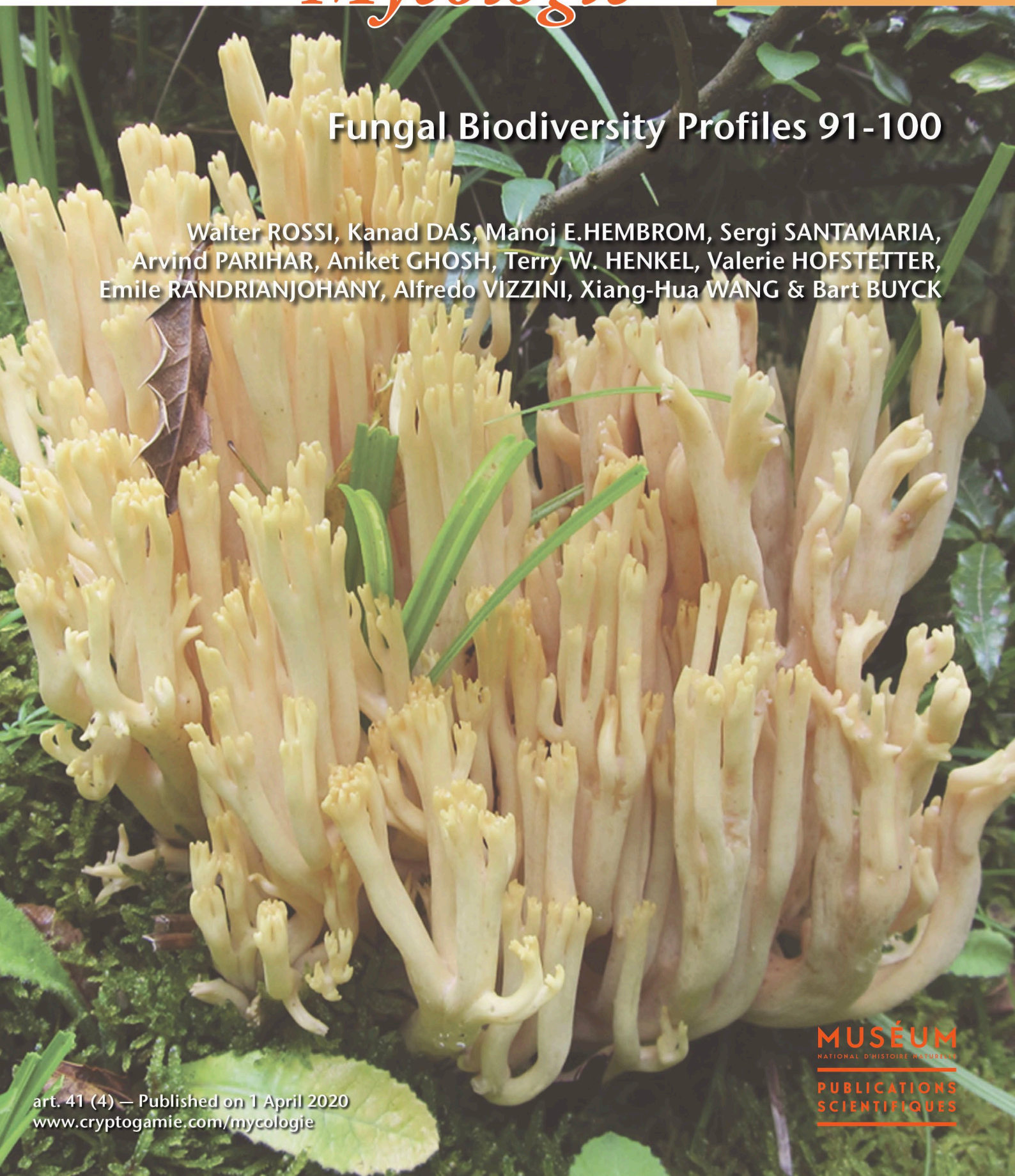
cryptogamie
Mycologie
2020 • 41 • 4

Fungal Biodiversity Profiles 91-100

Walter ROSSI, Kanad DAS, Manoj E.HEMBROM, Sergi SANTAMARIA, Arvind PARIHAR, Aniket GHOSH, Terry W. HENKEL, Valerie HOFSTETTER, Emile RANDRIANJOHANY, Alfredo VIZZINI, Xiang-Hua WANG & Bart BUYCK



art. 41 (4) — Published on 1 April 2020
www.cryptogamie.com/mycologie

MUSÉUM
NATIONAL D'HISTOIRE NATURELLE
PUBLICATIONS SCIENTIFIQUES

Couverture / *Cover* :
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– Biological Abstracts
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– Science Citation Index
– Publications bibliographiques du CNRS (Pascal).

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– BioOne® (http://www.bioone.org/loi/crym)

Cryptogamie, Mycologie est une revue en flux continu publiée par les Publications scientifiques du Muséum, Paris
Cryptogamie, Mycologie *is a fast track journal published by the Museum Science Press, Paris*

Les Publications scientifiques du Muséum publient aussi / *The Museum Science Press also publishes:*
Adansonia, ***Geodiversitas***, ***Zoosystema***, ***Anthropozoologica***, ***European Journal of Taxonomy***, ***Naturae***, **Cryptogamie sous-sections** ***Algologie***, ***Bryologie***.

Diffusion – Publications scientifiques Muséum national d'Histoire naturelle
CP 41 – 57 rue Cuvier F-75231 Paris cedex 05 (France)
Tél. : 33 (0)1 40 79 48 05 / Fax : 33 (0)1 40 79 38 40
diff.pub@mnhn.fr / http://sciencepress.mnhn.fr

ISSN (imprimé / *print*) : 0181-1584/ ISSN (électronique / *electronic*) : 1776-100

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Walter ROSSI
Sect. Environmental Sciences,
Dept. MeSVA, University of L'Aquila, I-67100 L'Aquila (Italy)

Kanad DAS
Acharya Jagadish Chandra Bose Indian Botanic Garden,
Botanical Survey of India, P. O. Botanic Garden, Howrah 711103 (India)
daskanadbsi@gmail.com

Manoj Emanuel HEMBROM
Acharya Jagadish Chandra Bose Indian Botanic Garden,
Botanical Survey of India, P. O. Botanic Garden,Howrah 711103 (India)
manojhembrom@yahoo.co.in

Sergi SANTAMARIA
Unitat de Botànica, Departament de Biologia Animal,
de Biologia Vegetal i d'Ecologia, Facultat de Biociències,
Universitat Autònoma de Barcelona, 08193-Bellaterra, Barcelona (Spain)
sergi.santamaria@uab.cat

Arvind PARIHAR
Acharya Jagadish Chandra Bose Indian Botanic Garden,
Botanical Survey of India P. O. Botanic Garden, Howrah 711103 (India)
arvind_peace@rediffmail.com

Aniket GHOSH
Department of Botany & Microbiology, H. N. B. Garhwal
University (A Central University) Srinagar, Garhwal 246174, Uttarakhand (India)
ghosh.aniket87@gmail.com

Terry W. HENKEL
Department of Biological Sciences, Humboldt State University,
Arcata, California, 95521 (United States)

Valerie HOFSTETTER
Department of Plant Protection,
Agroscope Changins-Wädenswil Research Station ACW,
Route De Duiller, CH-1260 Nyon 1 (Switzerland)
valerie.hofstetter@agroscope.admin.ch

Émile RANDRIANJOHANY
Centre national de Recherche sur l'Environnement (CNRE), BP 1739,
Laboratoire de Microbiologie de l'Environnement (LME),
Antananarivo (Madagascar)
randrianjohanye@yahoo.com

Alfredo VIZZINI
Department of Life Sciences and Systems Biology,
University of Torino, Viale P.A. Mattioli 25, I-10125 Torino (Italy)
alfredo.vizzini@unito.it

Xiang-Hua WANG
CAS Key Laboratory for Plant Diversity and Biogeography of East Asia,
Kunming Institute of Botany, Chinese Academy of Sciences,
Lanhei Road 132, Kunming 650201 (China)
xhwang@mail.kib.ac.cn

Bart BUYCK
ISYEB (CNRS, Sorbonne Université, EPHE)
Institut de Systématique, Évolution, Biodiversité, Muséum national d'Histoire naturelle,
case postale 39, 57 rue Cuvier, F-75231 Paris cedex 05 (France)
bart.buyck@mnhn.fr (corresponding author)

Submitted on 14 November 2019 | Accepted on 19 December 2019 | Published on 1 April 2020

Rossi W., Das K., Hembrom M. E., Santamaria S., Parihar A., Ghosh A., Henkel T. W., Hofstetter V., Randrianohany E., Vizzini A., Wang X.-H. & Buyck B. 2020. — Fungal Biodiversity Profiles 91-100. *Cryptogamie, Mycologie* 41 (4): 69-107. https://doi.org/10.5252/cryptogamie-mycologie2020v41a4. http://cryptogamie.com/mycologie/41/4

ABSTRACT
In this new series of Fungal Biodiversity Profiles, the authors describe three new Laboulbeniales (Ascomycota) based on morphology, viz. *Corethromyces gibbosus* W. Rossi & Santam., sp. nov., *C. marshallii* W. Rossi & Santam., sp. nov. and *Diphymyces torresii* W. Rossi & Santam., sp. nov. In Agaricomycotina (Basidiomycota), morphological features and multigene phylogenetic analyses support the description of *Cantharellus albidosquamosus* Buyck, T. W. Henkel & V. Hofst., sp. nov. (Cantharellales), while morphology and analyses of ITS sequence data support the description of *Gomphidius pseudoglutinosus* K. Das, Hembrom, A. Parihar & Vizzini, sp. nov. (Boletales) and of two Gomphales, *Hymenochaete boddingii* Hembrom, A. Parihar, K. Das & A. Ghosh, sp. nov. and *Ramaria thindii* K. Das, Hembrom, A. Parihar & A. Ghosh, sp. nov. In Russulales, recently published multigene phylogenetic analyses support the description of *Russula antsikana* Buyck & Randrianjohany, sp. nov. from Madagascar, and a barcode ITS sequence is newly provided for the holotype. In addition, a detailed description is given for the type of the West-African *Russula liberiensis* Sing., likely its closest relative. Still in genus *Russula*, a new multigene analysis supports the description of subsect. *Castanopsidum* Buyck & X.H. Wang, subsect. nov. for a species assemblage in the *Russula* crown clade that seems to have its main distribution in Asia.

KEYWORDS
Laboulbeniales,
Ascomycota,
Agaricales,
Boletales,
Gomphales,
Russulales,
new species,
new subsection.

RÉSUMÉ
Profils de la Biodiversité fongique 91-100.
Dans cette nouvelle série de Profils de la Biodiversité fongique, les auteurs décrivent trois nouveaux Laboulbeniales (Ascomycota) en se basant sur la morphologie, à savoir *Corethromyces gibbosus* W. Rossi & Santam., sp. nov., *C. marshallii* W. Rossi & Santam., sp. nov. et *Diphymyces torresii* W. Rossi & Santam., sp. nov. Dans les Agaricomycotina (Basidiomycota), les caractéristiques morphologiques et les analyses phylogénétiques multigènes appuient la description de *Cantharellus albidosquamosus* Buyck, Henkel & V. Hofst., sp. nov. (Cantharellales), tandis que la morphologie et les analyses des données de séquences ITS appuient la description de *Gomphidius pseudoglutinosus* K. Das, Hembrom, A. Parihar & Vizzini, sp. nov. (Boletales) et de deux Gomphales, *Hymenochaete boddingii* Hembrom, A. Parihar, K. Das & A. Ghosh, sp. nov. et *Ramaria thindii* K. Das, Hembrom, A. Parihar & A. Ghosh, sp. nov. Dans les Russulales, des analyses phylogénétiques multigènes récemment publiées justifient la description de *Russula antsikana* Buyck & Randrianjohany, sp. nov. de Madagascar, et une séquence ITS est nouvellement fournie pour l'holotype. En outre, une description détaillée est donnée pour le type de *Russula liberiensis* Sing. d'Afrique de l'Ouest, probablement son parent le plus proche. Toujours dans le genre *Russula*, une nouvelle analyse multigène justifie la description, dans le sous-genre *Russula*, de la sous-section *Castanopsidum* Buyck & X.H. Wang, subsect. nov. pour un assemblage d'espèces ayant leur distribution principale en Asie.

MOTS CLÉS
Laboulbeniales,
Ascomycota,
Agaricales,
Boletales,
Gomphales,
Russulales,
nouvelles espèces,
nouvelle sous-section.

INTRODUCTION

In this new series of Fungal Biodiversity Profiles, the authors describe three new Laboulbeniales (Ascomycota) based on morphology, viz. *Corethromyces gibbosus* W. Rossi & Santam., sp. nov., *C. marshallii* W. Rossi & Santam., sp. nov. and *Diphymyces torresii* W. Rossi & Santam., sp. nov. In Agaricomycotina (Basidiomycota), morphological features and analyses of multi-locus sequence data support the description of *Cantharellus albosquamosus* Buyck, T. W. Henkel & V. Hofst., sp. nov. (Cantharellales), a species from the African rain forest. Morphology and analyses of ITS sequence data support the description of three new species from the Indian Himalaya: *Gomphidius pseudoglutinosus* K. Das, Hembrom, A. Parihar & Vizzini, sp. nov., (Boletales) and two Gomphales, *Hymenochaete boddingii* Hembrom, A. Parihar, K. Das & A. Ghosh, sp. nov. and *Ramaria thindii* K. Das, Hembrom, A. Parihar & A. Ghosh, sp. nov. In Russulales, recently published multigene phylogenetic analyses (Buyck *et al.* 2018) support *Russula antsikana* Buyck & Randrianjohany, sp. nov. from Madagascar, and a barcode ITS sequence is newly provided for the holotype. In addition, a detailed description is given for the type of the West-African *Russula liberiensis* Sing., likely its closest relative. Still in genus *Russula*, a new multigene analysis supports the description of subsect. *Castanopsidum* Buyck & X. H. Wang, subsect. nov., for a species assemblage in the *Russula* crown clade that seems to have its main distribution in Asia. Both for the type species of the new subsection, the Asian *R. castanopsidis* Hongo, and for the recently described *R. purpureogracilis* Hampe & Looney from Thailand (Adamčík *et al.* 2019), we report and illustrate here multiple first collections from China.

MATERIAL AND METHODS

References to a colour code in descriptions follow Kornerup & Wanscher (1981). Short explanations on molecular methods that were used for building phylogenies are given in the legends of the individual phylogenetic trees.

TAXONOMY

Phylum ASCOMYCOTA R.H. Whittaker
Class LABOULBENIOMYCETES Engl.
Order LABOULBENIALES Lindau
Family LABOULBENIACEAE G. Winter
Genus *Corethromyces* Thaxt.

91. ***Corethromyces gibbosus*** W. Rossi & Santam., sp. nov. (Fig. 1)

Relatively small species lacking any blackening and any outgrowth from the receptacle; perithecium small and asymmetrical, with a distinct hump on the ventral side; appendage consisting of a linear series of five gradually smaller cells bearing antheridial branches on the inner side.

HOLOTYPE. — **Ecuador**. Prov. Cotopaxi, Canton Sigchos, San Francisco de Las Pampas, 13.VI.2009, C. Tapia, on elytra of *Dissochaetus curtus* Portevin (Coleoptera, Leiodidae) (FI[FI WR3417]).

MYCOBANK. — MB832702.

ETYMOLOGY. — From Latin : humpbacked, referring to the "hump" on the anterior side of the perithecium.

ADDITIONAL EXAMINED MATERIAL. — Same data as the holotype, at the elytral tips of *D. curtus*, slide WR 3393. **Ecuador**. Prov. Zamora-Chinchipe, Estación Científica San Francisco, 3°58'19"S, 79°04'44.06"W, about 1900 m, 10-14.VIII.2014, M. Bernardi, W. Rossi & J. Torres, on abdominal tip of *Dissochaetus curtus* (para-, FI[FI WR3917]).

DESCRIPTION

Thallus slightly to distinctly bent posteriorly. Perithecium amber-yellow; the rest of the fungus paler to almost hyaline. Including basal cells relatively stocky, about twice as long as broad, distinctly asymmetrical, with the posterior margin almost straight, while the anterior one is very convex, and sometimes forming a distinct "hump" at the junction with the conical tip; the apex is rounded and undifferentiated. Length from foot to perithecial apex 117-163 µm. Perithecium (including basal cells): 61-79 × 30-36 µm. Longest appendage up to 130 µm. Receptacle gradually broadening from below upwards. Cell I irregularly trapezoidal, from slightly to 3× longer than maximum width. Cell II much larger than the former, 2-3× longer than broad, separated from cell III by a very oblique septum, while the septum dividing it from cell VI is shorter and less oblique. Cell III about 1.5× longer than broad, with the upper, outer angle distinctly bulging outwards. Main axis of the appendage consisting of five cells obliquely superposed and gradually smaller, each giving rise from the inner upper side to one or more antheridial branches; the latter consisting of a single series of cells separated by oblique septa, which are converted directed into simple antheridia that in older specimens are replaced by short branchlets. Cell VI shorter and broader than cell III. Cell VII relatively large, clearly bulging externally on the anterior side.

NOTES

The species of *Corethromyces* accepted to date are 89. However, this figure is provisional because the genus limits are not well-defined, notwithstanding the rearrangement carried out by Tavares (1985). Most of these 89 species occur on rove beetles (Coleoptera, Staphylinidae) and six only are found on hosts of other insect families. Three of the latter fungi were described on Leiodidae, the same family of the host of *Corethromyces gibbosus* W. Rossi & Santam., sp. nov. These are *C. bernardii* Haelew. & W. Rossi, *C. bicolor* Thaxt., and *C. henrotii* Balazuc, all of which are not only very different from the new species, but differ greatly also between them. (Haelewaters & Rossi 2015; Rossi & Máca 2006; Weir & Huges 2002).

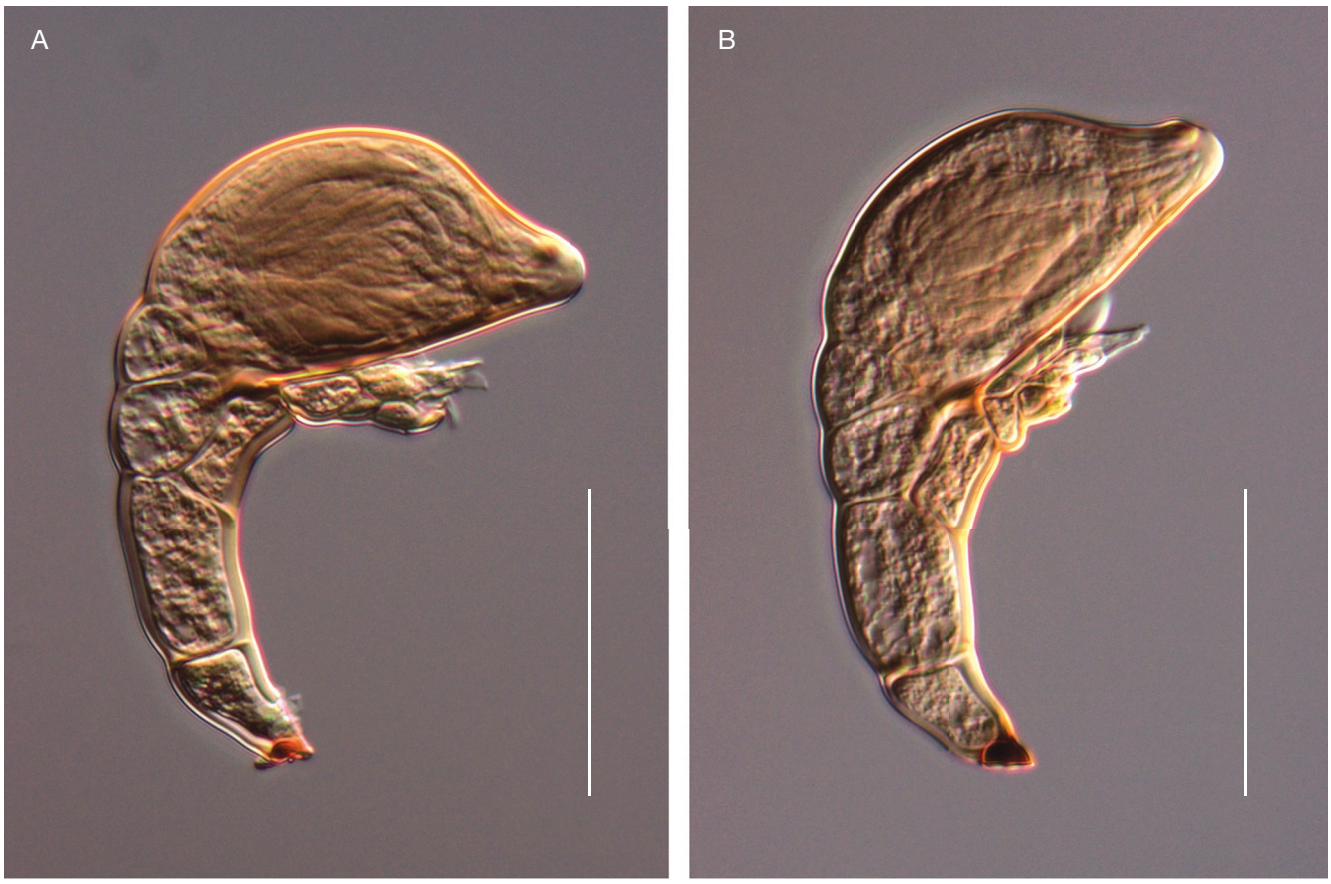


Fig. 1. — *Corethromyces gibbosus* W. Rossi & Santam., sp. nov.: **A**, **B**, two thalli from the type slide. Scale bars : 50 µm.

92. ***Corethromyces marshallii*** W. Rossi & Santam., sp. nov. (Fig. 2)

Thallus lacking any blackening and any outgrowth from the receptacle; cells II, III, and VI hyaline and elongate; perithecium russet, subsymmetrical, pear-shaped.

Holotype. — **Ecuador**. Prov. Napo/Pichincha, Quito-Baeza pass, 4000 m, 4-8.XI.1999, S. A. Marshall, on sternites of *Poecilantrops stellans* Kits & Marshall (Diptera, Sphaeroceridae) (FI[FI WR3521]).

Additional examined material. — Same data as the holotype (para-, FI[WR3530a, WR3530b, WR3531]).

MycoBank. — MB832704.

Etymology. — Named after the entomologist Stephen A. Marshall (Canada), who collected and kindly sent us the insects bearing the new species.

Description

Perithecial venter russet; the rest of the thallus is almost hyaline or very faintly tinged with yellowish gray. Receptacle consisting of three superimposed cells separated by well defined constrictions, of which the basal (cell I) small and strongly bent; the suprabasal (cell II) much larger, subcylindrical, variably elongate, up to four times longer than broad; the stalk cell of the appendage (cell III) elongate, slightly narrower and subequal in length or slightly longer than cell II. Appendage consisting of a large lower cell slightly longer than broad, followed by a linear series of 3-4 much smaller cells, each bearing on both sides short and hyaline branchlets variably branched; in fully mature thalli these branchlets form a rather unclear crest-like series usually exceeding in length the perithecial apex. Stalk cell of the perithecium (cell VI) distinctly shorter and narrower than cell III, usually directed obliquely outwards. The cells above distinguished by an abrupt constriction, relatively large and prominent, forming together a barrel-shaped structure usually longer than the maximum width. Perithecium pear-shaped, with the lower half symmetrically inflated, while the upper, subconical portion tapers gradually to a slightly asymmetrical, blunt apex. Length from foot to perithecial apex 150-295 µm; maximum length from foot to tip of appendages 375 µm; perithecium 53-100 × 23-47. The larger thalli were those growing on the sternites while the smaller ones were observed on the upper surface of the wings (and these latter never exceeding 175 µm from foot to perithecial apex).

Notes

Corethromyces marshallii W. Rossi & Santam., sp. nov., is the first species in the genus *Corethromyces* to be found on a fly: as mentioned above, most of the species in this genus are found on Staphylinidae. *Poecilantrops stellans* is a brachypterous fly living in the moss at high altitudes in the Equadorian Andes.

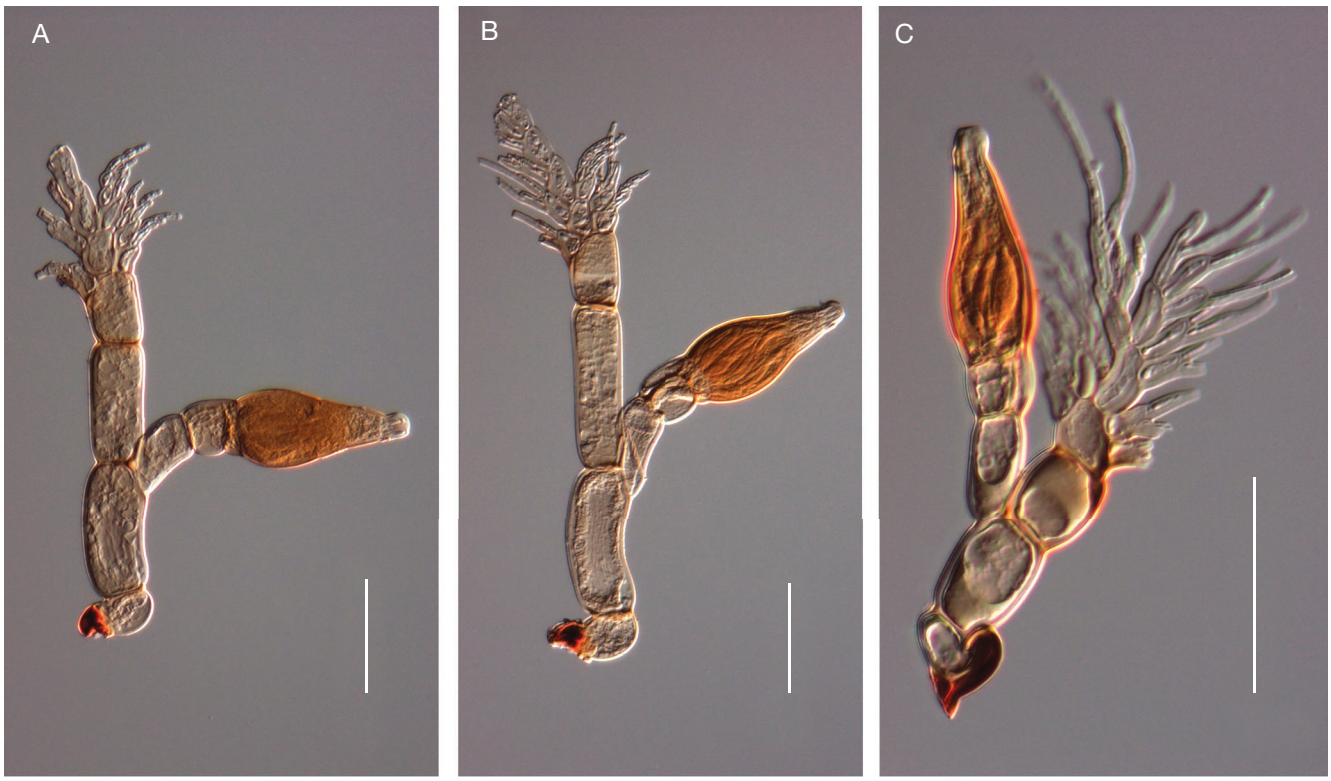


Fig. 2. — *Corethromyces marshallii* W. Rossi & Santam., sp. nov.: **A**, **B**, two thalli from the type slide; **C**, short thallus from the wing of the host insect, paratype WR3531. Scale bars : 50 µm.

The Laboulbeniales reaching the altitude of 4000 m are very few, the record being held by *Laboulbenia montana* W. Rossi & M. Leonardi with 4605 m a.s.l. (Das *et al.* 2018).

Genus *Diphymyces* I. I. Tav.

93. ***Diphymyces torresii*** W. Rossi & Santam., sp. nov. (Fig. 3)

Receptacle and appendage darkened on the posterior side; perithecium elongate and light colored with a distinctly asymmetrical tip lacking any outgrowth.

Holotype. — **Ecuador**. Prov. Zamora-Chinchipe, Estación Científica San Francisco, 3°58'19"S, 79°04'44.06"W, about 1900 m, 10-14. VIII.2014, M. Bernardi, W. Rossi & J. Torres, on right elytron of *Dissochaetus intermedius* Salgado (FI WR3916).

MycoBank. — MB832706.

Etymology. — Named after Juan Andres Torres Celi, student of the Ecuadorian Labulbeniales and one of the collectors of the new species.

Description

Thallus chestnut brown on the posterior side of cells II and III and the lower cells of the appendage, contrasting with the hyaline branchlets of the appendage, and with the remainder of the thallus, which is light brown. Cell I irregularly conical, with the lower, slenderer portion extending beyond the black foot. Cell II quadrangular, slightly broader at the distal end, about twice as long as it is broad. Cell III 1.5× longer than broad, giving rise apically to an erect series of 4-5 cells gradually paler and slenderer, each bearing on the inner side short antheridial branchlets that bifurcate from the base; each branchlet consists of a single series of cells separated by oblique septa, which are converted directly into simple antheridia with upwardly-directed efferent necks. Cell VI similar to cell II but somewhat slenderer, separated from the perithecial basal cells by a very oblique septum. Perithecium slender, about 5× as long as maximum width, very slightly inflated in the lower third; the asymmetrical tip bent posteriorly, somewhat convex on the posterior side and distinctly concave on the opposite side; ending with a blunt, oblique apex. Length from foot to perithecial apex 118-127 µm. Length from foot to longest appendage 113 µm. Perithecium: 82-88 × 17-18 µm. Ascospores about 20 µm in length.

Notes

To date, the number of species in the genus *Diphymyces* is 25, including the new one described here (Rossi & Santamaria 2010, Haelewaters *et al.* 2014, Haelewaters & Rossi 2015). These fungi are all associated with the small carrion beetles (Leiodidae) with the exception of *D. penicillifer* A. Weir & W. Rossi, which occurs on rove beetles (Staphylinidae) (Weir & Rossi 1997). Most of the species of *Diphymyces* are known only from the type series and none of them was reported from the African continent.

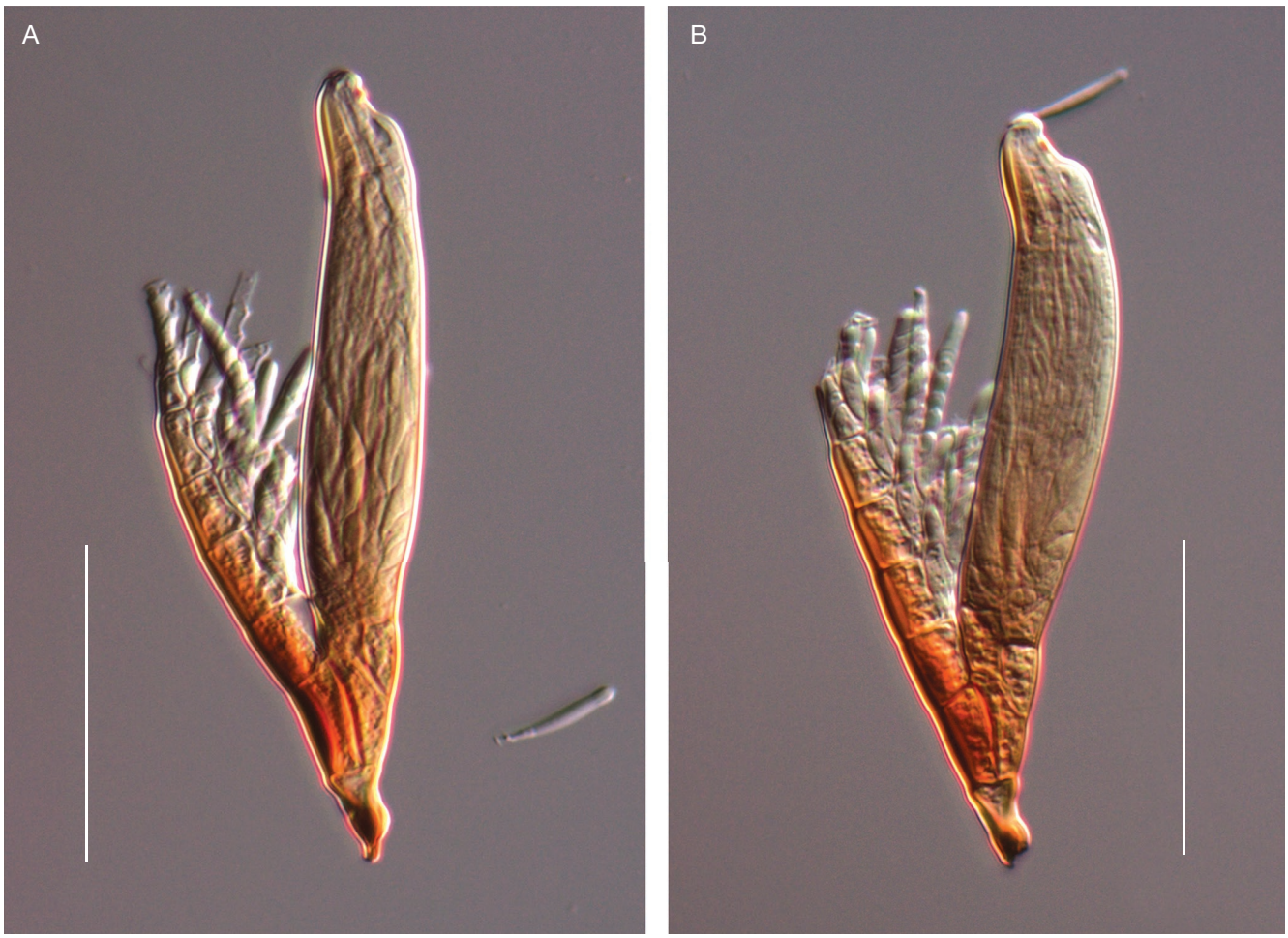


Fig. 3. — *Diphymyces torresii* W. Rossi & Santam., sp. nov.: **A**, **B**, two thalli from the type slide. Scale bars : 50 µm.

Phylum BASIDIOMYCOTA R. T. Moore
Class AGARICOMYCETES Doweld
Order CANTHARELLALES
Family Hydnaceae
Genus *Cantharellus* Adans.: Fr.

94. ***Cantharellus albidosquamosus*** Buyck, T.W. Henkel & V. Hofst., sp. nov. (Figs 4-6)

Differs from other African chanterelles with crowded gill folds by the combination of a white to pale yellow pileus, covered with suberect, dark brown squamulae, the absence of abundant anastomoses in between gill folds, the less intense yellowing of its context or surface upon injuries, and its association with *Uapaca* trees in the Central African rain forest.

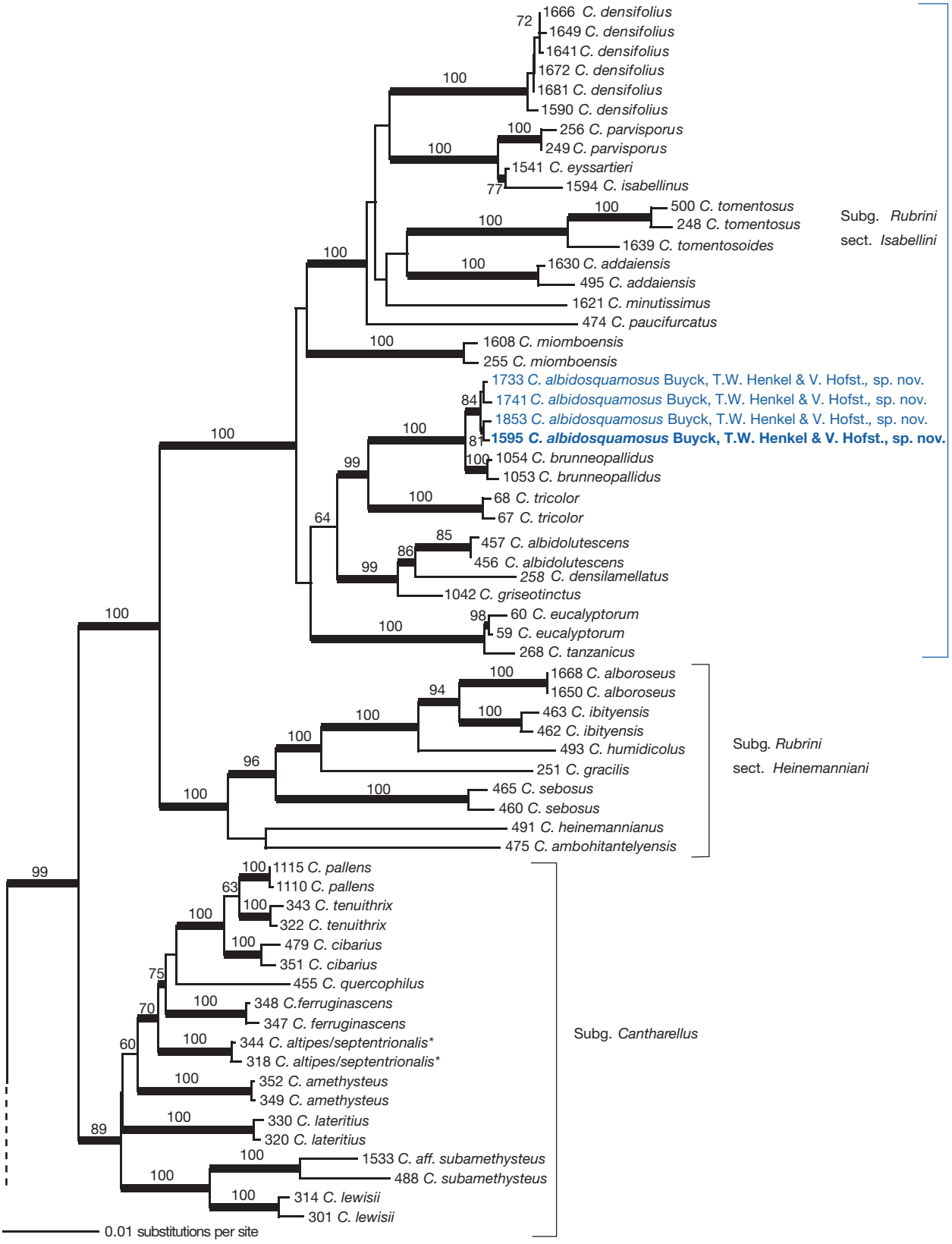
Holotype. — **Cameroon**. Eastern region, Haut-Nyong division, Somalomo subdivision, Dja Biosphere Reserve, in *Gilbertiodendron* rain forest, growing under *Uapaca* sp., 2.IX.2014, T. Henkel TH 10005 (holotype YA; isotypes PC[PC0713875], HSC G1291).

MycoBank. — MB834838.

Additional examined material. — **Cameroon**. Eastern region, Haut-Nyong division, Somalomo subdivision, Dja Biosphere Reserve, W of Dja base camp, *c.* 650 m alt., in *Gilbertiodendron* rain forest, 28.XI.2016, gregarious in group of six on one square meter at the basis of *Uapaca*, TH10314 (PC[PC0142511]); ibid., 400 m N of base camp in mixed forest, under *Uapaca acuminata*, 10.XII.2016, TH10375 (PC[PC0142517]); ibid., *c.* 5 km SW of base camp in *Gilbertiodendron* stand 4; under *G. dewevrei*, 20.IX.2018, TH10705 (TH 10314 (YA, PC[PC0142511], HSC G1292) TH 10375 (YA, PC[PC0142517], HSC G1293) TH 10705 (YA, PC[PC0142531], HSC G1294).

Etymology. — Named after the whitish to very pale yellowish pileus combined with the (often strongly) squamulose aspect of its surface in the pileus center.

Fig. 4. — Upper part of the most likely phlyogram (-ln = 24694.48913) inferred from combined analyses of 4 loci (mitSSU, nucLSU, *RPB2* and *Tef*-1) for 110 specimens (109 *Cantharellus* and one *Craterellus tubaeformis* as the outgroup). The sequences were manually aligned, and the final combined alignment included 3363 characters after exclusion of ambiguous regions (including all introns). Phylogenetic analyses were conducted in PhyML (Guindon & Gascuel 2003) under GTR evolutionary model with the number of substitutions categories, the proportion of invariable sites and the gamma shape parameters estimated during the searches. No significant conflict was detected between the four loci based on comparison of bootstrap values recovered from bootstrap analyses of individual



gene (200 bootstrap replicates with conflict assumed when two different relationships, one being monophyletic and the other being non-monophyletic, for the same set of taxa were both supported with significant bootstrap values equal or greater than 70%; Mason-Gamer & Kellog 1996). Searches for the most likely tree included three independent runs. The holotype of our new species is indicated in **bold**. Branches that received significant bootstrap (BS) support (equal or greater than 70%) based on 500 BS replicates are in bold and BS values indicated along the branches. Newly produced sequences are shown in **bold** in the Table 1.

Fig. 5. — *Cantharellus albidosquamosus* Buyck, T. W. Henkel & V. Hofst., sp. nov. (holotype): field habit. Note the crowded gill folds, strongly squamulose pileus and, on the lower specimen, the weak, yet distinct yellowing context after bruising. Photo Todd Elliott.

Description

Pileus

With downturned, inrolled margin and depressed center when young, then deeply infundibuliform with plane to uplifted and irregularly lobed or wavy margin, 29-46 mm diam., up to 23 mm high, the surface light tannish cream in the center (3-4A3), but topped with flesh brown to reddish brown, minute, fibrillose, erect squamules getting gradually lower, smaller and more and more dispersed toward the pileus margin.

Hymenophore

Decurrent, composed of well-developed, thin and crowded gill folds, these abruptly delimited from sterile stipe surface, repeatedly forking, pale orange-cream (3A2-3), unchanging, easily rubbed off and rather delicate, slightly interveined near the extreme margin; edges smooth.

Stipe

Subcylindrical, 15-18 × 5-7 mm, up to 9 mm wide at apex, concolorous with hymenophore, developing whitish tomentum at the extreme base.

Context

White to pale cream, thin (*c.* 1 mm) in pileus ad mid-radius, very slowly yellowing, very distinctly so in the lower stipe, but not turning ferruginous.

Taste

Mild.

Odor

Typical, of apricots, not strong.

Spores

Spore print not obtained. Shortly ellipsoid, (5.63)6.0-6.42-6.9(7.5) × (3.9)4.2-4.64-5.0(5.2) µm, Q = (1.2)1.3-1.39-1.5(1.6), smooth.

Basidia

Rather short, 35-50 × 6-7 µm, mostly 4-5(-6) spored. Subhymenium strongly pseudoparenchymatic, of large, inflated cells up to 4-5 septa down.

Cystidia

None.

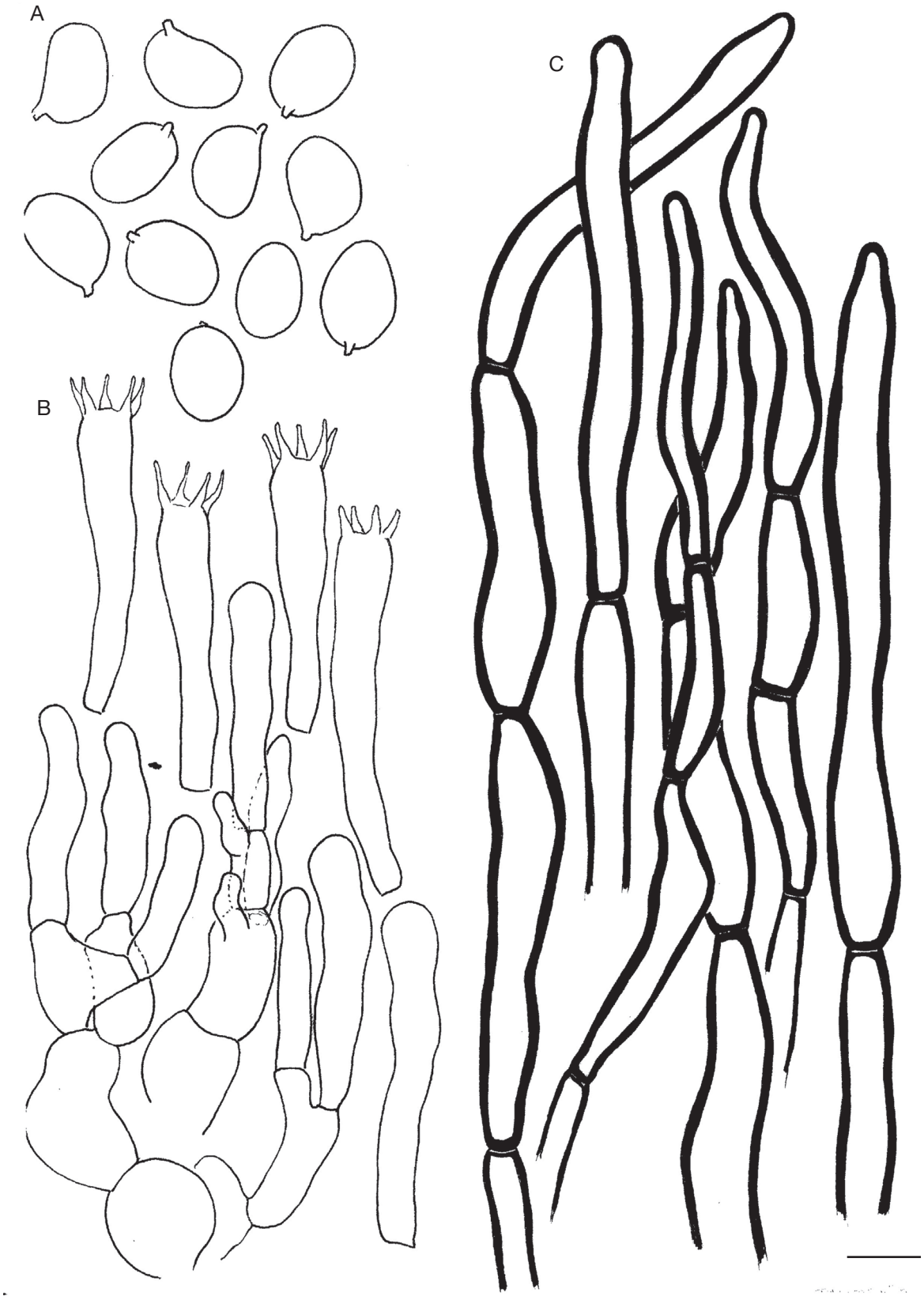


Fig. 6. — *Cantharellus albidosquamosus* Buyck, T. W. Henkel & V. Hofst., sp. nov. (holotype), microscopic features: **A**, spores; **B**, basidia and basidiola; **C**, hyphal extremities of the pileipellis. Scale bar: 10 µm, but only 5 µm for spores. Drawings: B. Buyck.

TABLE 1. Newly produced sequences used in the multilocus analysis (Fig. 4) are given in bold together with indication of extraction number, voucher reference, herbarium barcode number, geographic origin and typification data.

extr. Nr	voucher	PC barcode nr	LSU	mitSSU	RPB2	tef-1	origin	Type status
Cantharellus densifolius Heinem.								
1641	BB 16.021	PC0142486	MK422938	**MT002289**	**MT004798**	MG450680	Central Afr. Rep.	epitype
1672	BB 16.113	PC0142490	**MT002281**	**MT002290**	**MT004799**	MG450683	Central Afr. Rep.	
1681	BB 16.137	PC0142489	MK422939	**MT002288**	**MT004797**	MG450681	Central Afr. Rep.	
1666	BB 16.098		**MT002282**	**MT002291**	**MT004800**	MG450682	Central Afr. Rep.	
1649	16.065	PC0142488	**MT002283**	**MT002292**	**MT004801**	MG450681	Central Afr. Rep.	
Cantharellus tomentosoides Buyck & V. Hofst.								
1639	BB 16.007	PC0142485	MK422937	**MT002295**	**MT004804**	MG450685	Central Afr. Rep.	holotype
Cantharellus eyssartieri Buyck & Randrianjohany								
1541	BB 99.528 (=ER14.003)	PC0085158	MK422936	**MT002294**	**MT004803**	MH643965	Madagascar	holotype
Cantharellus isabellinus Eyssart. & Buyck								
1594	TH 9989	PC0713874	MK422935	**MT002293**	**MT004802**	MH643963	Cameroon	epitype
Cantharellus albidosquamosus Buyck, T. W. Henkel & V. Hofst., sp.nov.								
1595	TH 10005	PC0713875	**MT002284**	**MT002296**	**MT004805**	**MT002269**	Cameroon	holotype
1617	TH 10314	PC0142511	**MT002285**	**MT002297**	**MT004806**	**MT002270**	Cameroon	
1618	TH 10375	PC0142517	**MT002286**	**MT002298**	**MT004807**	**MT002271**	Cameroon	
1619	TH 10705	PC0142531	**MT002287**	**MT002299**	**MT004808**	**MT002272**	Cameroon	
Cantharellus subfloridulus Buyck & V. Hofst.								
1650	BB 16.016	PC0125009	MK422947	**MT002302**	**MT004812**	MG450686	Central Afr. Rep.	holotype
1668	BB 16.106	PC0125011	MK422946	**MT002303**	**MT004813**	MG450687	Central Afr. Rep.	
Cantharellus brunneopallidus Buyck, Randrianjohany & V. Hofst.								
1053	BB 11.105	PC0085584	MK422941	**MT002300**	–	MK422926	Madagascar	holotype
1054	BB 11.116	PC0085585	MK422940	**MT002301**	–	MK422925	Madagascar	paratype

Pileipellis
With hyphal terminations composed of chains of regularly subcylindrical cells, not particularly sinuous nor undulate in outline, 5-10 µm diam., distinctly thick-walled; the terminal cell frequently narrowed at the apex or subapically slightly constricted, not shorter compared to subapical cells, usually 50-100 µm long.

NOTES
Because of the crowded gill folds, our new species is strongly reminiscent of *C. densifolius* Heinem. for which it was undoubtedly mistaken in the past, even more as both are very similar under the microscope (see Buyck *et al.* 2019). The epitypification of *C. densifolius* by Buyck *et al.* (2019) has demonstrated that crowded gills are shared by several, more or less similar species in *C.* subg. *Rubrini* sect. *isabellini* Eyssart. & Buyck. Whereas our new species differs from *C. densifolius* and the recently described *C. tomentosoides* Buyck & V. Hofst. in the general coloration of the various parts of the fruiting body, it is more similar in the field to Malagasy *C. brunneopallidus* Buyck, Randrianjohany & V. Hofst. and *C. griseotinctus* Buyck, Randrianjohany & V. Hofst. (in Hyde *et al.* 2019), although the latter has more widely spaced gill folds. Our multigene phylogenetic analysis indeed places *C. albidosquamosus* Buyck, T. W. Henkel & V. Hofst., sp. nov. sister to the Malagasy *C. brunneopallidus* which is not a close relative to *C. densifolius*. Whereas *C. brunneopallidus* was so far only found under *Intsia* trees (Caesalpiniaceae) on Madagascar's east coast, our new chanterelle seems to have an equally specific habitat as nearly all collections were found under *Uapaca* trees (Phyllantaceae) in the *Gilbertiodendron*-dominated rain forest.

The various collections made for *C. albidosquamosus* Buyck, T.W. Henkel & V. Hofst., sp. nov. show that the strongest impact on its field habit is caused by the intensity of overall yellowing, some specimens becoming entirely pale yellow at maturity. In the latter case, our species is easily distinguished from the equally yellow and squamulose *C. luteopunctatus* Heinem. because the crowded gill folds of the latter species have abundant transversal anastomoses between individual gill folds, whereas these are completely lacking in our new species.

Order BOLETALES E.-J. Gilbert
Family GOMPHIDIACEAE Maire ex Jülich
Genus *Gomphidius* Fr.

95. ***Gomphidius pseudoglutinosus***
K. Das, Hembrom, A. Parihar & Vizzini, sp. nov.
(Figs 7-9)

Differs from other *Gomphidius* by nrITS sequence data and, morphologically, by the combination of the following features: color and size of the basidiomata (pileus 23-80 mm; stipe 40-90 × 10-25 mm), the presence of a glutinous superior annular zone, the yellow surface and context of the stipe base, the size of basidiospores (14.5-16.8-20.0 × 5.35-6.6-7.65 µm) and, finally, also by its exclusive occurrence under *Larix griffithii* Hook. f. in subalpine Himalaya.

HOLOTYPE. — **India**. Sikkim, North district, Dombang valley, 27°43'35.2"N, 88°45'15.2"E, 2920 m a.s.l., on the soil among mosses under *Larix griffithii* Hook.f., 24.VII.2013, *Kanad Das,* KD 13-019 (holo-, CAL[CAL1762]!).

MYCOBANK. — MB830221.

GenBank. — MK602650 (nrITS, holotype), MK602358 (nrITS, paratype).

Etymology. — Referring to the affinity with *G. glutinosus*.

Additional examined material. — **India**. Sikkim, North district, Dombang valley, 27°44'05.6"N, 88°45'56.4"E, 2897 m a.s.l., on the soil among mosses under *Larix griffithii* Hook.f., 22.VII.2013, *Kanad Das,* KD 13-004 (para-, CAL[CAL 1761]).

Description

Pileus
23-80 mm, broadly conical to pyramidal when very young, becoming convex, then plano-concave to broadly infundibuliform with a depressed centre at maturity; surface wet, strongly viscid with thick gluten, more or less smooth, glabrous, reddish golden to brownish orange (6-7C3) when young, then gradually white to greyish red (10A-B6) when gluten layer is eroded, brownish grey (10E2) on bruising, turning olive brown (4E4-5) with FeSO4; margin remains attached to stipe and covered/buried under glutinous velar attachment, incurved at maturity, often marked with thin grey-black lines of spore deposition.

Lamellae
Decurrent, close (*c.* 1/mm at pileus margin), unequal with lamellulae in four series, also forked at different distances, semi-transparent to smoky; edge concolorous.

Stipe
40-90 × 10-25 mm, cylindrical, broader above, gradually tapering at base, white and dry above annulus, lower half more or less lemon yellow to vivid yellow (3A8), becoming brownish with maturity or on bruising.

Annulus
Subapical, a broad, glutinous collar, blackish with spore deposition. *Context* of the pileus white, then pale red (7A3) or pale brownish, unchanging with guaiacol but turning English red to reddish brown (8D-E2) with $FeSO_4$.

Odour
Indistinctive.

Spore print
Black.

Basidiospores
14.5-16.8-20.0 × 5.35-6.6-7.65 µm, Q = 2.0-2.55-3.2, boletoid, apiculate, smooth, dark olivaceous brown, weakly dextrinoid.

Basidia
60-82 × 8-18 µm, clavate-pedicellate, 4-sterigmate; sterigmata 5-10 µm long.

Basidioles
Clavate with narrow stalk.

Pleurocystidia
92-162 × 10-17 µm, cylindrical to subfusiform, thin-walled, encrusted with thick crystals, hyaline in 3% KOH, coffee brown in Melzer's reagent, with dense cytoplasmic contents.

Cheilocystidia
Similar but smaller, 55-98 × 9-20 µm.

Hymenophoral trama
Inamyloid.

Pileipellis
An ixocutis composed of repent hyphae submerged in thick gluten (10-20 µm thick beyond hyphal elements), 2.5-9 µm wide, irregularly inflated, loosely interwoven, smooth (mostly) or encrusted in a somewhat zebroid pattern, hyaline.

Stipitipellis
Similar to pileipellis but more compact, with parallel hyphae, 3-8 µm wide, infrequently encrusted; thromboplerous hyphae present below hyphal layer, 3-8 µm wide, with dense homogeneous cytoplasmic contents, smooth, pale yellow in 3% KOH.

Hyphae of basal mycelium
3-8 µm wide, infrequently clamped, hyaline, few hyphae are olivaceous brown in 3% KOH, smooth to infrequently encrusted.

Clamp connections
Absent.

Notes

Gomphidius pseudoglutinosus K. Das, Hembrom, A. Parihar & Vizzini, sp. nov., representing the first report of the genus *Gomphidius* from India, is characterized by brownish orange to greyish red pileus that turns olive brown with FeSO4, decurrent smoky lamellae, white upper half and yellow lower half of stipe, glutinous annular band on upper half of stipe, thin-walled encrusted hymenial cystidia and its exclusive occurrence under *Larix* in subalpine Himalaya.

The genus *Gomphidius* currently encompasses some 21 accepted names (fide N. Wilson, https://mushroomobserver.org/project/show_project/162), but not all of these have reliable sequence data. When comparing our nrITS sequences through "Pairwise sequence alignment" with those of other *Gomphidius* deposited in GenBank, all are < 97% similar with those of our species, with one exception: a sequence from neighbouring Yunnan, China, identified as *G. 'aff. glutinosus'* (EU791578, see Li *et al.* 2009), which might represent and earlier collection of our new species (sequence similarity of 99.63% for 84% query coverage).

Our phylogenetic analysis (Fig. 7) suggests, although without support, that our new species is most closely related to

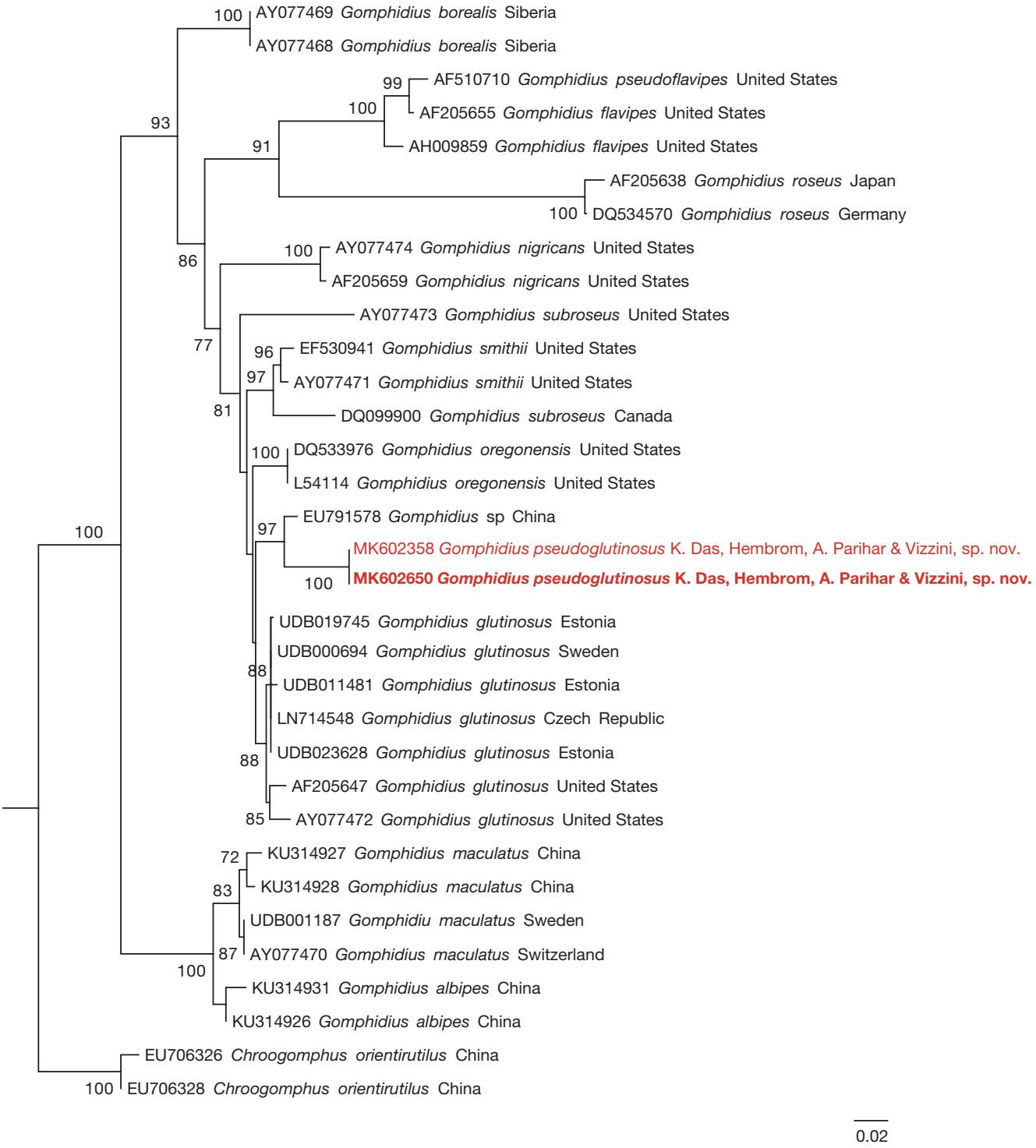


Fig. 7. — Maximum Likelihood (ML) phylogram inferred from raxmlGUI (Silvestro & Michalak 2012) based on nrITS sequences of *Gomphidius*. One thousand bootstrap replicates were analyzed to obtain nodal support values. Bootstrap support values (>70%) obtained from ML analysis are shown above or below the branches at nodes. Both collections of the novel Indian species are shown in red and the holotype is in **bold**.

the North American *G. subroseus* Kauffman and *G. smithii* Singer, and these three species are then suggested to be most closely related to *G. glutinosus* (Schaeff.) Fr., originally reported from Europe but later also found in North America (Miller & Miller 2006, Desjardin *et al.* 2015). Together, these four species form a significantly supported clade (77% BS) with *G. oregonensis* Peck, originally described from the Pacific North West and present in all the Pacific coast states. None

Fig. 8. — *Gomphidius pseudoglutinosus* K. Das, Hembrom, A. Parihar & Vizzini, sp. nov. (from holotype): **A**, **B**, fresh basidiomata in the forest and basecamp; **C**-**E**, basidiomata showing yellowish context towards stipe base; **F**, transverse section through lamella showing cheilocystidia; **G**, transverse section through pileipellis; **H**-**I**, cheilocystidia; **J**, basidium; **K**, basidiospores. Scale bars: F-G, 20 µm; H-K, 10 µm.

Fig. 9. — *Gomphidius pseudoglutinosus* K. Das, Hembrom, A. Parihar & Vizzini, sp. nov. (from holotype): **A**, basidiospores; **B**, cheilocystidia; **C**, pleurocystidia; **D**, basidia and basidioles; **E**, pileipellis. Scale bars: A-D, 10 µm; E, 25 µm.

of these other *Gomphidius*, however, is associated with *Larix*. The only other *Gomphidius* associated with *Larix* are the European *G. maculatus* (Scop.) Fr., the Russian *G. borealis* O.K. Mill., Aime & Peintner, and the recently described *G. albipes* Y. Li & L.L.Qi from northeastern China (Qi *et al.* 2017).

Gomphidius pseudoglutinosus K. Das, Hembrom, A. Parihar & Vizzini, sp. nov., is associated with *Larix griffithii* or Sikkim Larch, a tree found in Nepal, Sikkim (India), Bhutan and China, which figures on the IUCN red list of threatened plants.

Order HYMENOCHAETALES Oberw.
Family HYMENOCHAETACEAE Imazeki & Toki
Genus *Hymenochaete* Lév.

96 *Hymenochaete boddingii*
Hembrom, A. Parihar, K. Das & A. Ghosh, sp. nov.
(Figs 10-12)

Differs from allied taxa by combination of features like stipitate to substipitate (with primitive stipe mostly) humicolous basidiomata that arises from dead and decaying wood of *Shorea robusta* on the ground, with legulate pileus combined to form rosette shape macroscopically, minute ovoid basidiospores and sequence data of nrITS and nrLSU.

HOLOTYPE. — **India**. Jharkhand, Rajmahal hills, Sahibganj-district, Borio-block, from Sahibaganj-Borio road to Gowaibhita and surroundings, on the buried root and fallen litters of *Madhuca longifolia* (J. Koenig ex L.) J. F. Macbr. tree in *Shorea robusta* Gaertn. dominated forest, 152 m, 25°10'40.1"N, 87°40'29.4"E, 24.VIII.2013, *M. E. Hembrom*, MEH-66068 (holo-, CAL[CAL1784]!).

MYCOBANK — MB831414.

GENBANK. — MN030343 (nrITS, holotype), MN030341-MN030344 (nrITS); MN030345 (nrLSU, holotype), MN030346-MN030347 (nrLSU).

ETYMOLOGY. — Dedicated to Reverend Paul Olaf Bodding, a Norwegian missionary, linguist, folklorist and ethnobotanist who undertook pioneer work on the macrofungi of Rajmahal Hills.

ADDITIONAL SPECIMENS EXAMINED. — **India**. Jharkhand, Rajmahal hills, Sahibganj-district, Mandro-block, near fossil park forest, 25°01'31.5"N, 87°31'21.3"E, 144 m a.s.l., probably on the buried root of *Shorea robusta*, 24.VIII.2013, *M. E. Hembrom*, MEH-66068; *ibid.*, Sahibganj-district, Borio-block, Dhogoda paharia, north to Teenpahar-Borio road, 25°02'16.8"N, 87°39'40.0"E, 130 m a.s.l., on the soil near the cut stump of *S. roubusta*, 4.IX.2013, *M. E. Hembrom*, MEH-66150; *ibid.*, Sahibganj-district, Taljhari-block, Birdan (Brindaban) Panchayat, Joshkuti Rakha Bir, 25°01'50.5"N, 87°42'17.1"E, 62 m a.s.l. on the soil near the cut stump of *S. roubusta*, 31.VIII.2013, *M. E. Hembrom*, MEH-66150; *ibid.*, Taljhari-block, Birdan (Brindaban) Ludu Dumri, 25°01'13.4"N, 87°41'16.1"E, 85 m a.s.l., on the soil near the cut stump of *S. roubusta*, 31.VIII.2013, *M. E. Hembrom*, MEH-66150; *ibid.*, Sahibganj-district, Pathna-block, Pandan Bhitta and surroundings, 24°48'12.0"N, 87°39'01.4"E, 142 m a.s.l., on the soil near the cut stump of *S. roubusta*, 6.IX.2013, *M. E. Hembrom*, MEH-66176; *ibid.*, Rajmahal hills, Godda-district, Boarijore-block, Mangra village forest area, 25°09'45.9"N, 87°44'14.6"E, 65 m a.s.l., on the soil near the living tree of *M. longifolia*, 1.IX.2013, *M. E. Hembrom*, MEH-66163; *ibid.*, Rajmahal hills, Pakur-district, Litipara- block, Sathia, towards Narchi, 24°44'00.4"N, 87°29'44.2"E, 108 m a.s.l., on the soil near the cut stump of *Shorea roubusta*, 6.IX.2014, *M. E. Hembrom*, MEH-66391; *ibid.*, Litipara- block, Talpahari forest area, 24°36'55.5"N, 87°40'49.7"E, 106 m a.s.l. on the soil near the cut stump of *S. roubusta*, 22.IX.2014, *M. E. Hembrom*, MEH-66332; *ibid.*, Rajmahal hills, Dumka-district Kathikund-block, Talpahari Chaudhari forest area, 24°22'38.5"N, 87°27'36.2"E, 179 m a.s.l., on the soil near the cut stump of *Shorea roubusta*, 21.X.2015, *M. E. Hembrom*, MEH-69938; *ibid.*, Dumka-district, Maslia-block, Doman pahari, 24°13'56.3"N, 87°11'35.8"E, 180 m a.s.l., on the soil near the cut stump of *Shorea roubusta*, 31.X.2016, *M. E. Hembrom*, MEH-69996.

DESCRIPTION

Basidiomata

30-60 mm high and 5-150 mm wide, annual, solitary to gregarious, caespitose, consists of several legulate pilei joined together to form rosette appearance having short tapered stipe, consistency leathery and elastic when fresh while brittle and light when dry.

Pileus

5-50 × 3-45 mm and 0.5-1.5 mm thick near base, flabelliform to reniform, papery thin but gradually thickening towards base, many ligulate pileus arising from a common stipe to form rosette shape, pilear surface villose to tomentose when fresh, becoming glabrous at maturity; surface concentrically sulcate, weakly to distinctly zonate, marginal part light orange (5A4) to mid linoleum brown (5E7) and towards base coffee (5F7) to light orange to greyish orange (5A4-B4) when fresh, tobacco brown when dry.

Margin

Acute when young turning irregularly crenate to interrupted at maturity, sulcate, entire to lobed, recurved on maturity to golden yellow when fresh, pale yellow to concolourous when dry.

Hymenophore

Smooth when young gradually sulcate to papillate at maturity, decurrent and extended up to stipe, dull violet (18D3–E4) to almost purplish grey when fresh turning topaz to dull violet (5C5-18D3) to almost pale brownish with shades of mouse grey.

Context

0.4-0.8 mm wide, smooth, homogenous, compact, concolorous with pileus.

Stipe

Short but distinct (mostly) to long prostrate along with ground (rarely), 5-70 mm long and 3-10 mm in diameter sometimes widening up to 15 mm forming bulges, terminally either solitary/branched ends with several pilei; stipe irregularly cylindrical, solid, surface with small irregular outgrowths (protrudences), tomentose due to projecting setae, microscopically fertile bearing all the hymeneal structures, golden brown to coffee (5D7-F7).

Hyphal system

Monomitic, hyphae septate, thin-to distinctly thick-walled, pale yellow to yellowish brown, acyanophilic, inamyloid.

Tomentum

Trichoderm, composed of densely arranged erect hyphae of 2.5-5 µm wide, branched, septate, hyaline.

Pileus context

Composed of compactly interwoven hyphae ending with compact to loosely arranged subhymeneal region from where hymeneal setae arises, generative hyphae 2.5-5 µm wide.

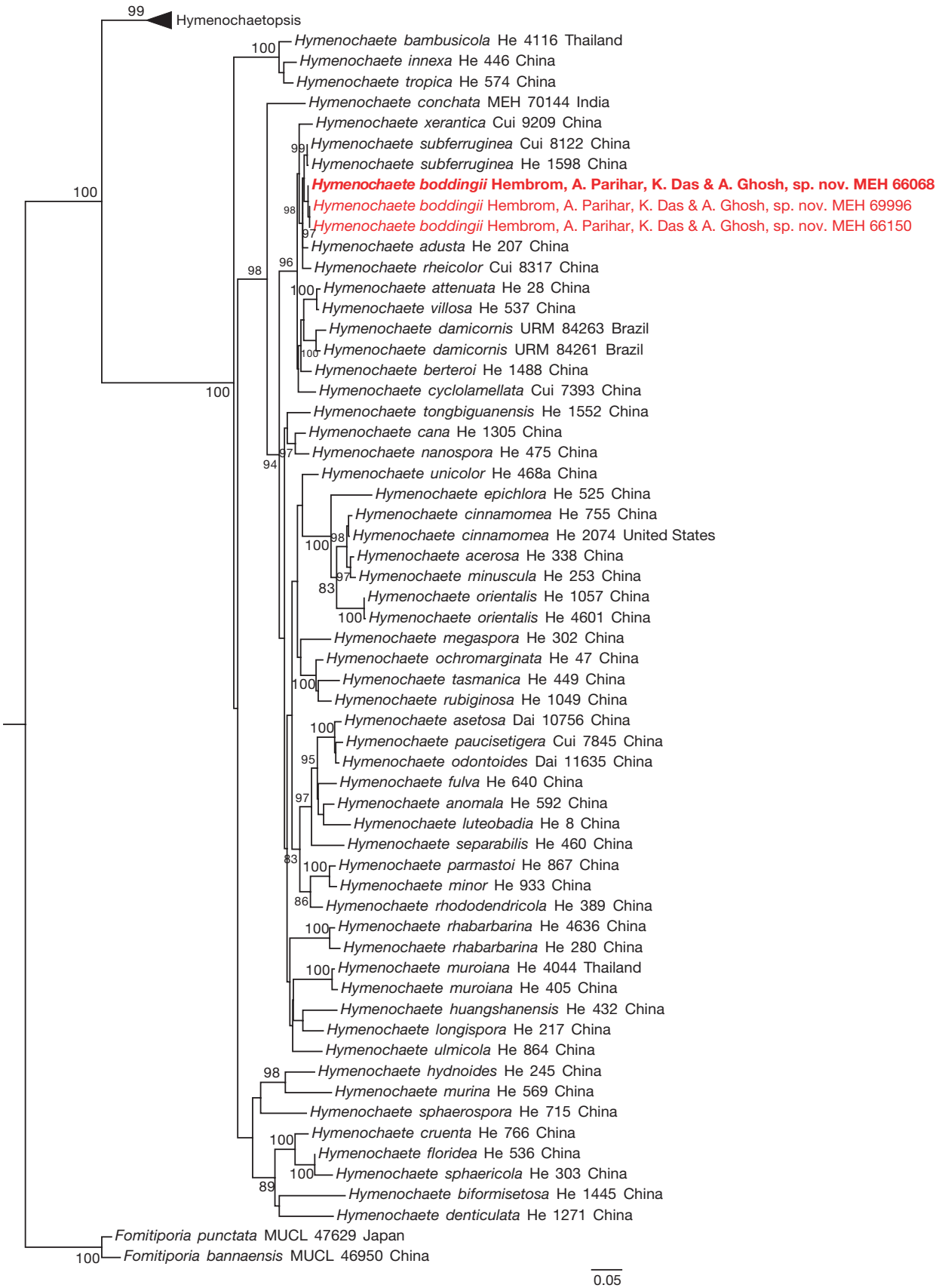


FIG. 10. — A Maximum Likelihood (ML) phylogram inferred from raxmlGUI (Silvestro & Michalak 2012) on a concatenated dataset of nrITS and nrLSU sequence data of *Hymenochaete* and *Hymenochaetopsis* species. One thousand bootstrap replicates were analyzed to obtain nodal support values. Bootstrap support values (>70%) obtained from ML analysis are shown above or below the branches at nodes. Three collections of our novel Indian species are shown in red and the holotype in **bold** in the phylogram. See Table 2 for details on used vouchers for the phylogenetic analysis.

Fig. 11. — *Hymenochaete boddingii* Hembrom, A. Parihar, K. Das & A. Ghosh, sp. nov. (from holotype): **A**-**D**, fresh basidiomata in the forest and basecamp; **E**, transverse section of the basidiomata showing compactly interwoven hyphae and hymeneal region; **F**, transverse section through hymenium; **G**, hymenial setae; **H**, thin- to distinctly thick-walled generative hyphae; **I**-**K**, basidia; **L**, cystidioles; **M**, *Hymenophore* showing setae, cystidioles, hyphidia, basidioles and basidia; **N**, basidiospores. Scale bars: E-F, 50 µm; G-N, 10 µm.

TABLE 2. — A list of species, specimens, and GenBank accession number of species used in this study.

Species name	Sample no.	GenBank accession no. ITS	GenBank accession no. nLSU	Reference
Hymenochaete acerosa	He 338	JQ279543	JQ279657	He & Dai 2012; Nie *et al*. 2017
H. adusta	He 207	JQ279523	KU975497	He & Dai 2012; Nie *et al*. 2017
H. anomala	He 592	JQ279566	JQ279650	He & Dai 2012; Nie *et al*. 2017
H. asetosa	Dai 10756	JQ279559	JQ279642	He & Dai 2012; Nie *et al*. 2017
H. attenuata	He 28	JQ279526	JQ279633	He & Dai 2012; Nie *et al*. 2017
H. bambusicola	He 4116	KY425674	KY425681	Nie *et al*. 2017; Nie *et al*. 2017
H. berteroi	He 1488	KU975459	KU975498	Yang *et al*. 2016
H. biformisetosa	He 1445	KF908247	KU975499	Yang & He 2014; Nie *et al*. 2017
H. boddingii	MEH 66068	MN030343	MN030345	In this study
H. boddingii	MEH 69996	MN030341	MN030347	In this study
H. boddingii	MEH 66150	MN030344	MN030344	In this study
H. cana	He 1305	KF438169	KF438172	He & Li 2014; Nie *et al*. 2017
H. cinnamomea	He 755	JQ279548	JQ279658	He & Dai 2012; Nie *et al*. 2017
H. cinnamomea	He 2074	KU975460	KU975500	Nie *et al*. 2017; Nie *et al*. 2017
H. conchata	MEH 70144	MF373838	—	Hembrom *et al*. 2017
H. cruenta	He 766	JQ279595	JQ279681	He & Dai 2012; Nie *et al*. 2017
H. cyclolamellata	Cui 7393	JQ279513	JQ279629	He & Dai 2012; Nie *et al*. 2017
H. damicornis	URM 84261	KC348466	—	Araujo *et al*. 2014
H. damicornis	URM 84263	KC348467	—	Araujo *et al*. 2014
H. denticulata	He 1271	KF438171	KF438174	He & Li 2014; Nie *et al*. 2017
H. epichlora	He 525	JQ279549	JQ279659	He & Dai 2012; Nie *et al*. 2017
H. floridea	He 536	JQ279597	JQ279683	He & Dai 2012; Nie *et al*. 2017
H. fulva	He 640	JQ279565	JQ279648	He & Dai 2012; Nie *et al*. 2017
H. huangshanensis	He 432	JQ279533	JQ279671	He & Dai 2012; Nie *et al*. 2017
H. hydnoides	He 245	JQ279590	JQ279680	He & Dai 2012; Nie *et al*. 2017
H. innexa	He 446	JQ279585	JQ279673	He & Dai 2012; Nie *et al*. 2017
H. longispora	He 217	JQ279537	KU975514	He & Dai 2012; Nie *et al*. 2017
H. luteobadia	He 8	JQ279569	KU975515	He & Dai 2012; Nie *et al*. 2017
H. megaspora	He 302	JQ279553	JQ279660	He & Dai 2012; Nie *et al*. 2017
H. minor	He 933	JQ279555	JQ279654	He & Dai 2012; Nie *et al*. 2017
H. minuscula	He 253	JQ279546	KU975516	He & Dai 2012; Nie *et al*. 2017
H. murina	He 569	JQ716406	JQ716412	He and Li 2013; Nie *et al*. 2017
H. muroiana	He 405	JQ279542	KU975517	He & Dai 2012; Nie *et al*. 2017
H. muroiana	He 4044	KY425676	KY425684	Nie *et al*. 2017
H. nanospora	He 475	JQ279531	JQ279672	He & Dai 2012; Nie *et al*. 2017
H. ochromarginata	He 47	JQ279579	JQ279666	He & Dai 2012; Nie *et al*. 2017
H. odontoides	Dai 11635	JQ279563	JQ279647	He & Dai 2012; Nie *et al*. 2017
H. orientalis	He 1057	KY425678	KY425686	Nie *et al*. 2017
H. orientalis	He 4601	KY425677	KY425685	Nie *et al*. 2017
H. parmastoi	He 867	JQ780063	KU975518	He & Li 2012; Nie *et al*. 2017
H. paucisetigera	Cui 7845	JQ279560	JQ279644	He & Dai 2012; Nie *et al*. 2017
H. rhabarbarina	He 280	JQ279574	KY425688	He & Dai 2012; Nie *et al*. 2017
H. rhabarbarina	He 4636	KY425680	KY425689	Nie *et al*. 2017
H. rheicolor	Cui 8317	JQ279529	—	He & Dai 2012
H. rhododendricola	He 389	JQ279577	JQ279653	He & Dai 2012; Nie *et al*. 2017
H. rubiginosa	He 1049	JQ716407	JQ279667	He & Li 2013; Nie *et al*. 2017
H. separabilis	He 460	JQ279572	JQ279655	He & Dai 2012; Nie *et al*. 2017
H. sphaericola	He 303	JQ279599	JQ279684	He & Dai 2012; Nie *et al*. 2017
H. sphaerospora	He 715	JQ279594	KU975531	He & Dai 2012; Nie *et al*. 2017
H. subferruginea	Cui 8122	JQ279521	—	He & Dai 2012
H. subferruginea	He 1598	KU975481	—	Yang & He 2017
H. tasmanica	He 449	JQ279582	JQ279663	He & Dai 2012; Nie *et al*. 2017
H. tongbiguanensis	He 1552	KF908248	KU975532	Yang & He 2014; Nie *et al*. 2017
H. tropica	He 574	JQ279587	JQ279675	He & Dai 2012; Nie *et al*. 2017
H. ulmicola	He 864	JQ780065	KU975534	Nie *et al*. 2017; Nie *et al*. 2017
H. unicolor	He 468	JQ279551	JQ279662	He & Dai 2012; Nie *et al*. 2017
H. villosa	He 537	JQ279528	JQ279634	He & Dai 2012; Nie *et al*. 2017
H. xerantica	Cui 9209	JQ279519	JQ279635	He & Dai 2012; Nie *et al*. 2017
Hymenochaetopsis corrugata	He 761	JQ279606	JQ279621	He & Dai 2012; Nie *et al*. 2017
H. intricata	He 412	JQ279608	JQ279624	He & Dai 2012; Nie *et al*. 2017
H. lamellata	Cui 7629	JQ279603	JQ279617	He & Dai 2012; Nie *et al*. 2017
H. laricicola	Dai 13485	KT828672	KT828676	Yang *et al*. 2016; Nie *et al*. 2017
H. latesetosa	He 502	JQ716405	JQ716410	He & Li 2012; Nie *et al*. 2017
H. olivacea	Dai 12789	KT828678	KT828679	Yang *et al*. 2016; Nie *et al*. 2017
H. rigidula	He 379	JQ279613	JQ279620	He & Dai 2012; Nie *et al*. 2017
H. subrigidula	He 1157	JQ716403	JQ716409	He & Li 2012; Nie *et al*. 2017
H. tabacina	He 810	JQ279611	JQ279626	He & Dai 2012; Nie *et al*. 2017
H. tabacinoides	Cui 10428	JQ279604	JQ279618	He & Dai 2012; Nie *et al*. 2017
Fomitiporia bannaensis	MUCL 46950	GU461943	EF429218	Amalfi *et al*. 2010; Nie *et al*. 2017
F. punctata	MUCL 47629	GU461950	GU461982	Amalfi *et al*. 2010; Nie *et al*. 2017

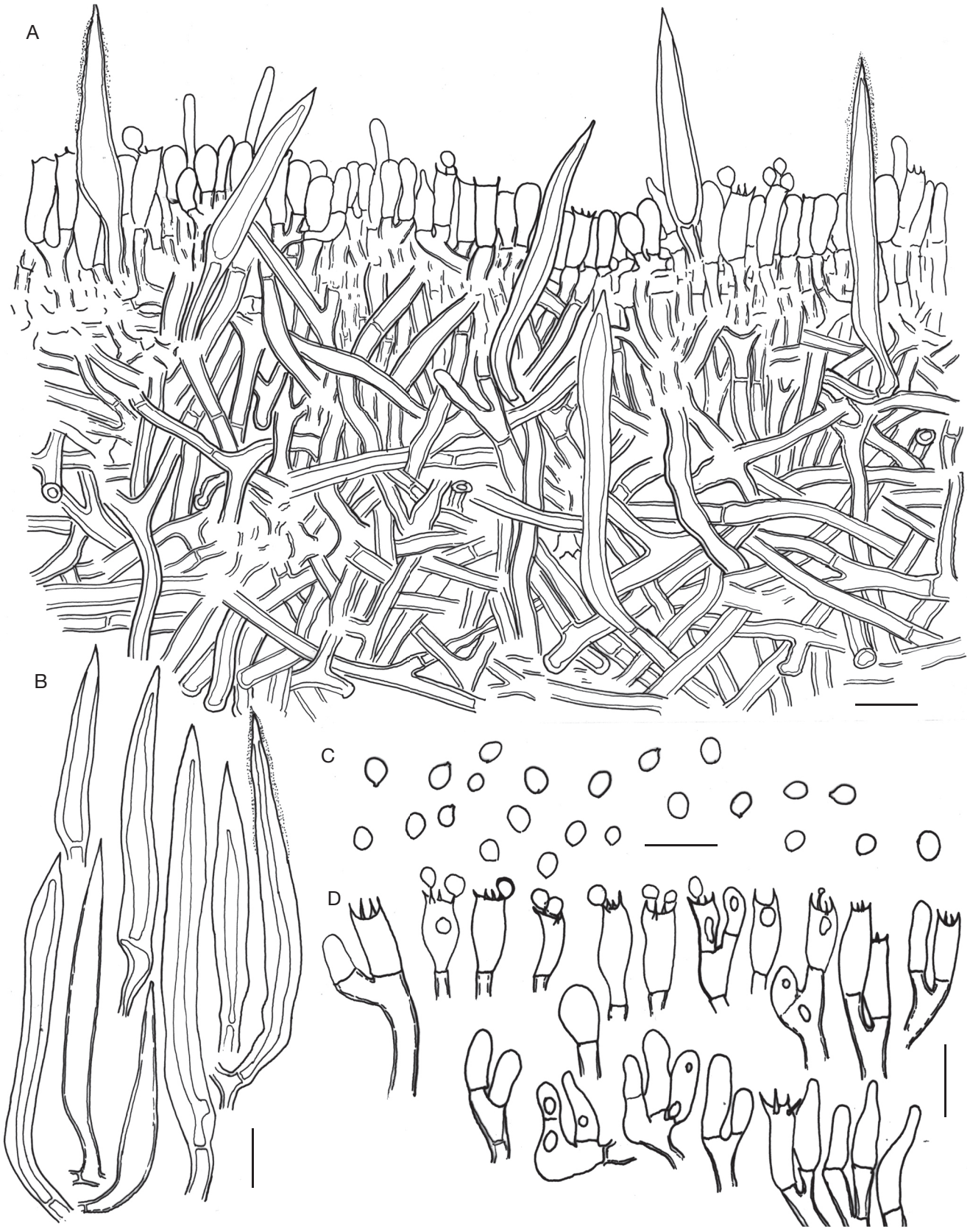


Fig. 12. — *Hymenochaete boddingii* Hembrom, A. Parihar, K. Das & A. Ghosh, sp. nov. (from holotype), microscopic features: **A**, transverse section of basidiomata showing details of context and hymenium; **B**, hymenial setae; **C**, basidiospores; **D**, basidia, basidioles and cystidioles. Scale bars: 10 µm.

Stipe context
Composed of compactly interwoven hyphae and cemented materials, difficult to tease out, hyphae almost similar to that of pileus.

Hymenophore
Composed of setae, infrequent cystidioles, infrequent hyphidia, basidioles and basidia; setae 22.5-75 × 5-10 µm, arising from subhymenium to hymenium regions, acute to obtuse, projecting up to 45 µm beyond hymenium, infrequently sheathed; cystidioles 10-15 × 3-4 µm, smooth, hyaline; basidia 7-13 × 2.5-3.5 µm, cylindrical clavate, 4-sterigmate (sterigmata 1-3.5 µm long), smooth, hyaline; basidioles 7-13 × 2.5-3.5 µm, cylindrical, smooth, hyaline.

Basidiospores
1.5-(2.8)-4 × 1.5-(2.27)-3.1 µm, Q = 1-(1.23)-1.47, ovoid, smooth, hyaline, weakly cyanophilic, inamyloid.

NOTES
Present novel species is unique among known species of *Hymenochaete* due to its terricolous, possibly parasitic habitat, being most probably attached to buried roots of nearby trees (*Shorea*, *Madhuca* and *Terminalia*) in the forest patches of the fossil-rich areas of Rajmahal hills, in the state of Jharkhand, India. The species appears as petaloid with a small stipe during young stages, while turning into large caespitose, rosette shaped basidiomata when older. The same stipitate growth habitat was also recorded in *H. damicornis* (Link) Lév and *H. reniformis* (Fr.) Lév., both exclusively known from neotropics. However, large hymenial setae (120-220 µm long) and larger basidiospores, respectively 5.5-7 × 4-5.5 µm (Ryvarden 1985) and 5.5-8.2 × 4-5.5 µm (Parmasto 2001), as well as absence of cystidioles in the hymenium of *H. damicornis*, distinguish these species from *H. boddingii*. *Hymenochaete reniformis* also differs by the presence of a thick cuticle layer (Ryvarden 1985) as compared to our species.

Two other related taxa with pileate to effused-reflexed basidiomata, namely *H. luteobadia* (Fr.) Höhn. & Litsch. and *H. rheiocolor* (Mont.) Lév. (both neither stipitate nor soil dwelling) are superficially similar to the dried basidiomata of the present species. *Hymenochaete luteobadia* differs from *H. boddingii* by sessile pileus, small sized setae (30-45 × 5-6 µm as Reeves & Welden 1967) and suballantoid basidiospores (4-5 × 2-2.5 µm as Reeves & Welden 1967), while *H. rheiocolor* differs by its sessile pileus with strigose pilear surface and cylindrical to suballantoid, large-sized basidiospores (5-6 × 1.8-2.5 µm, see Léger 1998).

In our combined (nrITS+nrLSU) phylogenetic analysis (Fig. 10), our species appeared as nested amongst some other Asian taxa, being very close and sister to *H. subferruginea* Bres. & Syd. However, *H. subferruginea* has elliptic basidiospores (3-3.5 × 1.5-2 µm, fide Léger 1998) and distinct setal layer in the pilear context which separate it from present novel species. A few other species like *H. adusta* (Lév.) Har. & Pat., *H. berteroi* Pat., *H. damicornis* (compared above), *H. villosa* (Lév.) Bres. and *H. attenuata* (Lév.) Lév. also appeared to be genetically close to *H. boddingii*. But, sequences of *H. berteroi* revealed only 97.477% and 93.77% similarity for nrLSU and nrITS respectively with our species, and it differs morphologically by possessing effused-adnate basidiomata, sheathed setae and larger (3.5-4.8 × 2.0-2.7 µm) ellipsoid, slightly flattened basidiospores (fide Parmasto 2005). *Hymenochaete villosa* shows pileate basidiomata with flabelliform pileus but differs by larger, ellipsoid basidiospores (3.5-4 × 2-3 µm, see Léger 1998). *Hymenochaete attenuata* has pileate to effused reflexed basidiomata and cylindrical basidiospores (3.5-4.5 × 1.5-2 µm, fide Léger 1998) in contrast to stipitate basidiomata and ovoid basidiospores in the present novel species. *Hymenochaete adusta* has cylindrical basidiospores (3-3.5 × 1.5-1.8 µm, fide Léger 1998) and setae that arise from hymenial layer, versus ovoid basidiospores and setae that are distributed throughout the context and hymenium in *H. boddingii*.

Order GOMPHALES Jülich
Family GOMPHACEAE Donk
Genus *Ramaria* Fr. ex Bonord.

97. ***Ramaria thindii*** K. Das, Hembrom, A. Parihar & A. Ghosh, sp. nov.
(Figs 13-15)

Distinct from other *Ramaria* by nrITS sequence data and by the combination of predominantly pale orange to yellow, medium to large-sized (50-190 × 13-80 mm) basidiomata with rhizomorphs at the white stipe base, the glutinous surface when fresh and the sour taste, the warty basidiospore ornamentation, absence of clamp connections and its occurrence under *Abies* in subalpine Himalaya.

HOLOTYPE. —**India**. Sikkim, East district, Memeinchu, 3539 m a.s.l., on soil under *Abies densa*, 2.VIII.2018, *Kanad Das,* KD 18-72 (holo-, CAL[CAL1786]!).

MYCOBANK. — MB831429.

GENBANK. —MN046114 (nrITS, holotype), MN046115 (nrITS, paratype).

ETYMOLOGY. — Commemorating Prof. K. S. Thind for his invaluable contribution to diversity and taxonomy of Indian *Ramaria*.

ADDITIONAL SPECIMENS EXAMINED. — **India**. Sikkim, East district, Opposite to firing range forest, 3700 m a.s.l., on soil under *Abies densa*, 5.VIII.2018, *Kanad Das,* KD 18-79 (para-, CAL[CAL1787]).

DESCRIPTION
Basidiomata
Medium to large, 50-190 × 13-80 mm, humicolous, gregarious to solitary, erect, cylindrical-coraloid in overall appearance but never like cauliflower, fleshy and glutinous when fresh.

Stipe
Mostly buried, 30-60 × 5-20 mm (above and below ground), narrowing gradually and rooting with distinct cord-like rhizomorph, widening towards branches, few laterally fused with

FIG. 13. — Maximum Likelihood (ML) phylogram inferred from raxmlGUI (Silvestro & Michalak 2012) based on nrITS sequences of *Ramaria* Fr. ex Bonord. with *Gomphus* Pers. chosen as outgroup. One thousand bootstrap replicates were analyzed to obtain nodal support values. Bootstrap support values (>50%) obtained from ML analysis are shown above or below the branches at nodes. Two collections of the novel Indian species are shown in red and the holotype in **bold** in the phylogram.

Fig. 14. — *Ramaria thindii* K. Das, Hembrom, A. Parihar & A. Ghosh, sp. nov. (from holotype): **A**-**C**, fresh basidiomata in the forest and basecamp; **D**, hyphae in trama of basal region; **E**, basidiospores. Scale bars: D, E, 10 µm.

adjacent stipe, deeply grooved at juncture of fused branches, smooth, glabrous, pale yellow to pastel yellow (3A3-A4) gradually paler, orange white to pale orange (5A2-A3) when fresh, pale pinkish when maturing or sometimes almost whitish throughout, mostly white towards rooting underground base; rhizomorph white; context pithy to hollow, glutinous, watery fluid exudes when broken, internal flesh tough waxy when dried, concolorous with surface, basal part buff white, unchanging when bruised.

Branches
In 4-5 ranks, dichotomously throughout, almost concolorous with above-ground part of stipe, becoming pale pink-orange with maturity or after handling; primary branch 3-8 in numbers, 5-25 mm wide, ascending to flaring; ultimate branchlet 2-7 mm long, dichotomous, elongated, apices acute to obtuse, cream to more or less ochraceous to pale lemon yellow, unchanging when bruised.

Context
Waxy translucent, turning olive green with FeSO4, unchanging with KOH.

Taste
Slightly sour.

Odour
Fungoid, pleasant.

Hyphal system
Monomitic, generative hyphae septate, branched, agglutinated with crystalline contents, difficult to discern, pale yellow in cluster, individually hyaline; tramal hyphae of basal region (stipe base) 2-10 µm wide, slightly inflated, branched, thin- to thick-walled (wall up to 1 µm), parallel, compactly arranged; tramal hyphae of branches 2-9 µm wide, slightly inflated, branched, thin- to thick-walled, parallel, compactly arranged.

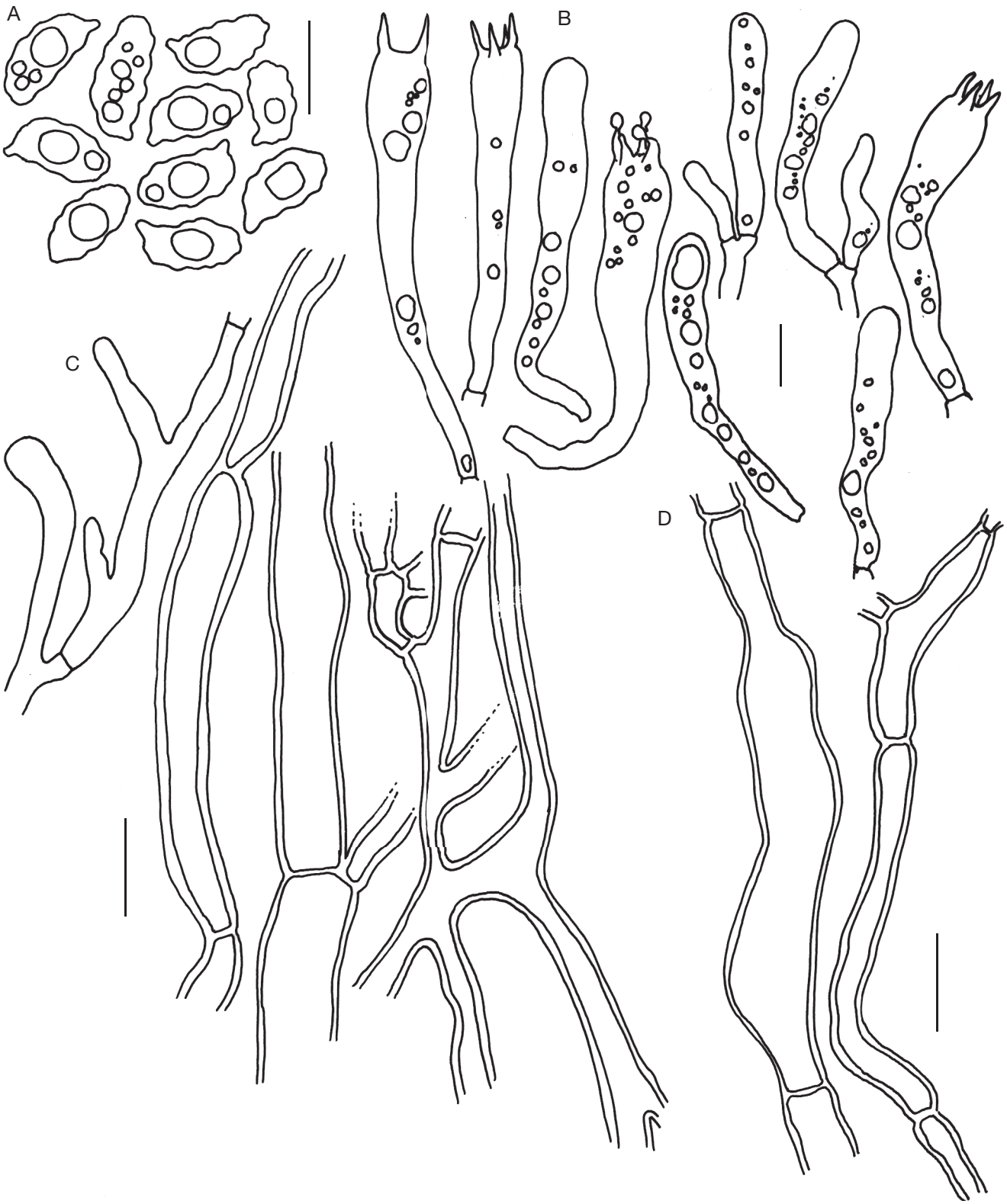


Fig. 15. — *Ramaria thindii* K. Das, Hembrom, A. Parihar & A. Ghosh, sp. nov. (from holotype), microscopic features: **A**, basidiospores; **B**, basidia and basidioles; **C**, hyphae in trama of branch region; **D**, hyphae in trama of basal region. Scale bars: 10 µm.

Hymenium
Throughout the basidiomata.

Basidioles
35-70 × 5-8 µm, clavate to elongate cylindrical, non-clamped, smooth, hyaline.

Basidia
40-75 × 9-12 µm, clavate to elongate-cylindrical, non-clamped, 2-4 stertigmate (sterigmata 5-7 µm long), smooth, hyaline.

Basidiospores
8-(10.2)-11(12) × 3.5-(4.69)-5.5 µm, Q = 1.6-(2.18)-2.75, ellipsoid or elongate, minute to distinctly verrucose, apiculate, one to multiguttulate, pale yellow to hyaline, non-cyanophilic, inamyloid.

NOTES
Ramaria Fr. ex Bonord. is characterized by white to vividly coloured, coral-like and poly- to dichotomously branched fruiting bodies that are usually composed of a mono- to dimitic hyphal system, with or without clamps on generative hyphae; basidiospores that may be guttulate, smooth or ornamented (echinulate/verrucose-reticulate or striate ornamentations) forming yellow to ochraceous or brown spore deposits [Corner (1950), Corner & Thind (1961), Thind (1961), Marr & Stuntz (1973), Petersen (1975, 1981), Zhishu *et al.* (1993), Humpert *et al.* (2001) and Sharma (2013)].

The newly described *R. thindii* is a highly appreciated edible mushroom in the state of Sikkim, India. The combination of brightly coloured, large and terricolous fruiting bodies having basal, thread-like, monomitic rhizomorphs, and non-clamped basidia producing warted (non-echinate) basidiospores of 8-10.2-11(12) × 3.5-4.7-5.5 µm place *R. thindii* in *R.* subg. *Laeticolora* Marr & D. E. Stuntz (Exeter *et al.* 2006).

In our nrITS-based phylogenetic analysis (Fig. 13), our collections of *R. thindii* formed a strongly supported clade (BS=100%) with three specimens of *R. verlotensis* Marr & D. E. Stuntz (including the holotype), a species described from the Pacific North West (see Gordon 2017). The latter species differs from *R. thindii* in its smaller (90 × 100 mm) fruiting bodies and indistinctive taste. Both species form again a well-supported clade (BS = 84%) with the Italian *R. abetonensis* Franchi & M. Marchetti and the American *R. gelatiniaurantia* Marr & D. E. Stuntz., both being equally very similar to our species.

In the field, *R. thindii* may further be confused with *R. subalpina* K. Das & K. Acharya, *R. subaurantiaca* Corner, *R. synaptopoda* Marr & D. E. Stuntz, *R. rasilispora* Marr & D. E. Stuntz and *R. flavobrunnescens* var. *formosoides* Corner. *Ramaria subalpina,* also originally described from Indian Himalaya, can easily be distinguished because the base of its fruiting bodies turns blood red to brownish red when bruised (Das *et al.* 2016). *Ramaria subaurantiaca*, also reported from the Himalayas (Thind 1961), turns pale yellow when bruised, remains non-glutinous and lacks the mild-sour taste of our species. *Ramaria synaptopoda* and *R. rasilispora* both have smaller basidiomata (up to 80 × 40 mm and up to 110 × 45 mm, respectively) without any basal rhizomorphs and they lack any distinctive taste (Sharda & Thind 1986). *R. flavobrunnescens* var. *formosoides* shows clamped basidia and larger [10.5-14(15) × 3.5-4.5 µm] basidiospores (Sharda & Thind 1986).

Order RUSSULALES
Kreisel ex P. M.Kirk, P. F. Cannon & J. C. David
Family RUSSULACEAE Lotsy
Genus *Russula* Pers.

98. ***Russula antsikana*** Buyck & Randrianjohany, sp. nov.
(Figs 16-19)

Well-characterized by the combination of its medium-sized, firm stature, frequently forked gills, a dry, almost felty, brownish to cream or whitish pileus, white stipe, pale spore print, whitish context with an unpleasant, somewhat fishy smell, and pinkish brown discoloration upon handling, subglobose to shortly ellipsoid spores with low and dense, subreticulate spore ornamentation of interconnected warts and fine crests, and a non- to faintly amyloid, verruculose suprahilar spot, a pileipellis composed of densely intricate, often very irregularly formed, long and repeatedly branched hyphal extremities with often tapering terminal cells, intermixed with inconspicuous, capitulate pileocystidia, as well as by its occurrence in seasonally dry woodlands.

HOLOTYPE. — **Madagascar**. Central Plateau, along RN7 between Antsirabe and Ambositra, at km 40, in secondary *Uapaca bojeri* woodland with *Pinus* ingression, 26.I.2008, Buyck 08.178 (holo-, PC[PC0124727!])

MYCOBANK. — MB834837.

GENBANK. — DQ422028 (ITS BB99.250), KU237557 (LSU), KU237405 (mitSSU), KU237702 (*RPB1*), KU237843 (*RPB2*), KU237988 (*tef1alpha*), all from holotype.

ETYMOLOGY. — Named after "*Antsikana",* a vernacular name for *Xerochlamys bojeriana* (Sarcolaenaceae), a possibly ectomycorrhizal, small shrub that is a typical inhabitant of *Uapaca bojeri* woodland and frequently observed to grow close to this *Russula* species.

ADDITIONAL EXAMINED MATERIAL. — **Madagascar**. East Coast. Toliara Prov. Just north of Fort Dauphin (Taolagnaro), littoral forest of Madena, 25.I.1999, Buyck 99.241 (PC[PC0125076]), 32 km south of Fort Dauphin, littoral dry forest of Petriky, 26.I.1999, Buyck 99.242 (PC[PC0125077]), Buyck 99.250 (PC[PC0125074]), Buyck 99.251 (PC[PC0125075]), Sainte Lucie, in dense, humid littoral forest North of Fort Dauphin, 27.I.1999, Buyck 99.255 (PC[PC0125078]), Buyck 99.259 (PC[PC0125079]), Central Plateau, Antananarivo Prov., along RN7 between Antsirabe and Ambositra, at km 40, in secondary *Uapaca bojeri* woodland with *Pinus* ingression, 26.I.2008, Buyck 08.180 (PC[PC0125073]).

DESCRIPTION
Basidiomata
Medium-sized, fleshy, isolated or more often in small groups of up to ten individuals.

Pileus
37-62 mm diam., quite regular in shape to slightly wavy near the margin, weakly depressed in center, not becoming deeply

Fig. 16. — *Russula antsikana* Buyck & Randrianjohany, sp. nov. Fruiting bodies photographed on its possible host plant *Xerochlamys bojeriana* (Baill.) Baker (Sarcolaenaceae, vernacular name: antsikana). Notice the distinct pinkish brown coloration of the gills in this specimen and the browning reaction after bruising. Photo B. Buyck.

infundibuliform, smooth near margin; surface feltyvelutinous, separable up to mid-radius, dull, never viscid, even not when wet, continuous and smooth in the pileus center, the very surface minutely cracked under a hand lens, then becoming coarsely cracked closer to the pileus margin, eventually even deeply fissured or completely split radially from the pileus margin to almost mid radius when fully expanded in sun-exposed places, usually pale-colored, from whitish to cream or pale yellowish over pale grayish brown to even occasionally darker reddish brown, not concentrically zoned, mostly remaining darker in the center.

Gills
Hardly adnate and subfree, equal or with rare lamellulae, frequent forkings present at different distances from stipe, *c.* 3-5 mm high, brittle, normally spaced (*c.* 1 L+l/mm) or slightly denser, off-white to ivory, then becoming cream to almost yellowish or dirty isabelline with age and often tinged with pinkish brown toward the gill edge; gill edge even, concolorous when young.

Stipe
Central, (35)41-52 × 8-16 mm, not annulate, subcylindrical or somewhat inflated in the middle, sometimes slightly narrowing downward, smooth to longitudinally wrinkled, glabrous, off-white, developing brownish-yellowish stains toward the base; the latter sometimes fragmenting transversely as in *R. cellulata*; stipe interior compact and firm, in age becoming more spongy in the center.

Context
Firm, fleshy, *c.* 6-7 mm thick above gill attachment, whitish, developing pale brown to pinkish brown stains in stipe context when cut, reacting greenish gray to $FeSO_4$ inside and on stipe.

Taste
Mild.

Odor
Disagreeable, somewhat fishy.

Spore print
Pale cream (IIa Romagnesi).

Spores
(sub)globose to shortly ellipsoid, (6.9)7.07-7.43-7.8(9.0) × (5.8)6.3-6.69-7.0(7.7) µm, Q = (1.03)1.07-1.11-1.16(1.21); ornamentation quite variable, composed of strongly amyloid,

Fig. 17. — *Russula antsikana* Buyck & Randrianjohany, sp. nov.: **A**, this particularly coloured collection from littoral forest near Fort Dauphin (Buyck 99.250) shows the areolate to radially fissuring pileus aspect in sun-exposed specimens. Note the numerous gill forkings easily observed on the specimen in the left upper corner; **B**, detail of the irregularly forking gills (Buyck 99.242); **C**, field habit of a collection of a more typical colour (Buyck 99.242); **D**, detail of pileus surface in the holotype collection; **E**, detail of the surface near the pileus center (Buyck 99.242). Photos: B. Buyck.

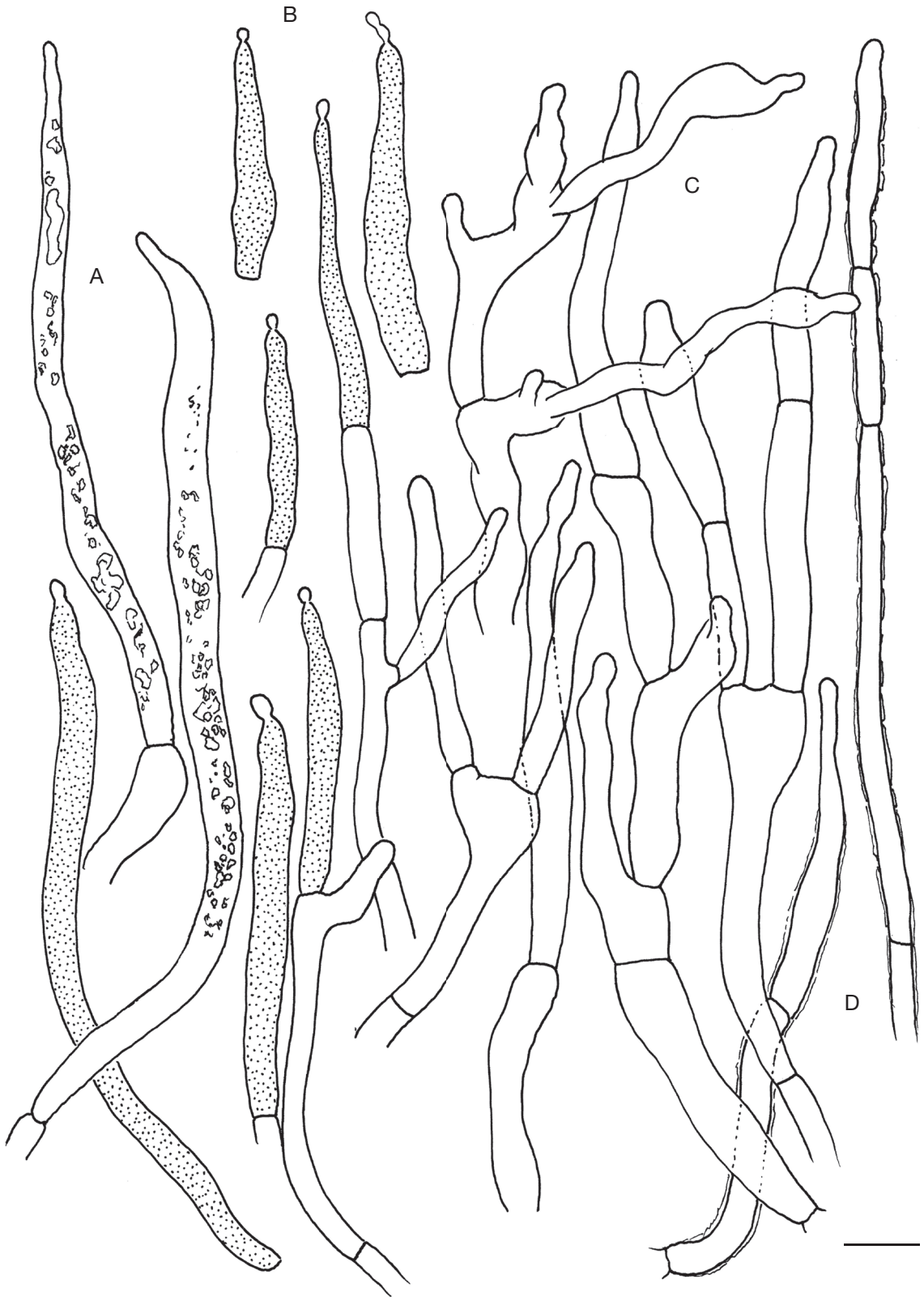


Fig. 18. — *Russula antsikana* Buyck & Randrianjohany, sp. nov.: **A**, pileocystidia arising from subpellis or from beneath the surface; **B**, terminal pileocystidia at the pileus surface; **C**, hyphal extremities of the pileipellis; **D**, incrustations of the hyphal walls shown in section. Drawings: B. Buyck. Scale bar: 10 µm.

obtuse warts of variable dimensions but overall quite low, generally < 0.5 µm high, sometimes laterally prolonged or fused in irregular short crests or interconnected by subtle lines in a subrecticulate network, mixed with some smaller interstitial isolated warts; suprahilar spot not or partly amyloid, often verruculose; apiculus long and distinct.

Basidia
Slender, largest in their upper part, (34)43-55(60) × 8-10 µm, four-spored, although two-spored ones are not rare close to the gill edge; basidiola strongly clavate; sterigmata slender and long, up to 7 × 2 µm for normally developed four-spored basidia.

Hymenial gloeocystidia
Moderately numerous (1000-1500/mm^2), slender, mostly 60-80 × 7-9 µm, nearly always minutely capitate, at the gill edge more abundant but frequently smaller, e.g. 42 × 5 µm, also narrowing or obtuse rounded at the tip shorter than on gill sides, thin-walled or with slightly thickened, refringent wall; contents usually restricted to the upper part, amorphous-guttulate to coarsely crystalline, SV-negative.

Subhymenium
Pseudoparenchymatic, composed of small cells, neither deep nor particularly well-developed.

Lamellar trama
With many sphaerocytes, neither very compact nor dense, also with frequent oleiferous hyphae or hyphal fragments.

Marginal cells
Not differentiated.

Pileipellis
Orthochromatic in cresyl blue, not distinctly delimited from the underlying trama. composed of a single layer that is a dense tissue of first more or less horizontal and then, closer to the pileus surface, more ascending hyphal extremities, embedded in a glutinous matrix that is not extending much further above the hyphal surface; hyphal extremities strongly branching and densely septate, composed of chains of 3-6 or more, often irregularly inflated cells that are frequently branching or just diverticulate, normally 3-7 µm wide, but some – particularly near branching points – more inflated and 10-15 µm diam., often more or less filled with refringent, dense contents, not or hardly pigmented, thin-walled but often sheathed with some hyaline substance, not exactly distinctly zebroid encrusted; terminal cell mostly 20-40 (70) µm long, usually tapering or variably restricted near the tip. Pileocystidia not abundant, but often not very apparent because of their sometimes poor, amorphous-granular, refringent contents, easiest to locate in the pileus center and best recognized when constituting the terminal cell of a typical extremity because of their globose – capitate tip, usually conical to flask-shaped, in the lower part of the pileipellis much longer and subcylindrical, measuring e.g. 100 × 5 µm, not observed in pileus trama.

Clamp connections
Absent in all tissues.

Notes
This species is a frequent inhabitant of the tapia (*Uapaca bojeri*) woodlands on the Central Plateau, but we found it equally in dry littoral forest at Petriky – and one collection even in somewhat more humid littoral forest at St Luce – at the very southeastern coast of Madagascar near Fort Dauphin, where its natural habitat is strongly endangered by mining activities. We have never found this species on the east coast in the more humid dense littoral forests north of Tamatave, nor in humid forests at higher altitudes such as at Ambohitantely or Andasibe.

A single ITS sequence, obtained from a specimen (Buyck 99.250) of *R. antsikana* Buyck & Randrianjohany, sp. nov. from the southeast coast had previously been deposited in GenBank (GenBank: DQ422028) in the context of an earlier study (Buyck *et al.* 2008) and is identical to the one obtained from the holotype, except for some erroneous readings at the very sequence start for the former.

Our recent multigene phylogeny (Buyck *et al.* 2018) placed *Russula antsikana* Buyck & Randrianjohany, sp. nov. (as "*R. hatsikiana* sp. ined.") firmly in *Russula* subg. *Malodora* Buyck & V. Hofst. There are no representatives of this subgenus known from Europe, but other northern hemisphere, i.e. Asian and North American, species, as well as Oceanian species of this subgenus are all part of section *Pseudocompactae* Buyck & V. Hofst. (see Das *et al.* 2017), while all African–Malagasy species with frequently forking gills were placed in section *Edules* Buyck & V. Hofst., typified by *R. edulis* Buyck (see Das *et al.* 2017). African-Malagasy species of subg. *Malodora* without forking gills are not part of sect. *Edules*, e.g. the recently described *R. capillaris* Buyck (in Wang *et al.* 2019), and these species likely merit to be placed in a new section of their own. The here newly described *R. antsikana* Buyck & Randrianjohany, sp. nov. is evidently part of sect. *Edules* and shares the frequently forking gills, presence of bad smell and very similar pileipellis composition with the other species of this section, such as the recently described *R. blennia* Buyck (in Wang *et al.* 2018) or *R. fissurata* Sanon & Buyck (Sanon et al. 2014). From all these species, *R. antsikana* Buyck & Randrianjohany, sp. nov. can easily be distinguished based on spore ornamentation and general habit. Spore size for Buyck 99.250, collected along the southern east coast, is slightly larger, but still very similar, compared to spore size for collections from the Central Plateau: (7.3) 7.7-8.21-8.7 (9.0) × (6.2) 6.7-7.14-7.6 (7.9) µm, Q = (1.05) 1.10-1.15-1.20 (1.25).

Russula antsikana Buyck & Randrianjohany, sp. nov. can be quite variable in general appearance with its overall color varying from reddish brown over pale grayish brown to cream or even white, but the abundantly forking gills and dry tomentose, minutely areolate pileus surface are reliable features. Depending on weather conditions, the pileus surface can become more strongly areolate or even

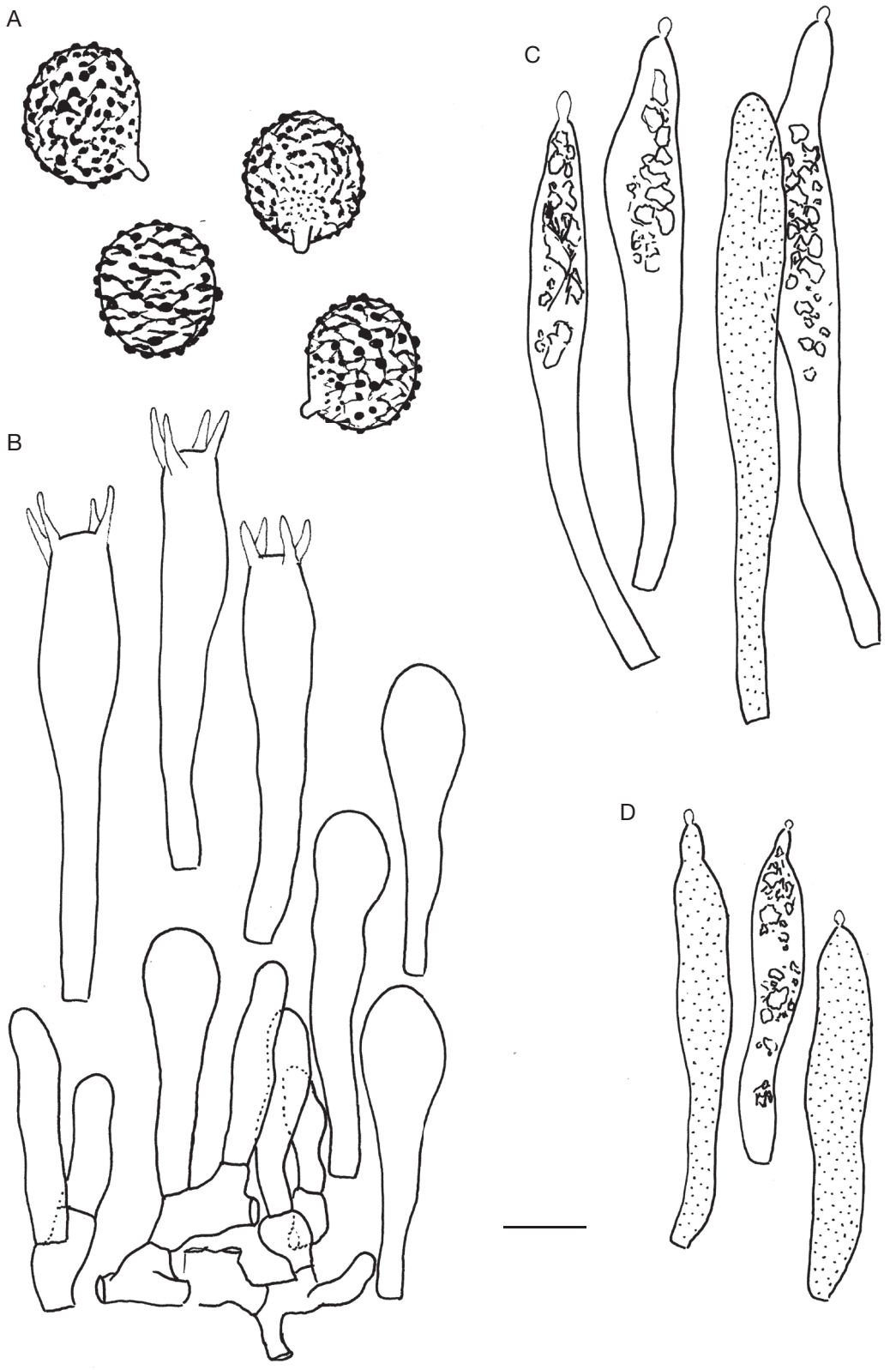


FIG. 19. — *Russula antsikana* Buyck & Randrianjohany, sp. nov.: **A**, spores as seen in Melzer's reagent; **B**, basidia and basidiola; **C**, pleurogloeocystidia; **D**, cheilogloeocystidia. Drawings: B. Buyck. Scale bar: A, 5 µm; B-D, 10 µm.

deeply fissured around the center and toward the margin; a feature it shares with most other species in subgenus *Malodora* sect. *Edules*.

Several somewhat similar *Russula* species have been described from Madagascar nearly a century ago but remain insufficiently known. These comprise *R. murinacea* Heim, *R. cinerea* Heim

(Heim 1938) as well as *R. cinerella* Pat. and *R. schizoderma* Pat. (Patouillard 1927). For none of these, the presence of frequently forking gills has been noted, and all three might have distinctly more ellipsoid spores judging from the drawings made by Heim (1938); moreover, all were collected in humid forest types. The lack of good field illustrations or sufficient microscopic detail for these older species makes further comparisons impossible as their type specimens are either lost or in too bad a condition for microscopic study. Performing nBLAST of the ITS sequence of *R. antsikana* Buyck & Randrianjohany, sp. nov. on GenBank, while allowing for environmental sequences, produces no hits on highly similar sequences. This is somewhat surprising as *R. antsikana* Buyck & Randrianjohany, sp. nov. is in our opinion not rare at all in Madagascar.

There is no doubt that our new species is also very close and very similar to *R. liberiensis* Sing. Singer (1948) described this new species based on a collection made by G. W. Harley in Nimba, Liberia (West Africa). We have studied the type specimen and provide its detailed description in the next entry of this compilation. It differs essentially by the absence of pileocystidia and absence of reticulation in the spore ornamentation (see below).

99. ***Russula liberiensis*** Sing.
(Figs 20-21)

Papers of the Michigan Academy of Sciences 32: 112 (1948) (for 1946).

Original diagnosis. — *Pileo fuligineo-fusco, rimosello-granuloso e verruculis punctiformibus, centro leviore, margine extremo striato, demum infundibuliformi, c. 60 mm. lato; granulis e sphaerocystis accumulatis, saepe ovoideis, paucis in hyphas ellipsoideas vel cylindraceas elongatis, omnibus crassotunicatis, constantibus; pigmento intracellulari dissolutoque et granuloso-globuloso ochraceo-brunneo manifesto; membranis 0.6-2 µm crassis, refringentibus. Lamellis albis, brunnescentibus fractu, sublinearibus, haud ventricosis, angustis, lamellulis perpaucis intermixtis, tenuibus, adnexis, confertissimis; sporis in cumulo haud visis, probabiliter albis vel albo-cremeis, sub microscopio 6.8-9.5 × 6-8.8 µm, distincte asymmetricis, subglobosis, plerumque 7-7.5 × 6-6.5 µm, ornamentatione 0.2-0.5 µm alta, cristulato-reticulata (typi I); basidiis c. 24 × 7 µm, tetrasporis; sterigmatibus 5-5.5 µm longis; cystidiis 32-53 × 4-10.5 µm, versiformibus, clavatis, fusoideis, etc., apice acutis vel rotundato-obtusis, intus granulosis vel corpusculis vermiformibus impletis; tramate sphaerocystis numerosis praedito. Stipite cremeo-albido, tactu brunneolo-albido, furfuraceo-granuloso, spongioso, solido, aequali, c. 55 × 14 mm.; granulis e corpusculis eis pilei similibus, sed magis elongatis, plerumque catenulatis efformatis; membris individualibus catenulae 5.5-13 µm crassis, membrana c. 0.7 µm crassa, intus subgranulosis. Carne alba, in pileo fragili, in stipite spongioso; odore terreo; sapore haud notato; sulphovanillinae actione haud mutata sed granulis externalibus nonnullis brunnescentibus. In terra humosa, verne. Nengbe, Liberia. G. W. Harley, 50.*

Description

Pileus
Rather fleshy, 60 mm diam., plane, then widely depressed in the center; margin most likely smooth, surface layer not separable, dull, finely tomentose under a hand lens, brownish gray, profusely fissured-areolate in appressed squamulae.

Lamellae
Shortly adnexed, not brittle, probably equal, dense, narrow and 3 mm high, narrowing toward the extremities, whitish, browning when touched.

Stipe
Firm, *c.* 55 × 14 mm, subcylindrical, dull, smooth, cream-colored, spongiose inside.

Context
White, browning when cut in the stipe.

Smell
Insignificant, of soil.

Taste
Mild.

Spore print
Not obtained, most likely cream, certainly pale.

Spores
Subglobose, 6.4-6.79-7.3 × 5.8-6.35-6.8 µm, (Q = 1.02-1.07-1.13; n = 20), densely ornamented with obtuse, isolated warts, < 0.5 µm high, from minutely verrucose to hemisphaerical or droplet-like, sometimes laterally prolonged or locally confluent but not forming crests and without any form of reticulation, distinctly amyloid; suprahilar spot not amyloid, verrucose and densely covered with minute, hardly amyloid warts.

Basidia
40- 48 × 9-13 µm, four-spored; sterigmata 6-8 × 1.5-2.5 µm.

Cystidia
Very numerous on the gill edge, much less so on the gill sides, 40-70 × 8-11 µm, fusiformous to clavate, obtuse-rounded or mucronate-appendiculate, thin- to slightly thick-walled, filled with abundant cristalline contents that hardly react to SV.

Marginal cells
Not differentiated.

Pileipellis
Two-layered, orthochromatic in Cresyl blue ; subpellis poorly gelified but not very dense, composed of 5-10 µm wide, rather densely septate, intertwined hyphae; suprapellis discontinuous but dense, forming an fragmented trichoderm of densely septate and strongly ramified, thin- to slightly thick-walled hyphal extremities that are composed of cells of variable dimensions, often cylindrical or ellipsoid, but also more irregular and variable in outline, mostly filled with a brownish, granular-guttate pigment; terminal cells mostly attenuated toward the apex, obtuse, sometimes subcapitate; pileocystidia absent. Stipitipellis less differentiated and showing very long, cylindrical, thin-walled caulocystidia running below the stipe surface in the lower stipe portion, *c.* 3-6 µm wide and filled with typical, granular to crystalline, refringent contents.

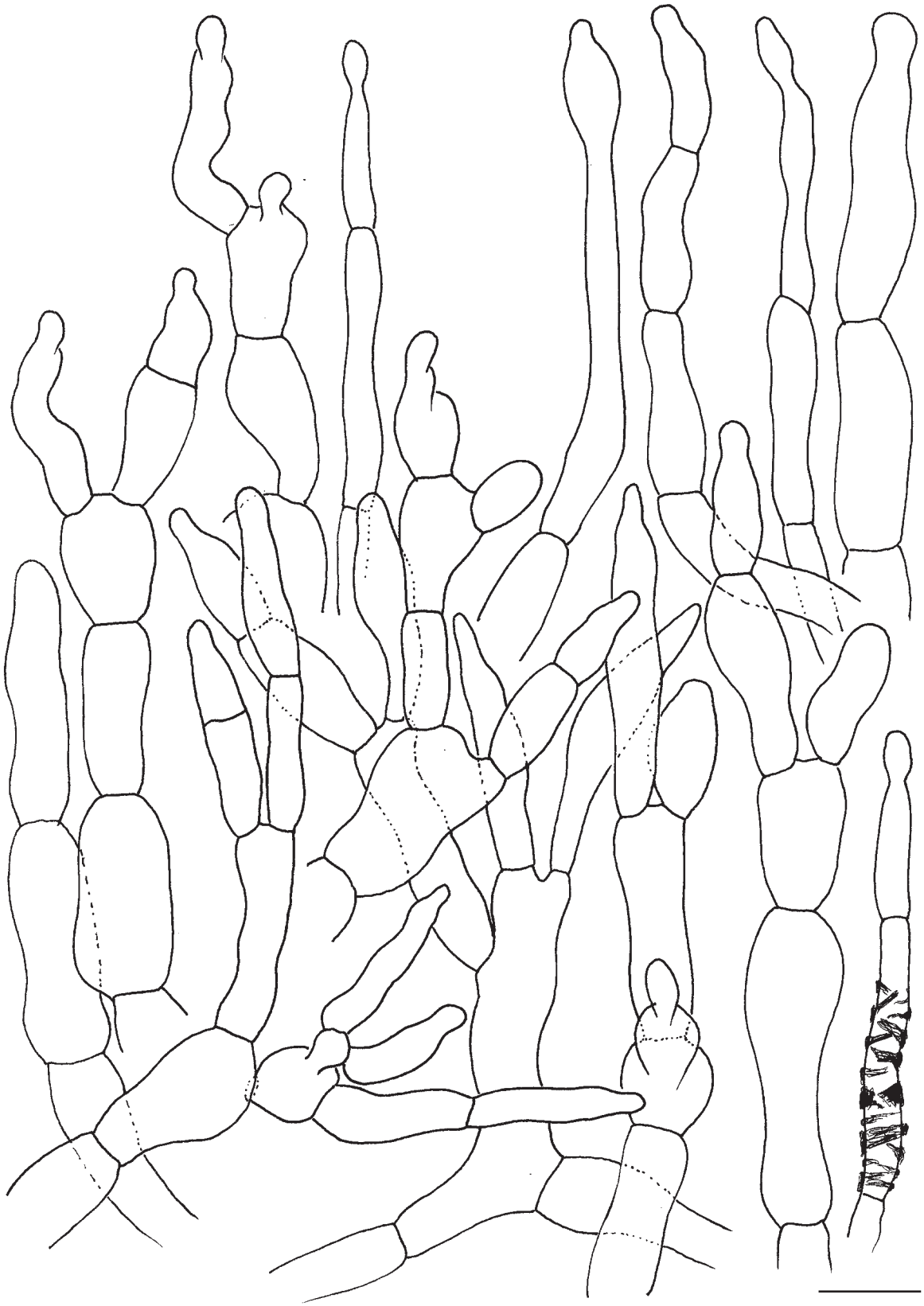


Fig. 20. — *Russula liberiensis* Sing. (holotype). Hyphal extremities of the pileipellis; note the strong branching and often subcapitate apices of the terminal cells. Note in the lower right corner a detail of zebroid incrustations that are clearly visible on most hyphal endings (and beneath). Drawings: B. Buyck. Scale bar: 10 µm.

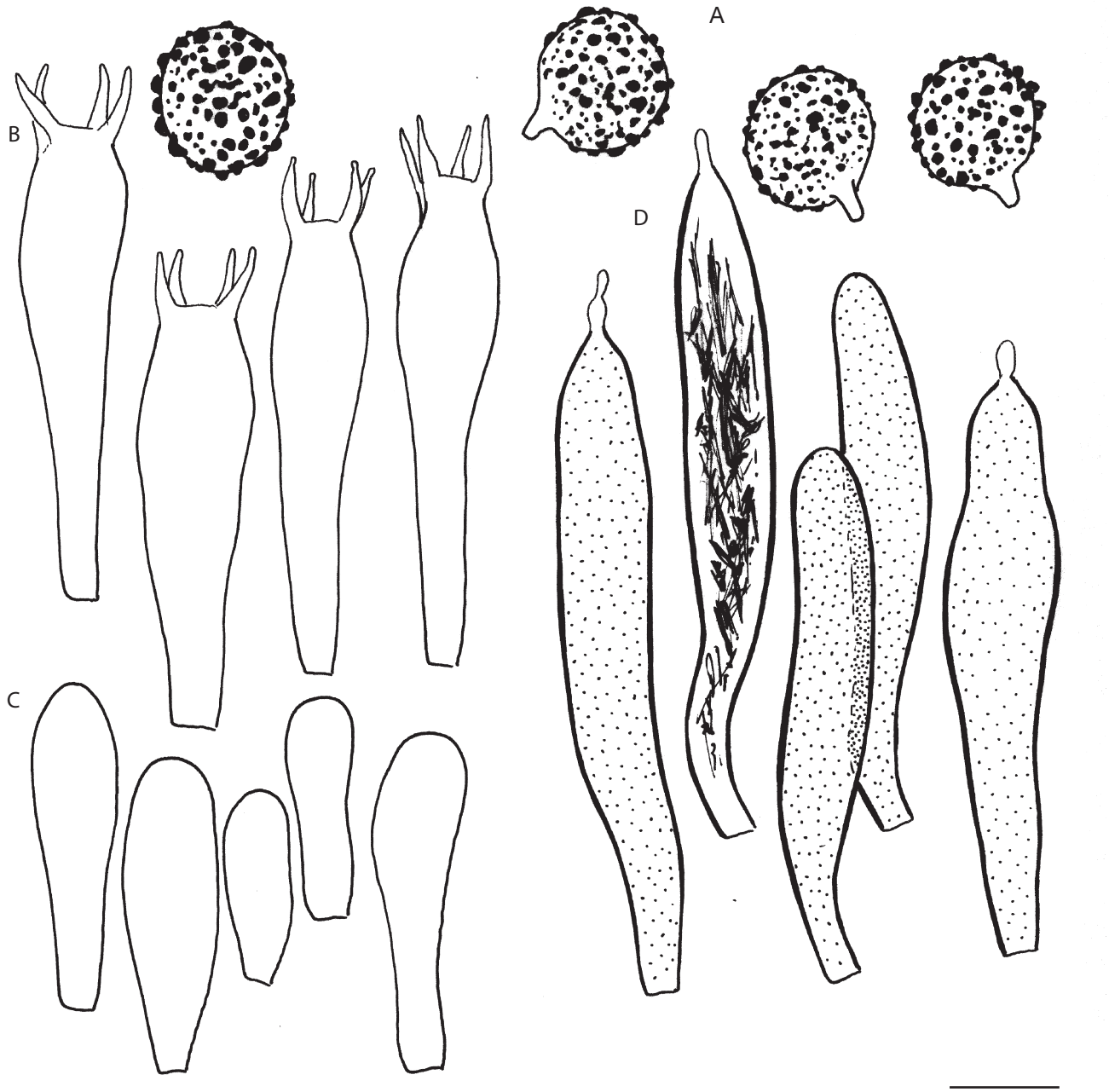


Fig. 21. — *Russula liberiensis* Sing. (holotype), microscopic elements of the hymenium. **A**, spores in Melzer's reagent; **B**, basidia; **C**, basidiola; **D**, pleurocystidia (left) and cheilocystidia (right) with contents schematically indicated in all but one. Drawings: B. Buyck. Scale bar: A, 5 µm; B-D, 10 µm.

Clamp connections
Absent from all tissues.

Notes
Our description of field characters is based on Harley's field notes, which explains why it deviates from Singer's original description on several points. However, one of the most important differences between Singer's description and our own observations consists in our inability to find the thick-walled cells in the pileipellis, with cell walls mentioned by Singer as "up to 2 µm" thick! This feature was his main argument for suggesting affinities with the American *R. crassotunicata* Singer. In addition, several of Singer's measurements are inaccurate being distinctly to low with only 24 × 7 µm for basidia and 32-53 × 4-10.5 µm for hymenial gloeocystidia. Singer's spore measurements are, on the contrary, far too high (even when knowing that Singer often included spore ornamentation in his measurements, which in this case would not have

had a profound impact). Also Singer's description of spore ornamentation is difficult to conceal with what we observed on the type. Like Singer, we were unable to find pileocystidia, but caulocystidia are definitely present on the lower stipe. We also confirm Singer's mention of yellowish brown globules inside the hyphal extremities of the pileus, in a similar way as these exist in, e.g. the Central African *R. meleagris* Buyck.

Both the macroscopic and microscopic features (spore ornamentation and elements of the pileipellis) strongly suggest that *R. liberiensis* belongs in *Russula* subg. *Malodora* sect. *Edules*. If so, it is most likely that frequent gill forkings are also present in *R. liberiensis*, contrary to Singer's description, mentioning only the presence of rare lamellulae. The Malagasy *R. antsikana* Buyck & Randrianjohany, sp. nov. differs from the type of *R. liberiensis* in the more reticulate-crested spore ornamentation and in the undeniable presence of pileocystidia, both at the pileus surface and in the underlying subpellis. Singer's description also suggests that *R. liberiensis* is a much more fragile species, considering his mention of a striate pileus margin and fragile context, compared to the quite robust and fleshy basidiomata of *R. antsikana* Buyck & Randrianjohany, sp. nov.

Russula liberiensis "sensu lato" has previously been reported by us from Tanzania (in Härkönen *et al* 1993) and the Democratic Republic of the Congo (Buyck 1993), while we (BB) may have collected it many years ago also in Burundi and Zambia based on the near identical field habit of our collections. Whether or not these morphologically similar specimens are conspecific remains to be verified by more collections and, in particular, by sequence data.

100. *Russula* subsect. Castanopsidum Buyck & X. H. Wang, subsect. nov. (Figs 22-25)

Pileus dull, dry, hardly peeling, variously colored, rapidly rupturing and fissurate, becoming areolate, granular, context unchanging when cut, mild and without particular smell. Stipe slender and typically longer than pileus diameter, hollowing, often furfuraceus and with the same color as the pileus. Lamellae equal, adnate, pale colored. Spore print pale (off-white to cream). Basidiospores never reticulate; ornamentation composed of spines which are completely isolated or sparsely interconnected; suprahilar spot distinct and amyloid. Hymenium composed of relatively wide and short basidia and dispersed gloeocystidia with poor contents and sometimes slightly thickened walls. Pileipellis orthochromatic in Cresyl blue, pseudoparenchymatic, composed of inflated, thin-walled, gradually narrowing cells, without gloeoplerous elements (neither pileocystidia near the surface, nor cystidioid hyphae in the context), but ending in dispersed, encrusted, cylindrical cells that usually surpass the general pileipellis surface.

TYPE SPECIES. — *R. castanopsidis* Hongo, *Notulae Mycologicae* 12: 42 (1973).

MYCOBANK. — MB834837.

GENBANK. — *R. castanopsidis:* MN134522–MN134533 (ITS); MN134540–MN134541 (LSU); MN158651–MN158652 (mitSSU); MN165069–MN165070 (*rpb1);* MN165065–MN165066 *(rpb2)*; MN165061–MN165062 (*tef1)* ; *R. purpureogracilis:* MN134534–MN134539 (ITS); MN134542–MN134543 (LSU); MN158653–MN158654 (mitSSU); MN165071–MN165072 (*rpb1);* MN165067–MN165068 *(rpb2)*; MN165063–MN165064 (*tef1)*

MATERIAL EXAMINED. — ***R. castanopsidis***: **China**. Yunnan Prov.: Maguan Co., Bazhai Town, Duimenzhai, 22°59'16"N, 104°02'47"E, 1656 m a.s.l., 8.VIII.2017, coll. B. Buyck & X. H. Wang, no. 4413 (PC[PC0125082]), no. 4414 (HKAS 104787, PC[PC0125083]); Dalishu Town, Adushangba, 23°06'55"N, 104°08'24"E, 1840 m a.s.l., 7.VIII.2017, coll. B. Buyck & X. H. Wang, no. 4366 (HKAS 104781, PC[PC0125081]), no. 4367 (HKAS 104872, PC[PC0125080]); Dalishu Town, road from Dalishu to Damagu, 23°04'55"N, 104°12'58"E, 1630 m a.s.l., 6.VIII.2017, coll. B. Buyck & X. H. Wang, no. 4334 (HKAS 104880), no. 4336 (HKAS 104774), no. 4347 (HKAS 104777); Dalishu Town, Xiangchang, 23°04'55"N, 104°12'58"E, 1660 m a.s.l., 14.X.2017, coll. X. H. Wang, no. 4747 (HKA 104746); *ibid.*, 23°04'10.1"N, 104°12'34.1"E, 1683 m a.s.l., 14.X.2017, coll. J. Wang, no. 305 (HKAS 104848); Jiahanqing Town, Dabao, 22°49'32"N, 104°24'31"E, 1536 m a.s.l., 13.VIII.2016, coll. X. H. Wang, no. 3958 (HKAS 96547); Mabai Town, Yubo, 23°00'58"N, 104°20'59"E, 1345 m a.s.l., 15.X.2017, coll. X. H. Wang, no. 4797 (HKAS 104752); Muchang Town, Shangxinzhai, 22°55'23"N, 104°09'56"E, 1420 m a.s.l., 10.VIII.2017, coll. B. Buyck & X. H. Wang, no. 4448 (HKAS 104795); Nanlao Town, Xiaomalipo, 23°03'24"N, 104°31'07"E, 1186 m a.s.l., 17.X.2017, coll. X.H. Wang, no. 4841 (HKAS 104758); Puer, Xinfang reservoir, 22°43'19"N, 100°57'56"E,1370 m a.s.l., 6.VII.2012, coll. X. H. Wang, no. 3476 (HKAS 76025); Xinping Co., Ailao Mts. nature reserve, Jinshan virgin forest, 23°57'33"N, 101°31'26"E, 2170 m a.s.l., 13.VIII.2017, coll. B. Buyck & X. H. Wang, no. 4524 (HKAS 104824, PC[PC0125085]). Japan. Tanakami-Sekinotsu, Otsu, under *Castanopsis cuspidata*, 15.VII.1971, herbarium T. Hongo no. 4458 holotype, isotype in Horak EH-3227 ***R. purpureogracilis***: **China**. Yunnan Prov.: Maguan Co., Dalishu Town, road from Dalishu to Damagu, 23°04'55"N, 104°12'58"E, 1630 m a.s.l., 6.VIII.2017, coll. B. Buyck & X. H. Wang, no. 4337 (HKAS 104775, PC[PC0125106]); Dalishu Town, Xiangchang, 23°04'08"N, 104°12'31.7"E, 1635 m a.s.l., 14.X.2017, coll. X. H. Wang, no. 4770 (HKAS 106469); Zhenyuan Co., Heping Town, road from Xinping to Zhenyuan, milemark 79 km, 13.VIII.2017, coll. X. H. Wang, no 4515 (HKAS 104817, PC[PC0125102]), no. 4516 (HKAS 104818,, PC[PC0125103]), no. 4517 (HKAS 104819, PC[PC0125104]), no. 4521 (HKAS 104822, PC[PC0125105]).

NOTES

The *R. castanopsidis* lineage was recently discussed by Adamčík *et al.* (2019) and is here formally described and placed with significant support within the recently published multigene phylogeny of the genus (Buyck *et al.* 2018). At present, it has been shown to host at least three Asian species, viz. *Russula purpureogracilis,* F. Hampe *et al.*, *R. castanopsidis* Hongo and *R. darjeelingensis* S. Paloi *et al.* (for detailed descriptions, see Adamčík *et al.* 2019, Paloi *et al.* 2018), as well as at least one, still undetermined, North American species supported by environmental sequences from Florida (see Adamčík *et al.* 2019).

Reported host associations for this clade comprise dipterocarps for Thai *R. purpureogracilis* and Indian *R. darjeelingensis. Castanopsis* was the host associated with *R. castanopsidis* in Japan (Hongo 1973), but more recent reports mention also dipterocarps as host trees in Malaysia (Chua *et al.* 2012). Our Chinese samples are the first records for both species from China and some of these Chinese collections are illustrated in Figures 24-25. The Chinese specimens were all collected in fagaceous forests with *Castanopsis, Lithocarpus* and *Quercus.*

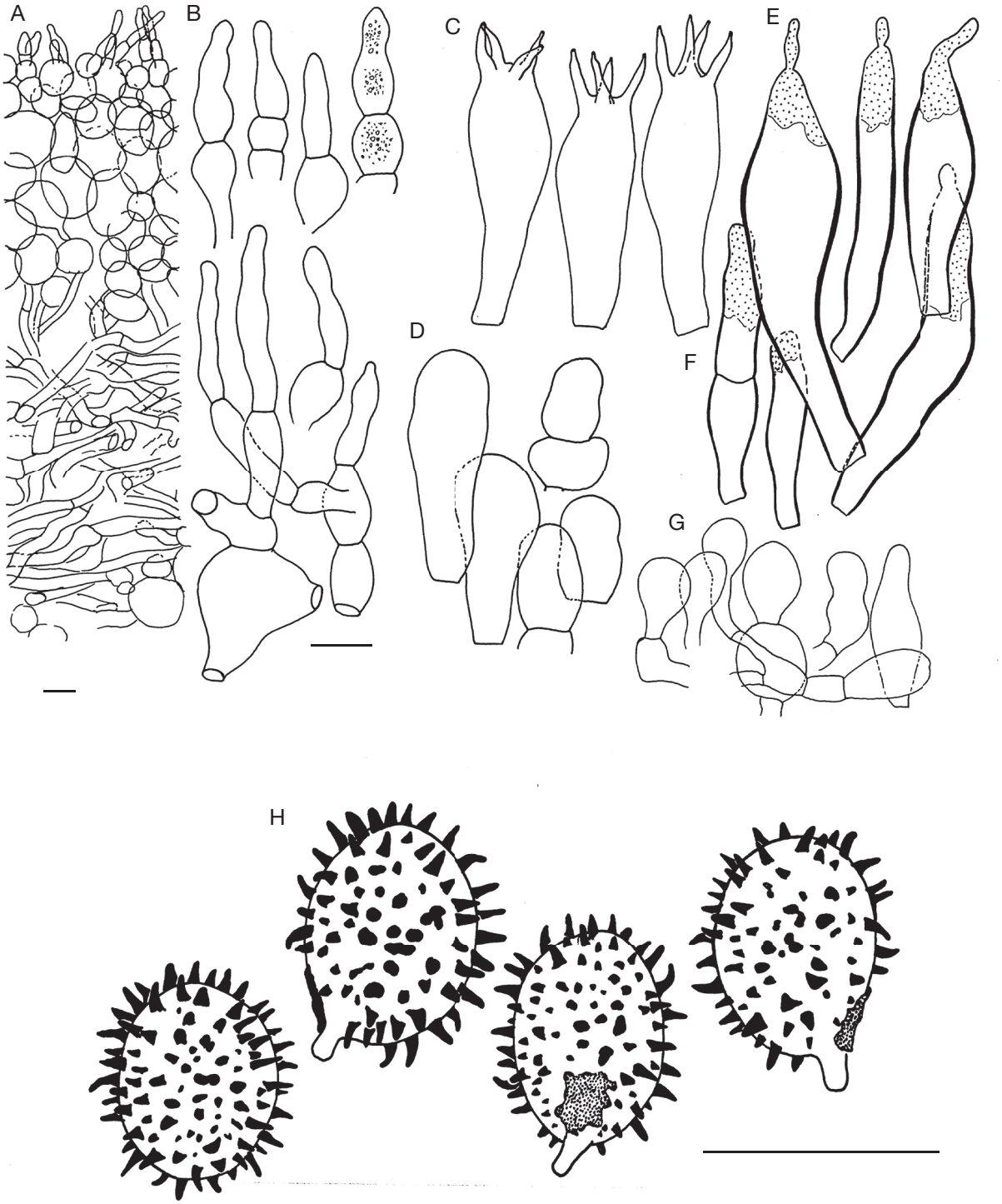


Fig. 22. — *Russula castanopsidis* Hongo, the type species of subsect. *Castanopsidum* Buyck & X. H. Wang, subsect. nov.; microscopic features of the type collection. **A**, vertical section of the pileipellis; **B**, hyphal terminations of the pileipellis; **C**, basidia; **D**, basidiola; **E**, hymenial gloeocystidia on gill sides; **F**, hymenial gloeocystidia on gill edge; **G**, marginal cells, **H**, spores in Melzer's reagent. Drawings: B. Buyck. Scale bars: A-H, 10 µm.

The here presented multilocus phylogeny (Fig. 23) places *R. castanopsidis* and *R. purpureogracilis* with full support in a clade that is sister to another fully supported clade that corresponds to subsect. *Tricholomopsidae* Buyck & V. Hofst. (in Das *et al.* 2017). Following a recent discussion with nomenclatural experts (S. Pennycook [Landcare Research, New Zealand] and S. Redhead [Montreal, Canada]) the latter name needs a typographic correction to the plural genitive '*Tricholomopsidum*' as it refers indeed to a resemblance with the genus *Tricholomopsis* and not to the 'hairs' on the pileus surface (fide J. Cooper [New Zealand], pers. comm.). Subsections *Tricholomopsidum* and *Castanopsidum* subsect. nov. form together a fully supported clade that is sister with significant support (BS = 80%) to an assemblage of species

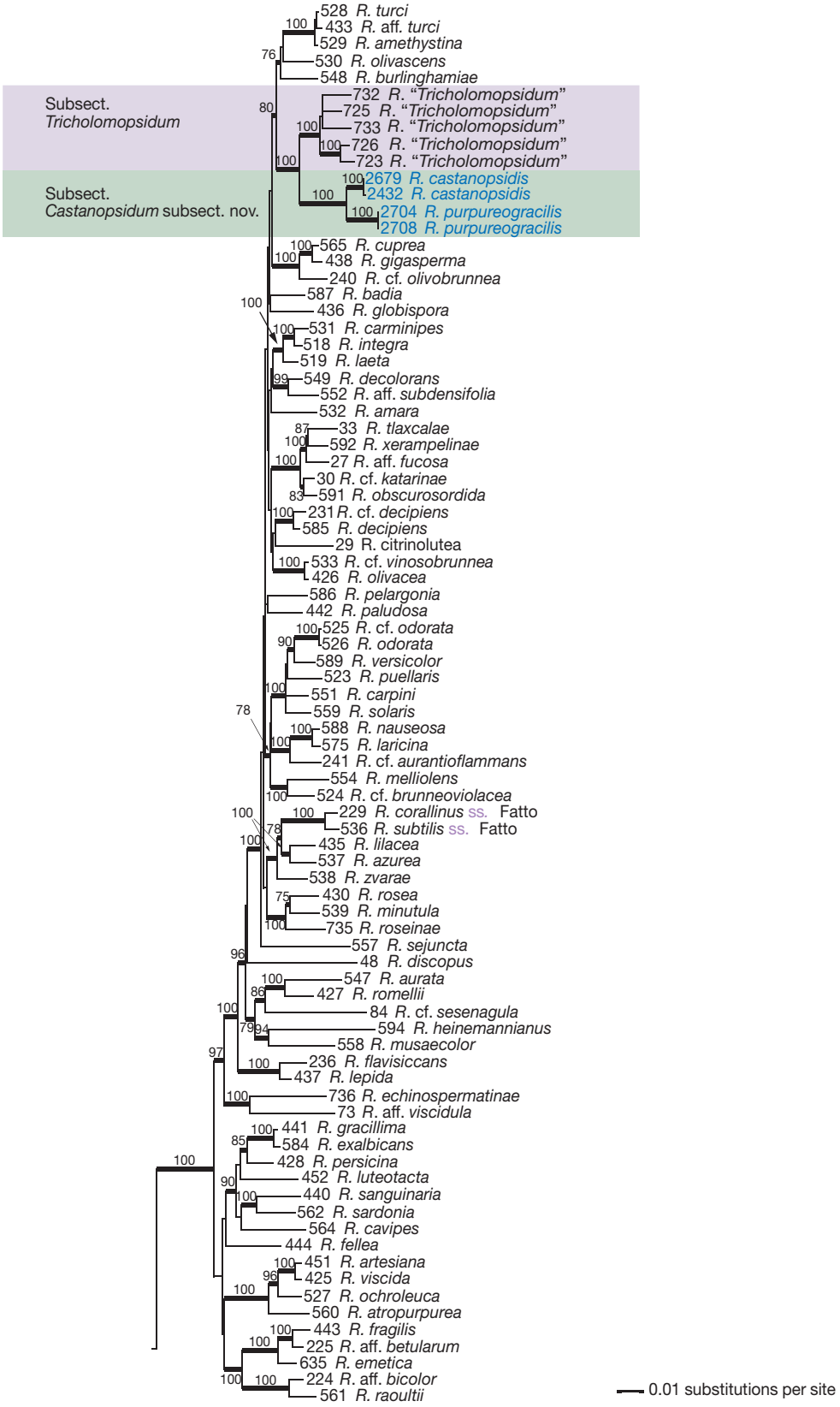


FIG. 23. — Part of the most likely tree obtained by ML analysis of a 168 specimens/5 locus dataset (-ln 57423.49377). For details on vouchers, see Buyck *et al*. (2018); only subgenus *Russula* is here depicted; other subgenera are as shown in Buyck *et al*. (2018). Branches significantly supported are in **bold** and bootstrap values indicated along the branches. Newly sequenced taxa are in blue font and the new section is indicated as a green rectangle.

Fig. 24. — *Russula purpureogracilis* Hampe & Looney, field habit (coll. X. H. Wang, no 4515 [HKAS104817, PC0125102], no. 4516 [HKAS104818, PC0125103]), Photos: B. Buyck.

Fig. 25. — *Russula castanopsidis* Hongo field habit (coll. B. Buyck & X.H. Wang, no. 4524 [HKAS 104824, PC0125085]). Photos: B. Buyck.

corresponding to subsections *Amethystinae* and *Chamaeleontinae*, but including also *R. burlinghamiae* Sing. and, most likely, *R. clavatohyphata* R.P. Bhatt *et al.* (see Wang *et al.* 2019). Subsect. *Tricholomopsidum* differs from subsect. *Castanopsidum* subsect. nov. in the less slender basidiomata, the presence of (sometimes extremely) long, encrusted 'hairs' emerging from the pileipellis surface, the subreticulate, warted-crested (rather than spiny) spore ornamentation and their predominant association with *Nothofagus* (sensu lato) trees.

Acknowledgements

The authors are grateful to the Director, Botanical Survey of India, Kolkata for providing facilities. MEH is thankful to Head of Office, Central National Herbarium, Botanical Survey of India, Howrah and Santhal & Paharia aboriginals of Rajmahal hills for providing him facilities during survey and collection trips. KD is thankful to the Scientist-in-charge, BSI, Gangtok and the entire forest department of Sikkim for providing the permit to undertake macrofungal survey in restricted areas of Sikkim.

B. Buyck & V. Hofstetter are grateful to the staff members of CNRE in Antananarivo for logistic support and field assistance; while field work in Madagascar was financed in part by the National Geographic Society (grants 6365-98, 7921-05) and in more recent years by the ATM-project "Past and present biodiversity" of the Museum national d'histoire naturelle (Dirs. Ph. Janvier and S. Peigne).

Funding was provided to T. W. Henkel by National Geographic Society's Committee for Research and Exploration grant 9235-13 and National Science Foundation grant DEB-1556338. In Cameroon the Ministry of Research and Scientific Innovation issued research permits. The Conservator of the Dja Biosphere Reserve, Mr. Ndinga Hilaire, and his staff greatly assisted the fieldwork in the Dja. Congo Basin Institute staff provided much logistical support. Field assistance in Cameroon was provided by Mei Lin Chin, Todd Elliott, Camille Truong, Bryn Dentinger, Cathie Aime, Rachel Koch, Blaise Jumbam, Olivier Séné, Carolyn Delevich, Kennan Mighell, Jessie Uehling, Noah Siegel, Alamane Gabriel (a.k.a. Sikiro), and Essambe Jean-Pierre (a.k.a. Papa Chef).

The 2017 joint field trip of Buyck and X. H. Wang in Yunnan was supported by "Investigation of Macrofungi of Maguan County" issued by Ministry of Ecology and Environment, P. R. China, and the sequencing of *Russula* samples was funded by the CAS Key Laboratory for Plant Diversity and Biogeography of East Asia, Kunming Institute of Botany, Chinese Academy of Sciences (project no. LPB201501).

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Submitted on 14 November 2019;
accepted on 19 December 2019;
published on 1 April 2020.