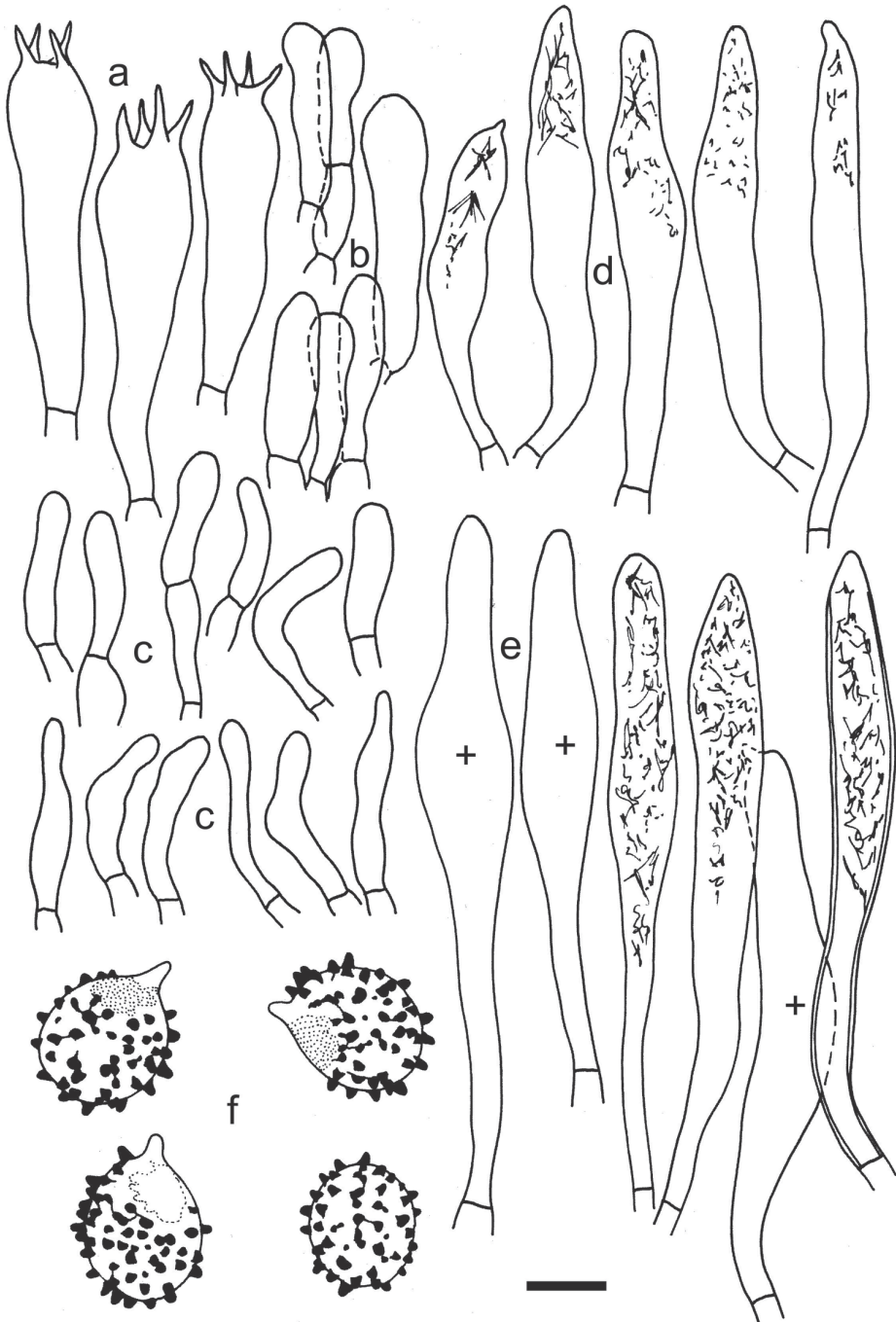


Fig. 40. *Russula ochrophylla* (holotype). a. Basidia. b. Basidiola. c. Marginal cells on edges of the lamellae. d. Hymenial cystidia on edges of the lamellae. e. Hymenial cystidia on sides of the lamellae. f. Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m, but only 5 μ m for spores.

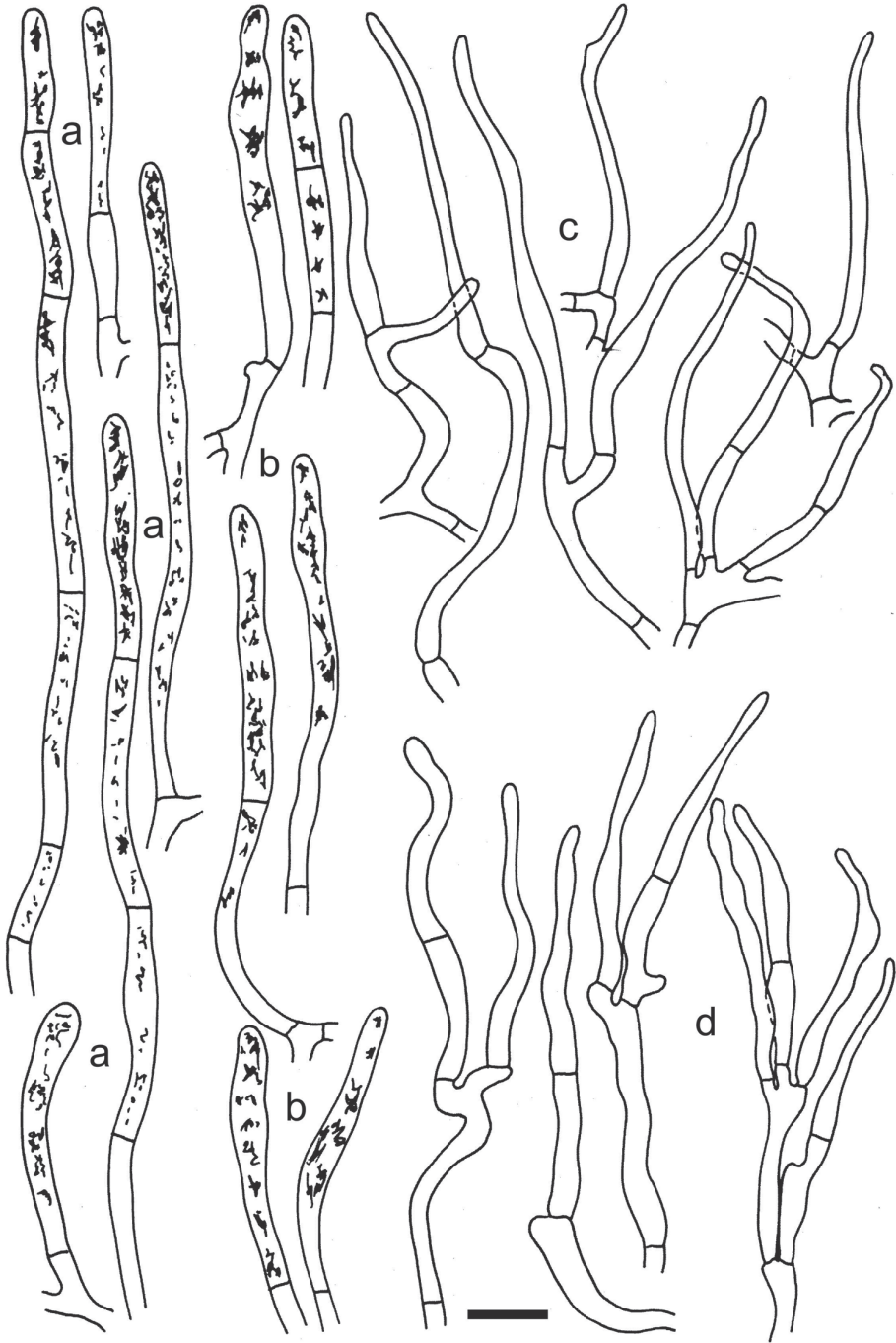


Fig. 41. *Russula ochrophylla* var. *albipes* (holotype). a. Pileocystidia near the pileus centre. b. Pileocystidia near the pileus margin. c. Hyphal terminations near the pileus center. d. Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

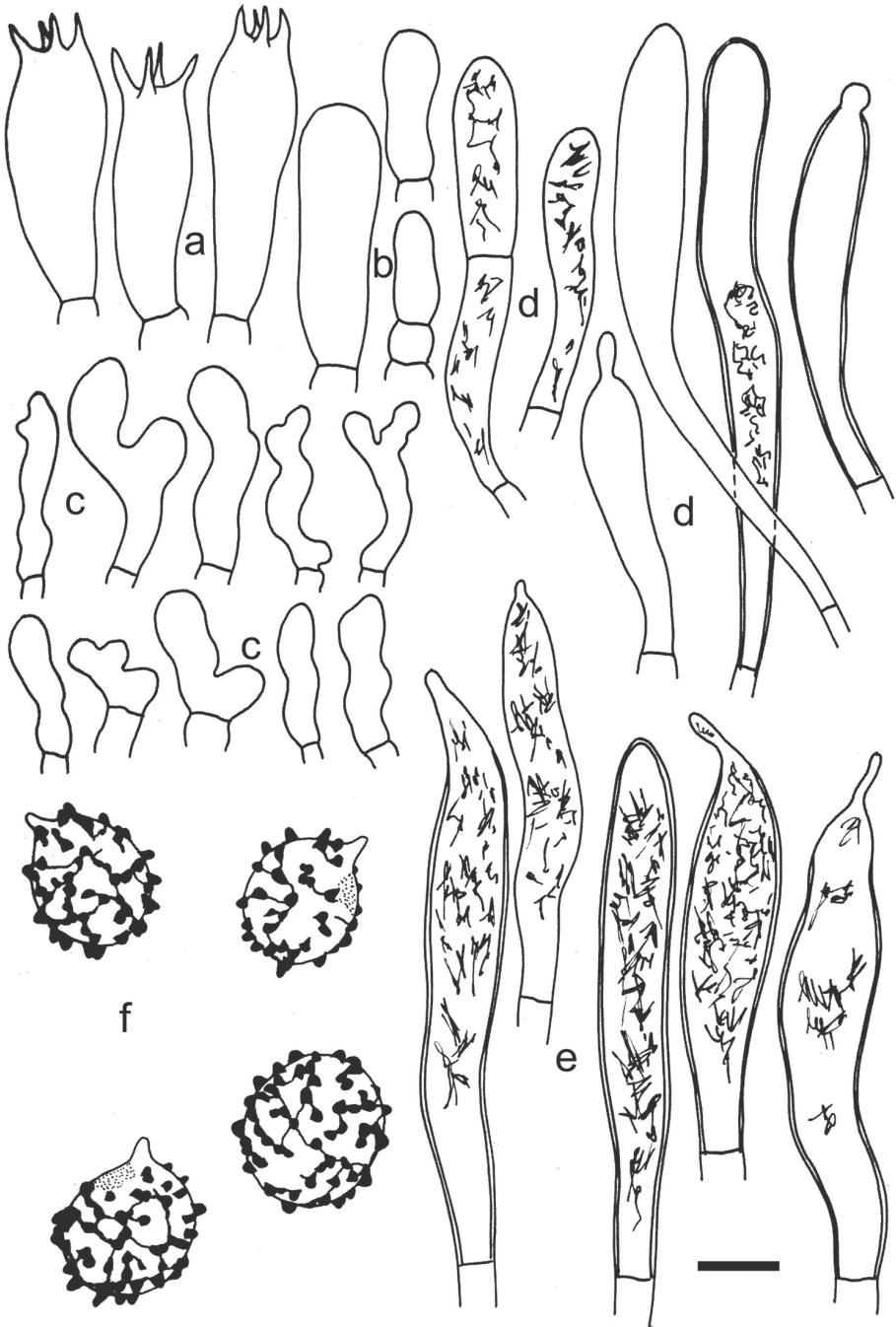


Fig. 42. *Russula ochrophylla* var. *albipes* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on edges of the lamellae. **e.** Hymenial cystidia on sides of the lamellae. **f.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red. Scale bar = 10 μm , but only 5 μm for spores.

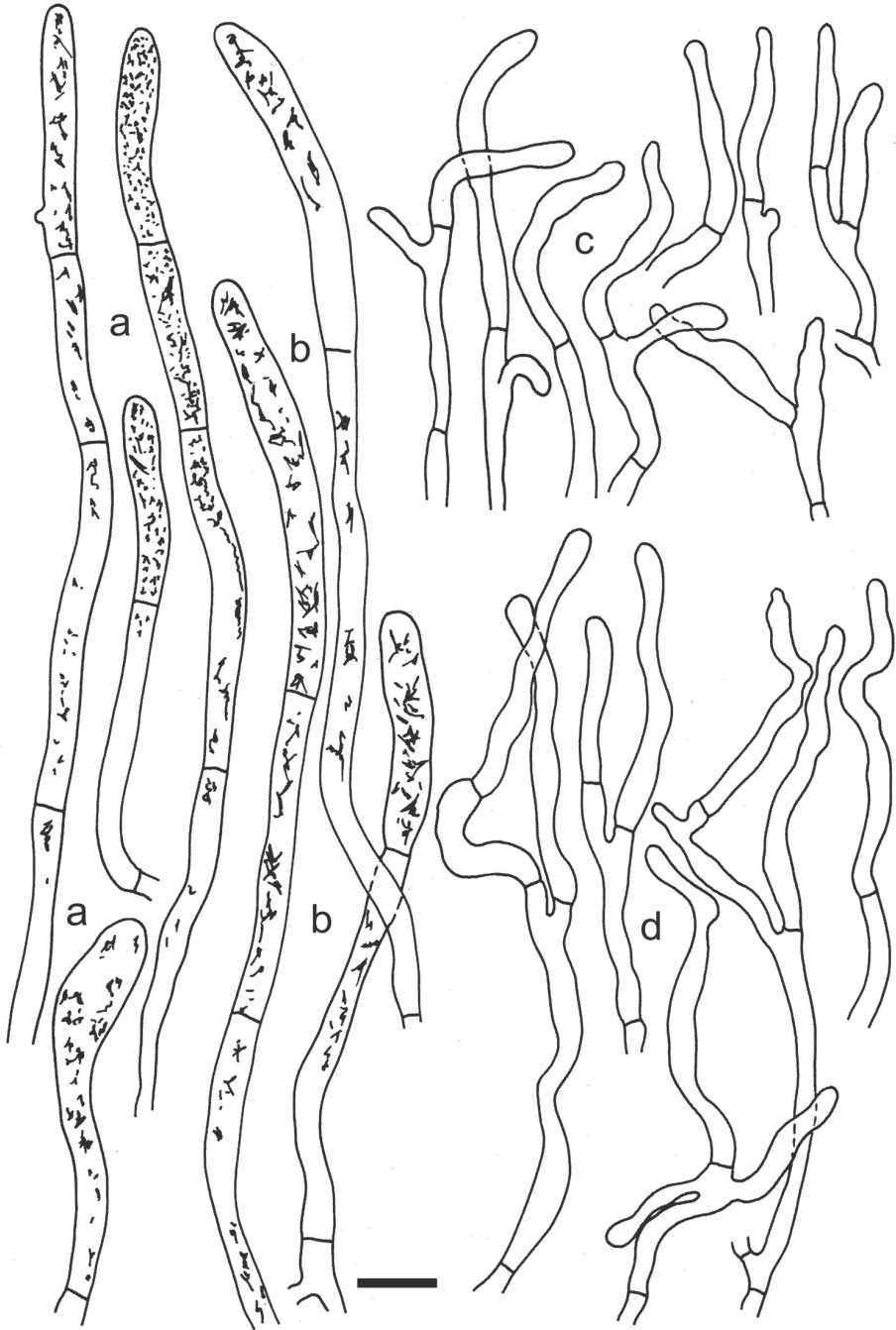


Fig. 43. *Russula palustris* (holotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

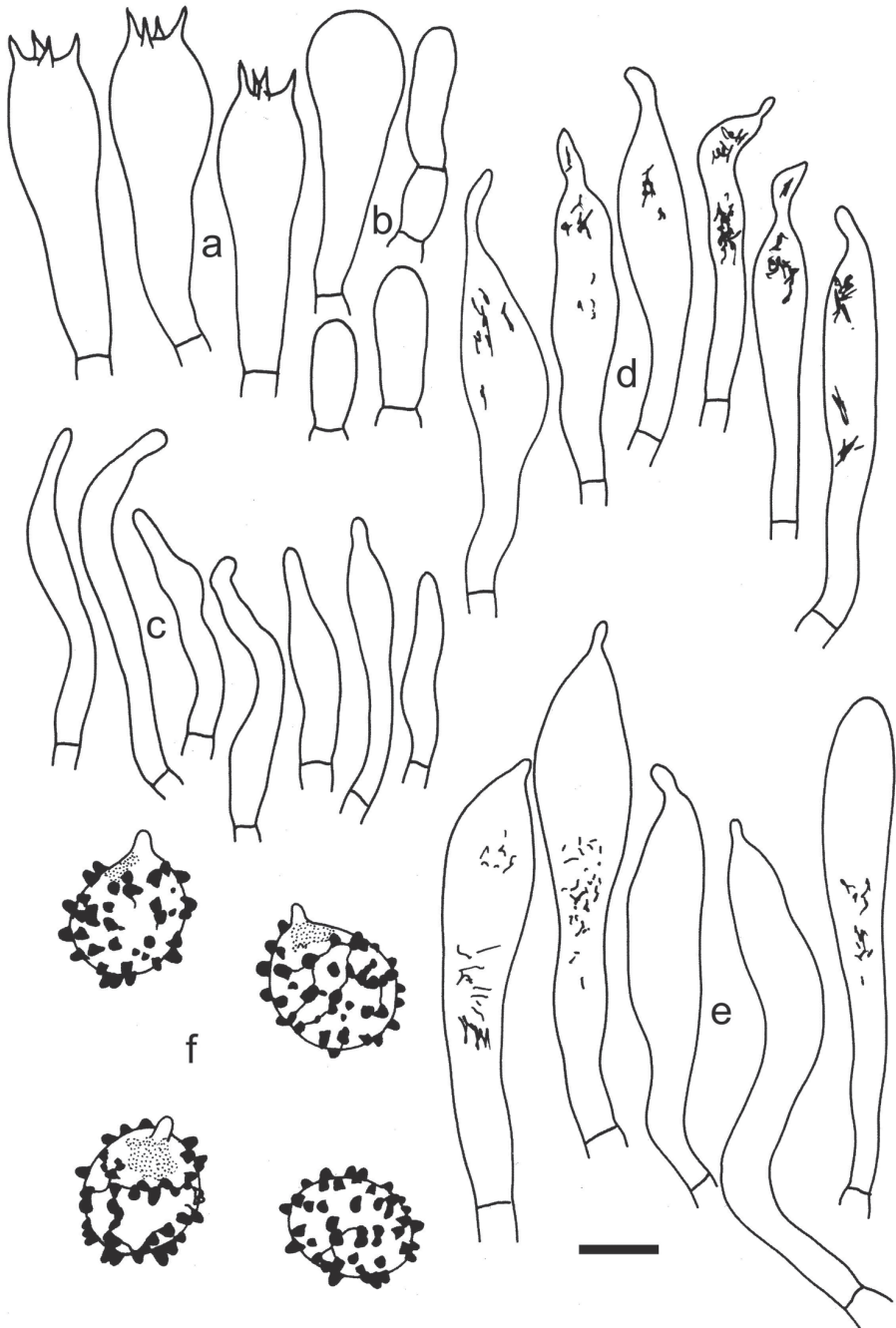


Fig. 44. *Russula palustris* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on edges of the lamellae. **e.** Hymenial cystidia on sides of the lamellae. **f.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red. Scale bar = 10 µm, but only 5 µm for spores.

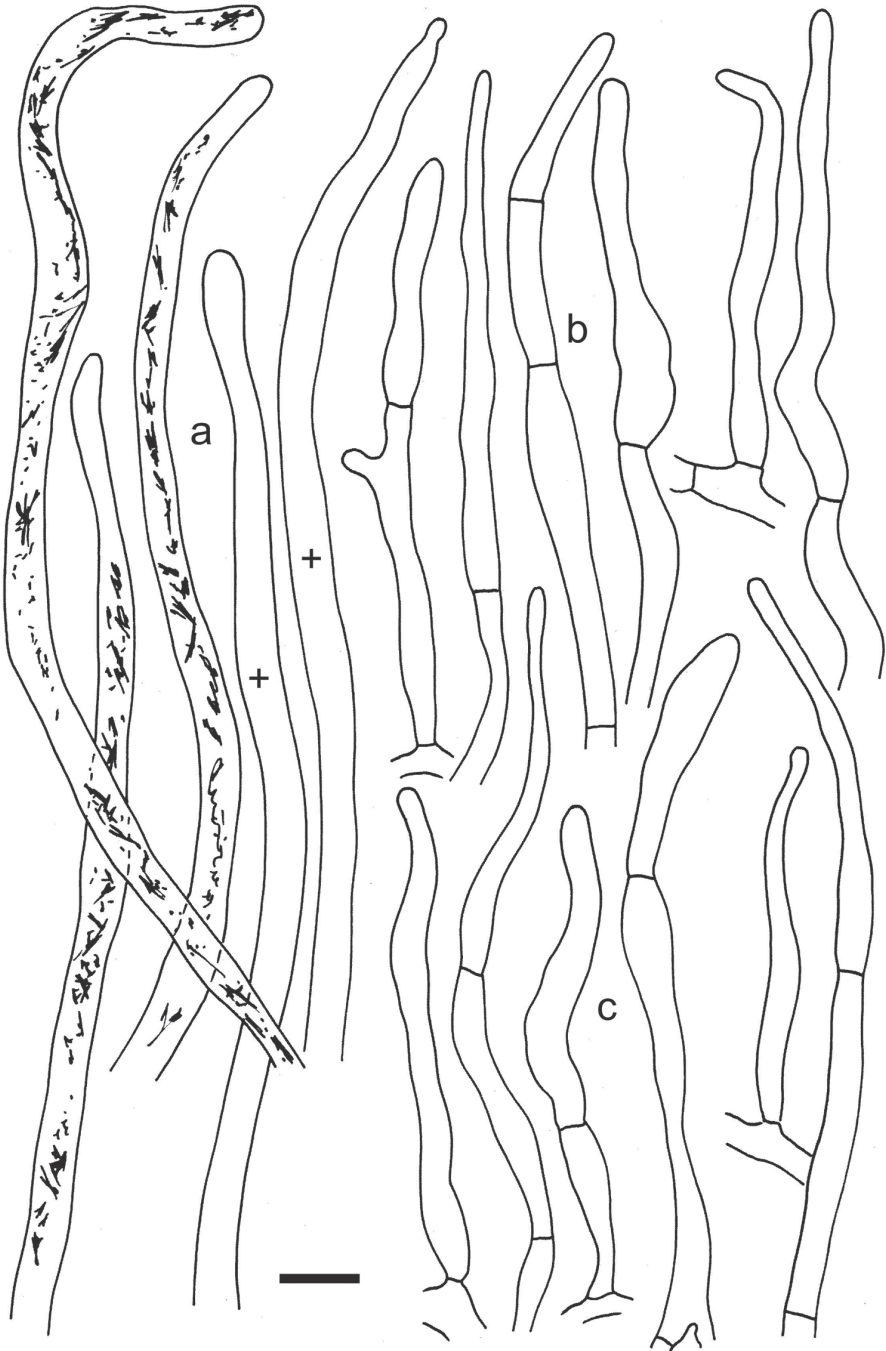


Fig. 45. *Russula polyphylla* (holotype). **a.** Pileocystidia near the pileus margin. **b.** Hyphal terminations near the pileus center. **c.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red, but some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m.

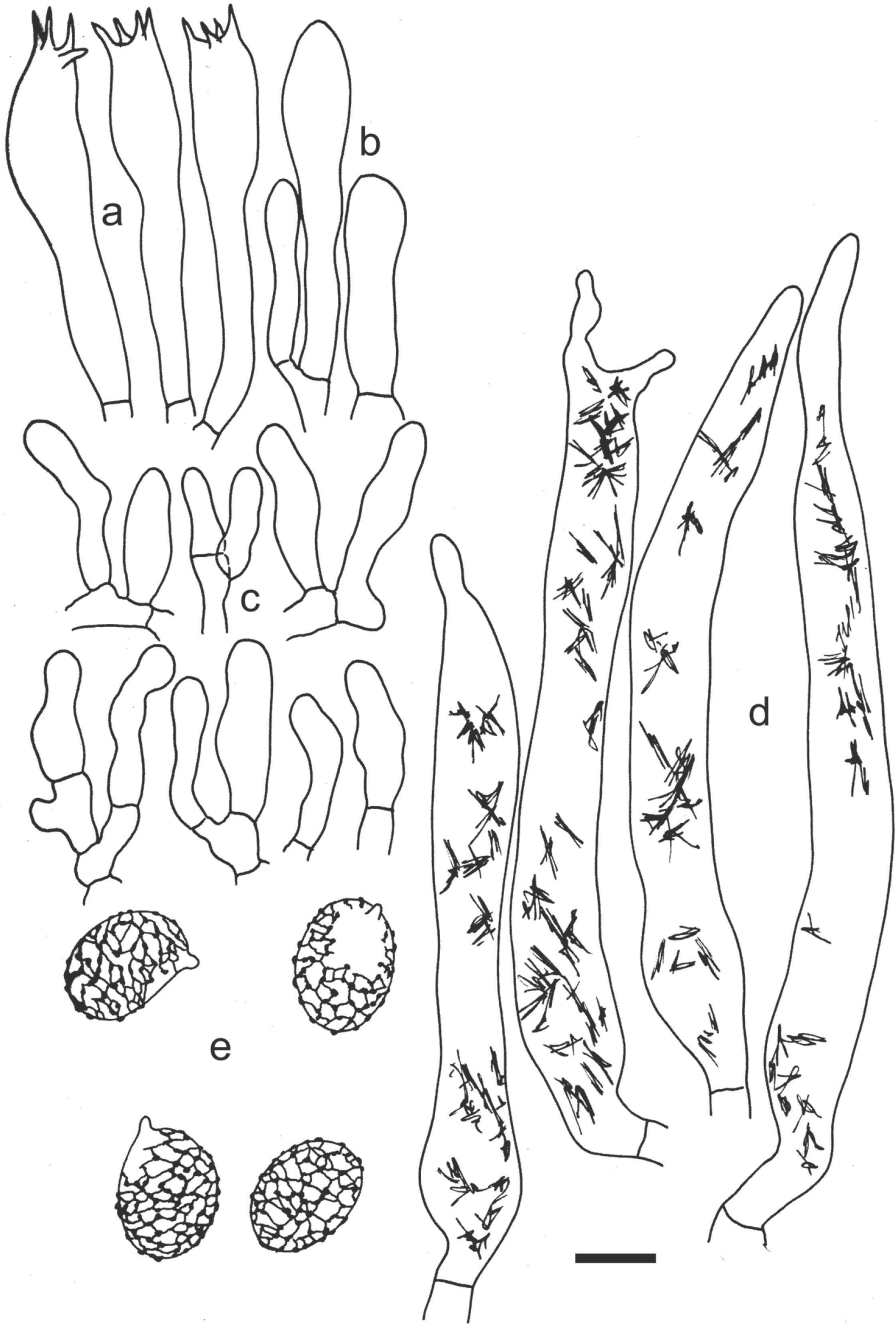


Fig. 46. *Russula polyphylla* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on sides of the lamellae. **e.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red. Scale bar = 10 μm , but only 5 μm for spores.

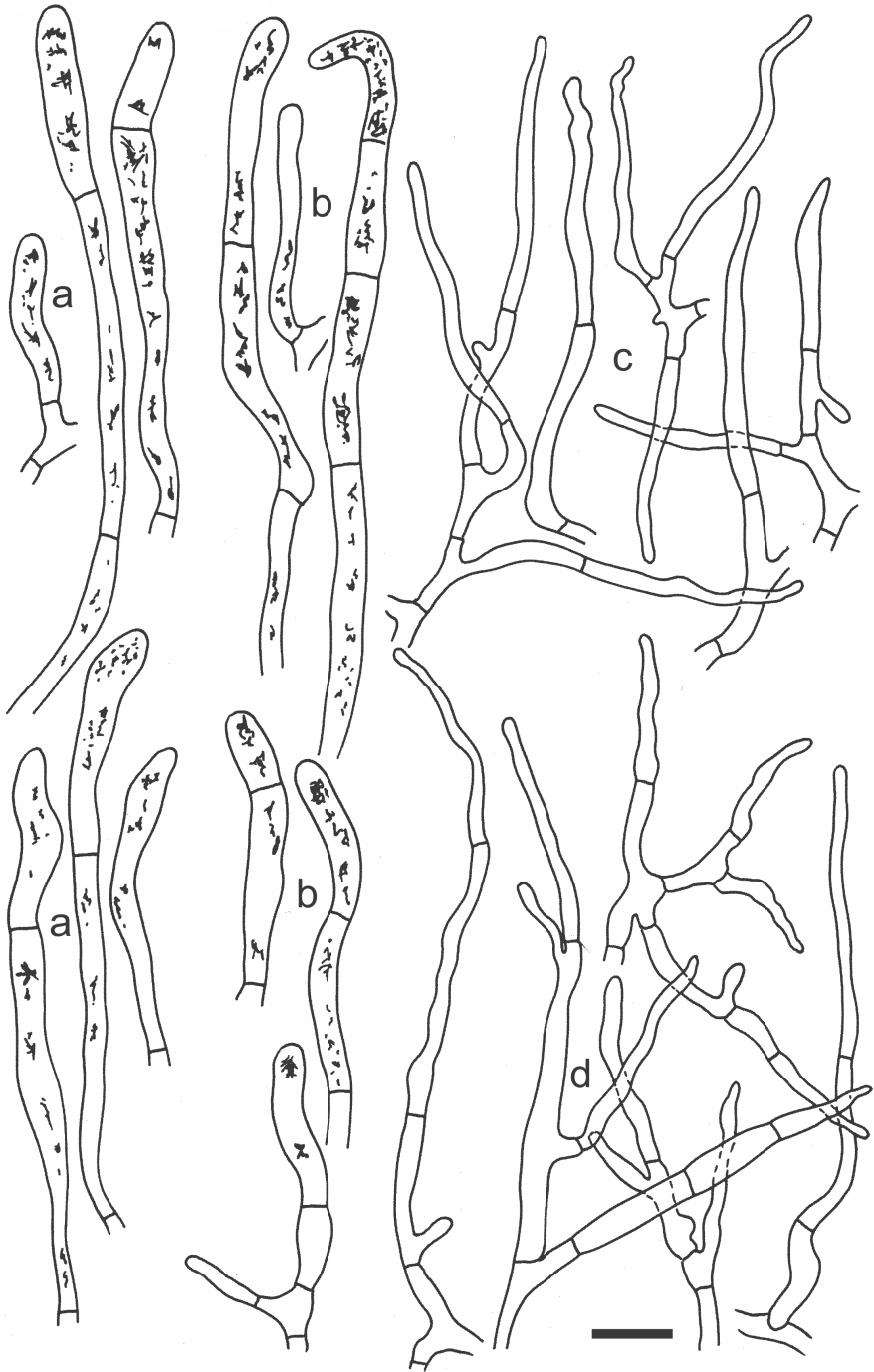


Fig. 47. *Russula pusilla* (holotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

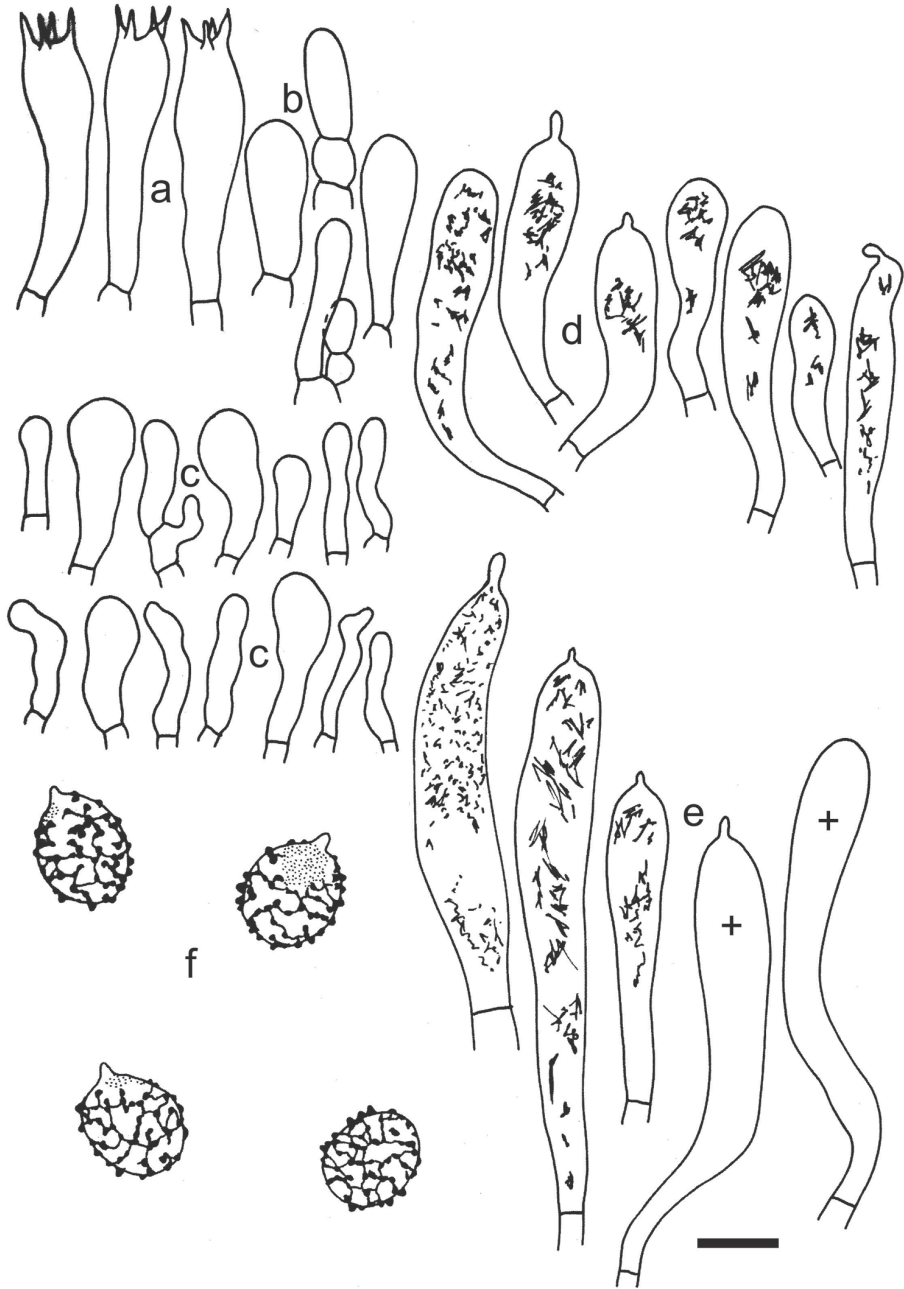


Fig. 48. *Russula pusilla* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on edges of the lamellae. **e.** Hymenial cystidia on sides of the lamellae. **f.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m, but only 5 μ m for spores.

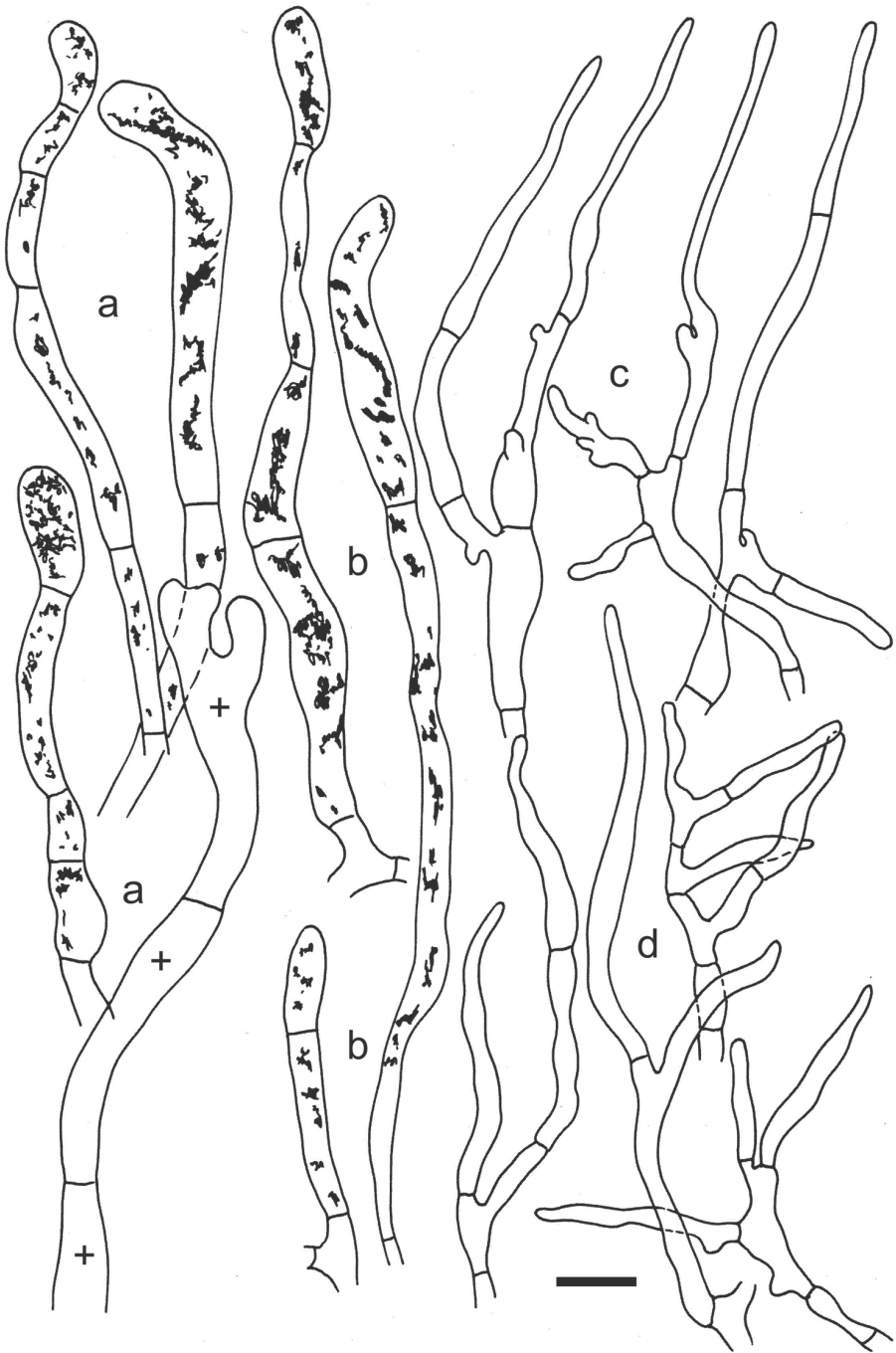


Fig. 49. *Russula rugulosa* (lectotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red, but some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m.

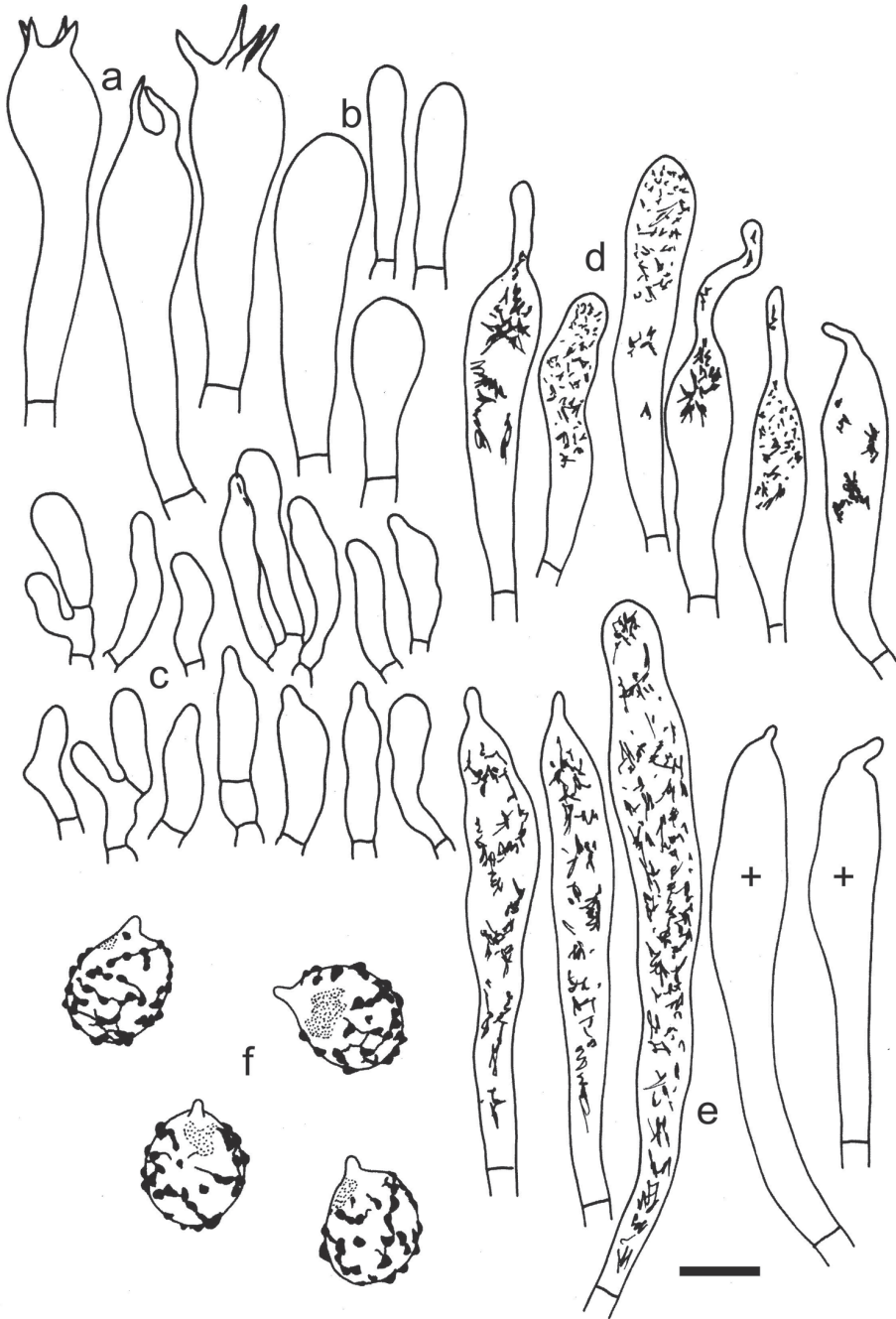


Fig. 50. *Russula rugulosa* (lectotype). a. Basidia. b. Basidiola. c. Marginal cells on edges of the lamellae. d. Hymenial cystidia on edges of the lamellae. e. Hymenial cystidia on sides of the lamellae. f. Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m, but only 5 μ m for spores.

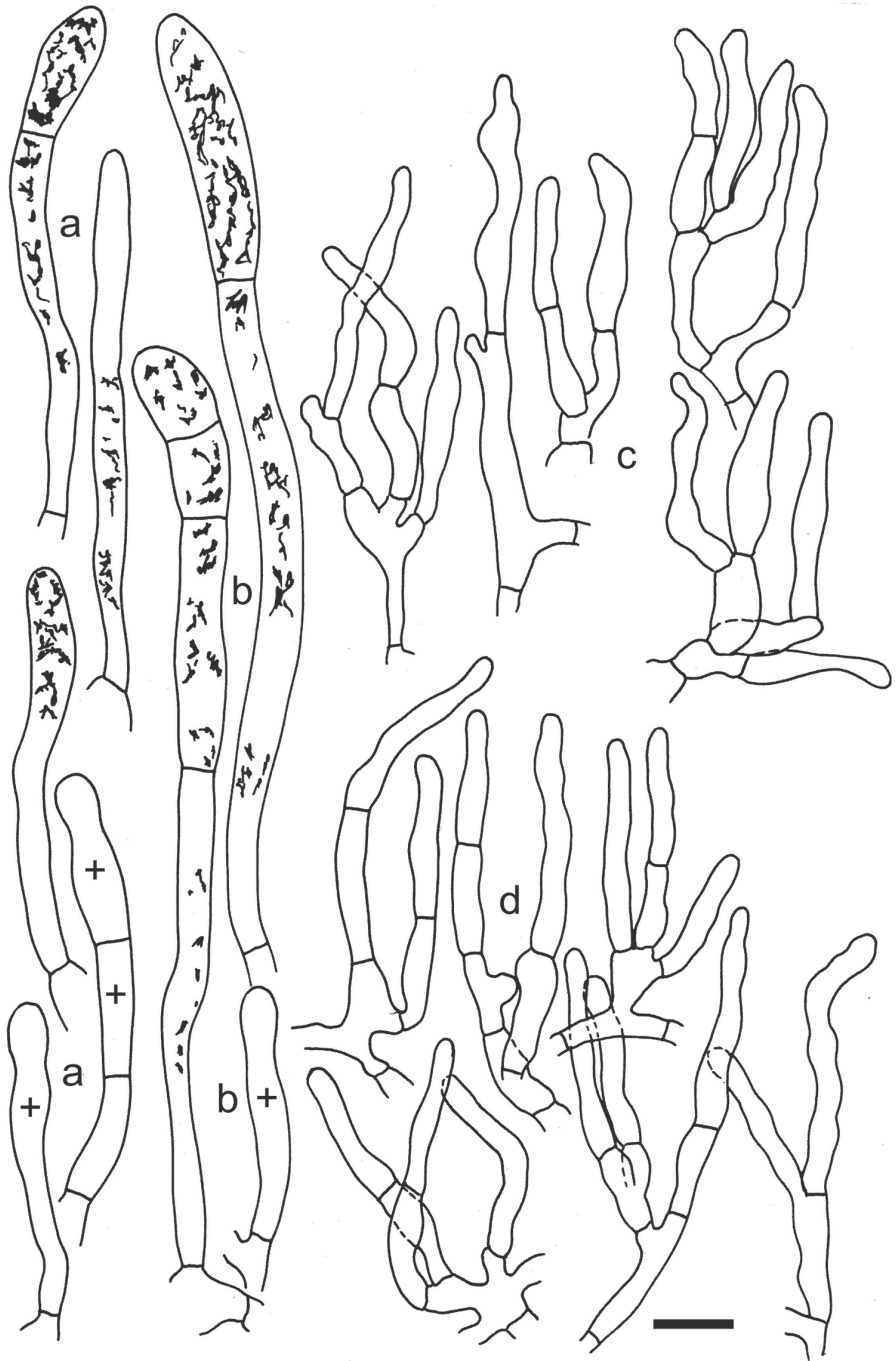


Fig. 51. *Russula simillima* (holotype). **a.** Pileocystidia near the pileus centre. **b.** Pileocystidia near the pileus margin. **c.** Hyphal terminations near the pileus center. **d.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red, but some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m.

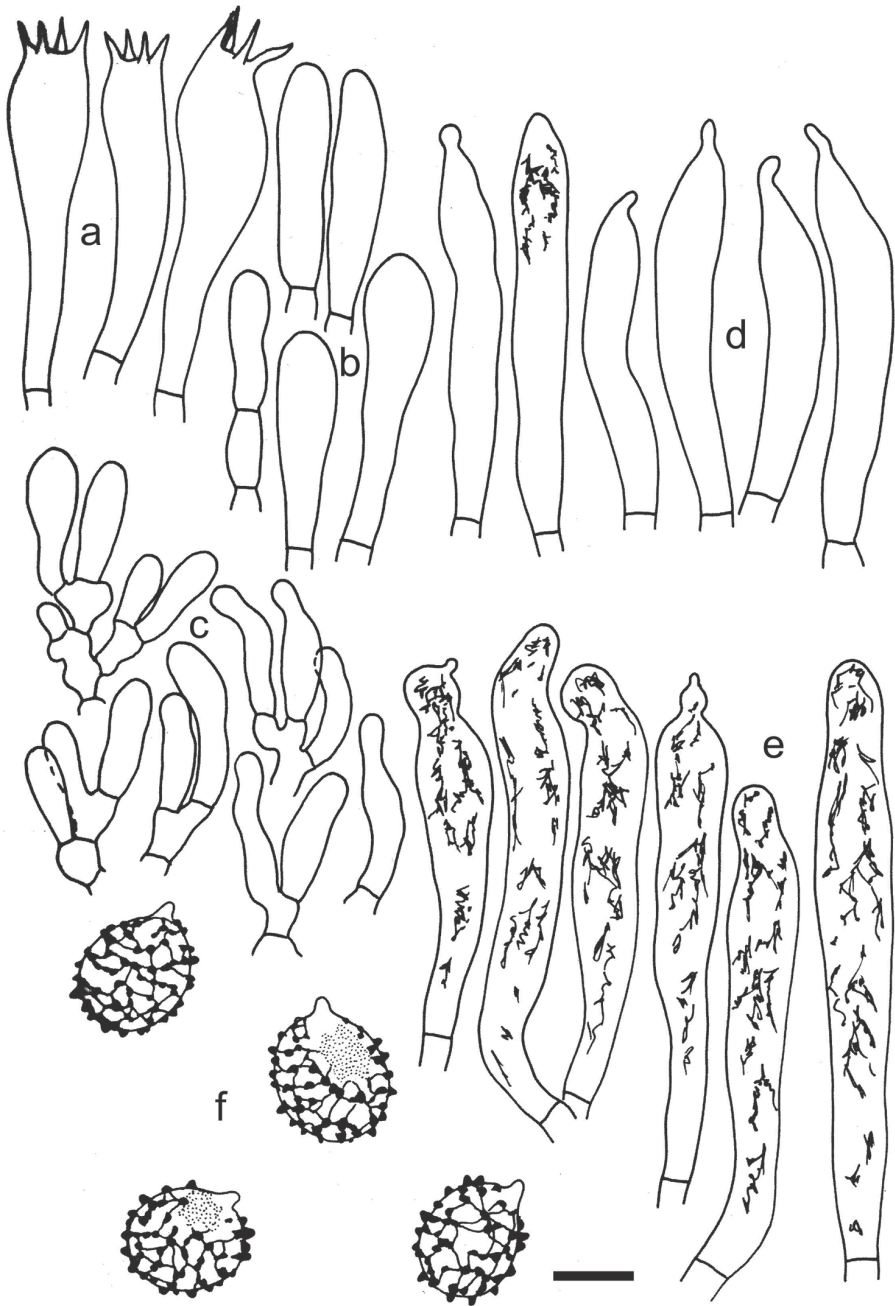


Fig. 52. *Russula simillima* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on edges of the lamellae. **e.** Hymenial cystidia on sides of the lamellae. **f.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red. Scale bar = 10 μ m, but only 5 μ m for spores.

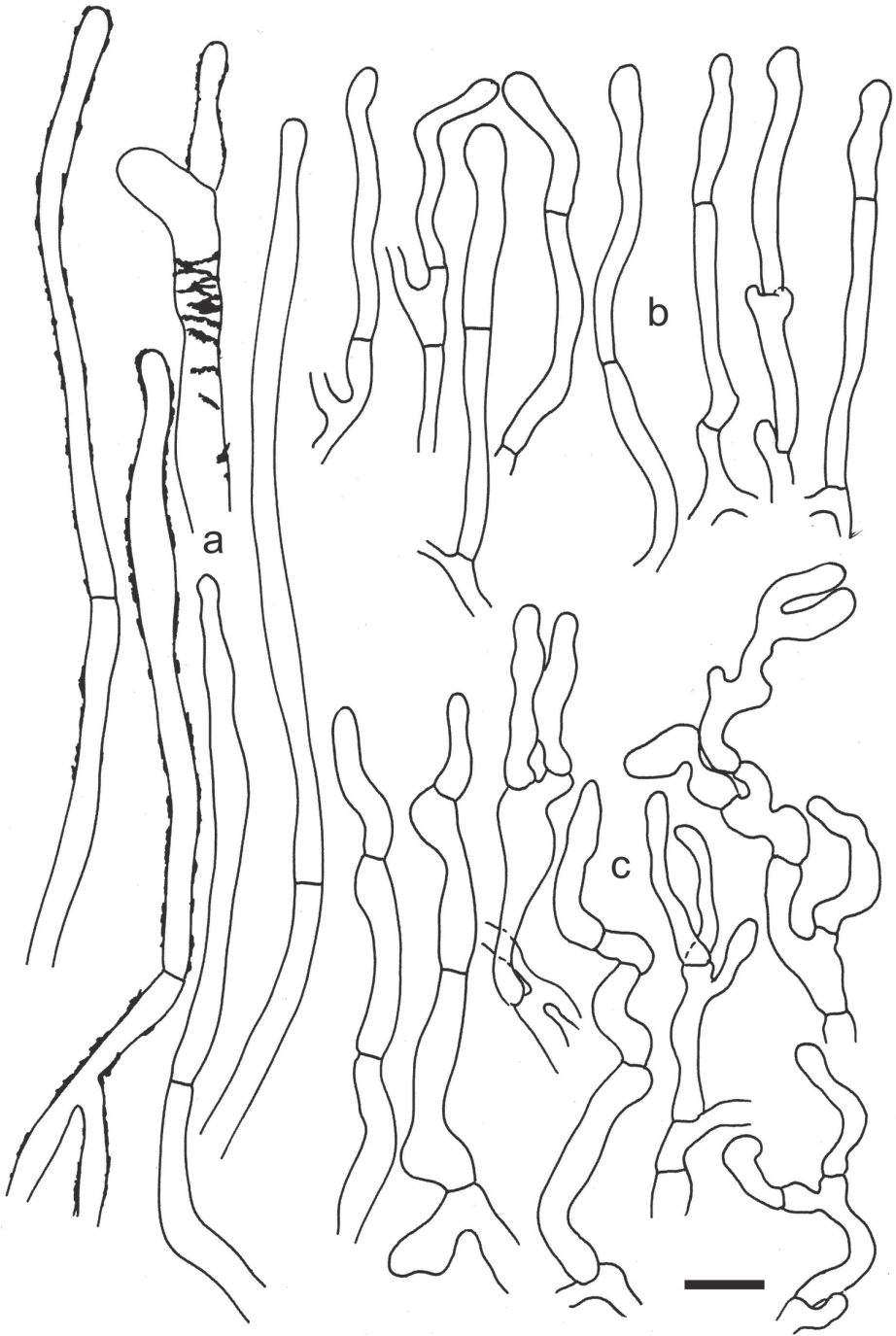


Fig. 53. *Russula subdepallens* (holotype). **a.** Pileocystidia near the pileus margin. **b.** Hyphal terminations near the pileus center. **c.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red. Scale bar = 10 μ m.

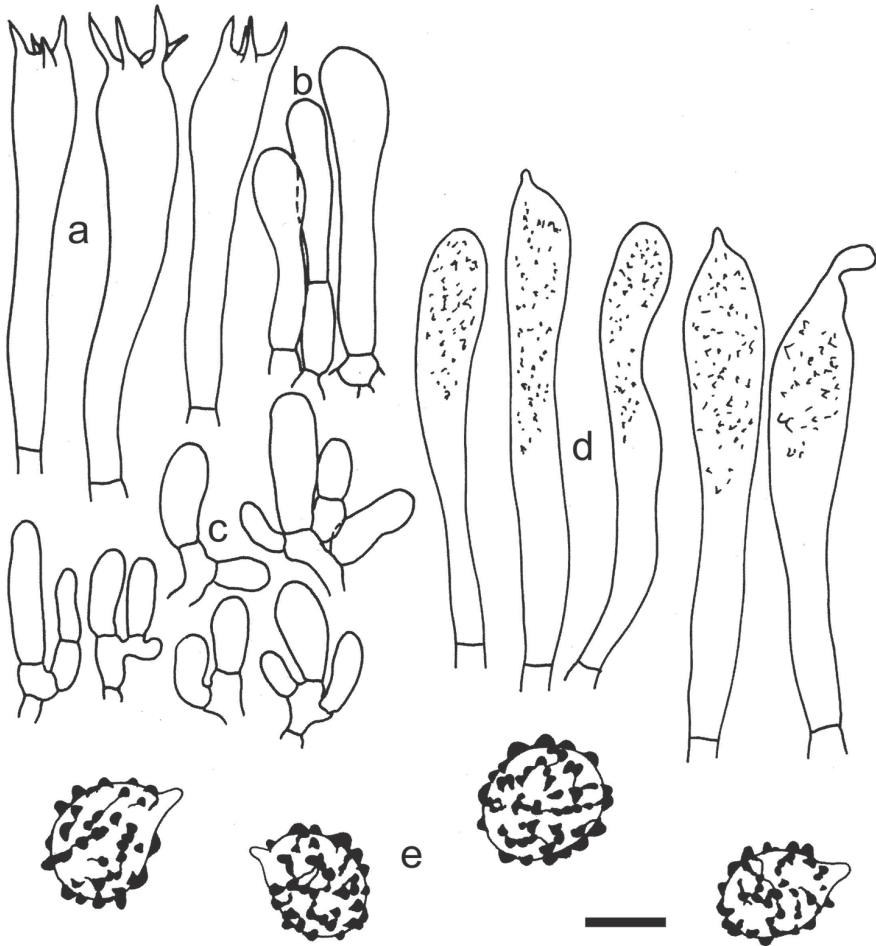


Fig. 54. *Russula subdepallens* (holotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on sides of the lamellae. **e.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red. Scale bar = 10 μm , but only 5 μm for spores.

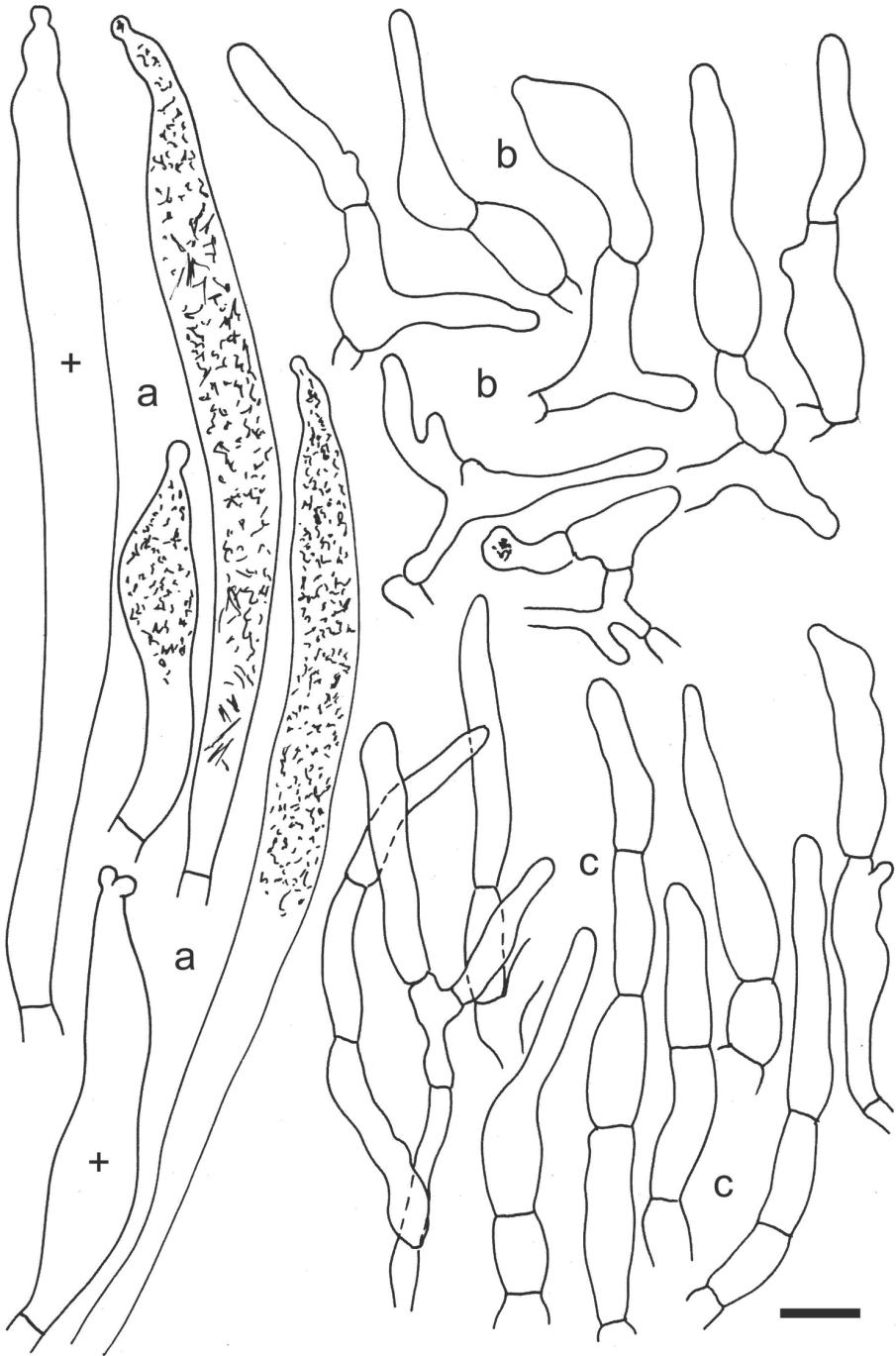


Fig. 55. *Russula viridella* (lectotype). **a.** Pileocystidia near the pileus margin. **b.** Hyphal terminations near the pileus center. **c.** Hyphal terminations near the pileus margin. Cystidial contents as observed in Congo Red, but some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m.

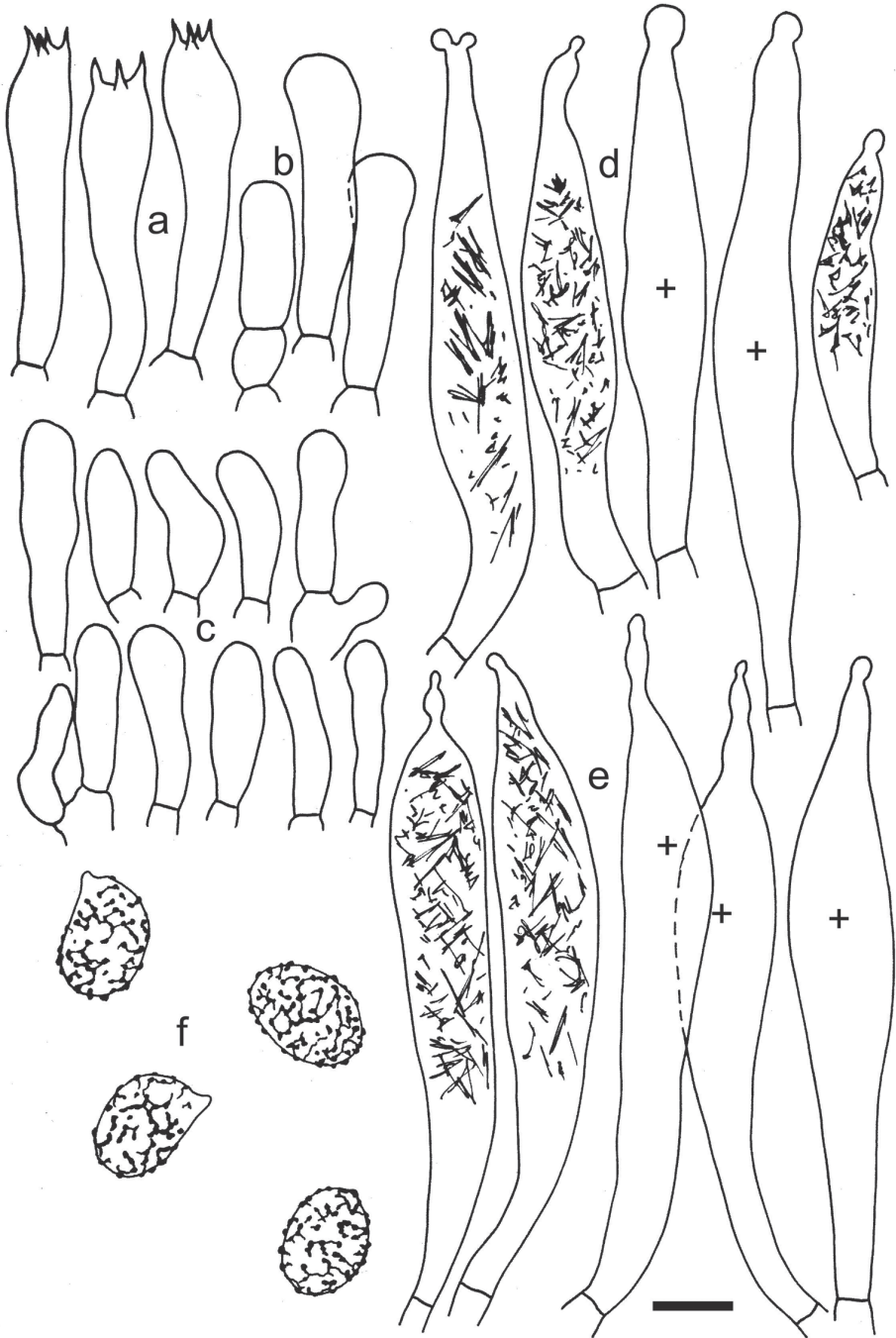


Fig. 56. *Russula viridella* (lectotype). **a.** Basidia. **b.** Basidiola. **c.** Marginal cells on edges of the lamellae. **d.** Hymenial cystidia on edges of the lamellae. **e.** Hymenial cystidia on sides of the lamellae. **f.** Spores as seen in Melzer's reagent. Cystidia with contents as observed in Congo Red, but for some elements with contents indicated schematically by a plus sign (+). Scale bar = 10 μ m, but only 5 μ m for spores