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Marasmioid and gymnopoid fungi of the Republic of Korea. 2. *Marasmius* sect. *Globulares*

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Key words

ITS
LSU
nomenclature
taxonomy

Abstract Seven species of *Marasmius* sect. *Globulares* with smooth pileipellis cells (sect. *Globulares* s. Singer) have been collected in the Republic of Korea (South Korea) to date, viz. *M. aurantioferrugineus*, *M. brunneospermus*, *M. maximus*, *M. nivicola*, *M. purpureostriatus*, *M. wynneae* and *M. fusicystidiosus*. Descriptions of their macro- and microscopic features with a discussion of similar taxa are given. Their taxonomic position was confirmed using DNA data. *Marasmius fusicystidiosus* is described as a new species. A key to aid in their identification is also provided.

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INTRODUCTION

The genus *Marasmius* was considered a rather homogeneous group until the end of the last century (e.g. Antonín & Noordeloos 1993). However, Moncalvo et al. (2002) showed that it is polyphyletic and its members belong to a number of distinct clades (/omphalotaceae, /physalacriaceae, /marasmiaceae). According to other studies (Wilson & Desjardin 2005, Matheny et al. 2006), only the sections *Marasmius*, *Hygrometrici*, *Globulares* and *Sicci* belong to *Marasmius* s.str. (family *Marasmiaceae*), whereas species of the sections *Globulares* and *Sicci* belong to one section called *Globulares*. Moreover, species of this section forming a hymeniform pileipellis of smooth (*Globulares*) or broom cells (*Sicci*) do not even belong to separate subsections, but are intermixed (Desjardin pers. comm.).

In this paper, South Korean species of *Globulares* with smooth pileipellis cells and no setae (not mixed with broom cells of the *Siccus*-type and well-developed setae = former sect. *Sicci*, ser. *Spinulosi*) are studied as part of a project on the genus *Marasmius* and related taxa in the Republic of Korea.

MATERIALS AND METHODS

Macroscopic and microscopic studies

Macroscopic descriptions of collected specimens are based on fresh basidiocarps and made by the first and the second author. Microscopic features are described from dried material mounted in H_2O, KOH, Melzer's reagent and Congo Red using an Olympus BX-50 light microscope with a magnification of ×1 000. For basidiospores, the factors E (quotient of length and width in any one spore) and Q (mean of E-values) are used. Authors of fungal names are cited according to the International Plant Names Index Authors website (http://www.ipni.org/ipni/authorsearchpage.do). Colour abbreviations follow Kornerup & Wanscher (1983) and herbarium abbreviations are according to Holmgren & Holmgren (1998). For the list of studied specimens, including GenBank numbers, see Table 1.

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DNA extraction, PCR amplification and sequencing

DNA extraction was undertaken as described previously by Lee & Taylor (1990). Genomic DNA was extracted using a small piece (3–4 mm^3) of the basidiocarp.

PCR primers LR0R (5' ACC CGC TGA ACT TAA GC 3') and LR7 (5' TAC TAC CAC CAA GAT CT 3') were used for amplification of the LSU (the nuclear large ribosomal subunit) region of rDNA (Moncalvo et al. 2002). PCR cycling started with 3 min at 94 °C, denaturation for 30 s at 94 °C, annealing for 45 s at 45 °C, and extension for 90 s at 72 °C. Thirty-five cycles were run with the first denaturation and last extension times.

PCR amplification of rDNA ITS (the internal transcribed spacer) region was performed according to the modified method of Gardes & Bruns (1993). The forward primer ITS1-F (5' CTT GGT CAT TTA GAG GAA GTA A 3') and reverse primer ITS4-B (5' CAG GAG ACT TGT ACA CGG TCC AG 3') were used for selective amplification of the complete ITS region of rDNA. Temperature cycling was performed with denaturation for 30 s at 94 °C, annealing for 30 s at 56 °C, and extension for 1 min at 72 °C. Thirty-five cycles were run with the first denaturation and last extension times extended to 2 and 5 min, respectively.

Purified DNAs were directly sequenced on an ABI Prism TM 377 DNA automatic DNA Sequencer (Applied Biosystems, Foster City, CA, USA) using a BigDye™ cycle sequencing kit, v3.1 (Applied Biosystems). Primers were identical with those in ITS whereas LR0R, LR7 and the internal primer LR3 (5' CCG TGT TTC AAG ACG GG 3') were used for amplification in LSU, respectively.

Sequence alignment and phylogenetic analysis

Sequences were edited with the DNASTAR software, v5.0.5 (DNAstar, Madison, WI, USA). Alignment of the sequences was performed using CLUSTAL_X (Thompson et al. 1997). Phylogenetic trees were obtained from the data using Bayesian modelling (MCMC). MCMC analysis was performed using MrBayes, v3.0b4 (Ronquist & Huelsenbeck 2003). This program performs a Bayesian inference of the phylogeny, using Metropolis-coupled Markov chain Monte Carlo analyses (Geyer 1991). For a given dataset, the general time reversible (GTR) model was employed with gamma-distributed substitution rates. Markov chains were run for 10^6 generations, saving a

Table 1 List of specimens used for molecular studies. Abbreviations: RK = Republic of Korea, J = Japan.

Species	Locality	Herbarium specimen	GenBank acc. number	
			ITS	LSU
M. aurantioferrugineus	RK, Hongcheon, Bukbang-myeon	BRNM 714752	FJ904944	FJ904962
M. aurantioferrugineus	RK, Pyeongchang, Bongpyung-myeon, Heungjeong-ri, Mt Heungjeong	HCCN – GBDS 2861	FJ904945	FJ904963
M. aurantioferrugineus	RK, Hongcheon, Bukbang-myeon	HCCN – 3517	FJ904946	FJ904964
M. brunneospermus	RK, Seoul, Hongreung Arboretum	BRNM 714568	FJ904966	FJ904948
M. brunneospermus	RK, Mt Sobaeksan National Park, Saebat valley	BRNM 714569	FJ904967	FJ904949
M. brunneospermus	RK, Seoul, Hongreung Arboretum	BRNM 714670	FJ904968	FJ904950
M. brunneospermus	RK, Seoul, Mt Achasan	BRNM 714669	FJ904965	FJ904947
M. brunneospermus	J, Kanagawa, Yamato	KPM-NC 0005011 (holotype)	FJ904969	FJ904951
M. fusicystidiosus	RK, Jeju, Jocheon-eup, Seonheul-ri	BRNM 714567	FJ917624	FJ936144
M. maximus	RK, Jeju, Jeju City Park	BRNM 714570	FJ904976	FJ904959
M. maximus	RK, Jeju, Udo-myeon	BRNM 714571	FJ904977	FJ904958
M. maximus	RK, Seoul, Sangam World Cup Park	BRNM 714671	FJ904975	FJ904957
M. maximus	RK, Seoul, Jungreung stream	BRNM 714672	FJ904974	FJ904956
M. nivicola	RK, Mt Sobaeksan National Park, Darian river valley	BRNM 714572	FJ904970	FJ904952
M. nivicola	RK, Mt Sobaeksan National Park, Darian river valley	BRNM 714573	FJ904971	FJ904953
M. nivicola	RK, Chuncheon, Dongsan-myeon, Bongmyeong-ri	BRNM 714574	FJ904972	FJ904954
M. nivicola	J, Kanagawa prefecture, Yamato-shi	KPM-NC 0006038 (holotype)	FJ904973	FJ904955
M. purpureostriatus	RK, Jeju, Jocheon-eup, Seonheul-ri	BRNM 714566	FJ904978	FJ904960
M. wynneae	RK, Mt Yongmun, Yongmun-myeon, Sinjum-ri	HCCN – G86	FJ904979	FJ904961

tree every 100th generation. Among these, the first 1 000 trees were discarded. MrBayes was used to compute a 50 % majority rule consensus of the remaining trees to obtain estimates of the posterior probabilities (PPs) of the groups. Sequences of *Marasmius rotula* and *M. capillaris* were selected as outgroup taxa for rooting purposes.

RESULTS

Key to the species of sect. Globulares with smooth pileipellis cells in the Republic of Korea

1. Pileus distinctly sulcate, striped, centre and striae violet brown, sulcae whitish; lamellae distant (L = c. 12); basidiospores large, 21–25 × 5.0–6.5 µm; pleurocystidia absent; caulocystidia absent . . . . . **6. *M. purpureostriatus***
1. Pileus sulcate or not, but never striate, colour different; lamellae closer (L > 16); basidiospores distinctly smaller, less than 15 µm long; pleuro- and caulocystidia absent or present 2
2. Pleurocystidia present 3
2. Pleurocystidia absent 4
3. Stipe long and slender, up to 110 × 3 mm; basidiospores (8.0–)8.5–10 × 3.5–4.0 µm, average = 8.9 × 3.7 µm; cheilocystidia 12–23 × 5.0–12 µm; pleurocystidia fusoid, sometimes pedicellate; caulocystidia absent . . . . . **3. *M. fusicystidiosus***
3. Stipe shorter and more robust, 30–60 × 2.5–6 mm; basidiospores 6.0–8.0 × 3.0–4.0 µm, average = 7.4 × 3.4 µm; cheilocystidia 21–42 × 7.0–10(–14) µm; pleurocystidia fusoid, subcylindrical, sublageniform; caulocystidia present, numerous . . . . . **2. *M. brunneospermus***
4. Pileus orange-ferrugineous; basidiospores 11.5–15 × (4.0–)4.5–6.0 µm . . . . . **1. *M. aurantioferrugineus***
4. Pileus differently coloured, never orange-ferrugineous; basidiospores smaller, never over 10 µm long 5
5. Basidiocarps robust, macroscopically similar to *M. oreades*; basidiospores 7.0–9.5(–10) × 4.5–6.0 µm, average = 8.5 × 5.1 µm; caulocystidia numerous, forming a compact layer of interwoven, cylindrical, narrowly clavate, subfusoid, narrowly cylindrical, often irregular or branched, up to 10 µm wide cells . . . . . **4. *M. maximus***
5. Basidiocarps less robust, single or in clusters, never macroscopically reminding *M. oreades*; basidiospores 6.5–8.0 × 3.7–5.0 µm, average = 7.2–7.3 × 3.6–4.1 µm; caulocystidia not forming a compact layer 6
6. Pileus white-off, whitish to yellowish white or pale yellow with brownish or greyish tinge at centre, never violaceous tinged; lamellae distinctly anastomosed already when young, white, pale yellow, greyish cream or pale cream; basal tomentum forming a ± solid mycelial mat around stipe base . . . . . **5. *M. nivicola***
6. Pileus white or grey-ochraceous when young, then milky white, grey, or grey-violaceous; lamellae not intervenose or only when old, white to cream or grey, sometimes with violaceous tinge; basal tomentum never forming a ± solid mycelial mat around stipe base . . . . . **7. *M. wynneae***

1. *Marasmius aurantioferrugineus* Hongo, Mem. Fac. Lib. Arts Educ. Shiga Univ., Nat. Sci. 15: 74. 1965. — Fig. 1c, 2

Pileus 30–70 mm broad, convex, then expanded, obtuse, with involute margin when young, dry, radially rugose, orange-ferrugineous. Lamellae subdistant, adnate to almost free. Stipe 50–120 × 3–6 mm, cylindrical, with broadened base, straight, silky-fibrillose, twisted, pruinose at apex, solid, whitish. Context thick in centre, thin at margin, tough, white, with mild taste and indistinct smell (according to Hongo 1965). *Basidiospores* 11.5–15 × (4.0–)4.5–6.0 µm, average = 13.2 × 4.7 µm, E = 2.3–3.3, Q = 2.7–2.9, fusoid, clavate, sublacrimoid, smooth, hyaline; slightly thick-walled spores present. Basidia 26–28 × 8.0–11 µm, 4-spored, clavate. Basidioles up to 42 × 5.0–10 µm, cylindrical, clavate or subfusoid. Cheilocystidia 15–30 × 6.0–11(–14) µm, clavate, fusoid, subcylindrical, (sub)vesiculose, irregular or regular, thin-walled. Pleurocystidia absent. Trama hyphae made up of cylindrical to (sub)inflated, ± thin-walled, hyaline, smooth or minutely incrusted, up to 15(–20) µm wide cells. Pileipellis a hymeniderm composed of cells 20–41 × (8.0–)10–22(–30) µm, clavate or pyriform, pedicellate and capitate or subvesiculose, regular, rarely irregular, thin- to slightly thick-walled, smooth, subhyaline to pale orange-brown in KOH. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, smooth, up to 6.0 µm wide hyphae. Caulocystidia appressed to erect, (13–)22–45 × 5.0–9.0 µm, cylindrical, (narrowly) clavate, (sub)fusoid, obtuse, thin- to slightly thick-walled. Clamp connections present in all tissues.

Chemical reactions — Pileipellis, hymenium and basidiospores non-dextrinoid (but thick-walled spores dextrinoid), caulocystidia non-dextrinoid or dextrinoid, other tissues distinctly dextrinoid.

Habitat — On fallen needles of *Pinus densiflora* and a coniferous tree.

Fig. 1 Photos of basidiocarps. a. *Marasmius purpureostriatus*; b. *M. brunneospermus*; c. *M. aurantioferrugineus*; d. *M. maximus*; e, f, g. *M. nivicola*. Photos by: a–b, d–g: V. Antonín; c. R. Ryoo.

Specimens examined. Republic of Korea, Pyeongchang, Bongpyung-myeon, Heungjeong-ri, Mt Heungjeong, 1 Sept. 1995, *Y.H. Park*, HCCN – GBDS 2861; Hongcheon, Bukbang-myeon, Experimental forest of Kangwon National University, alt. c. 1080 m, 37°48'48.69"N, 127°51'04.14"E, 25 Aug. 1990, *Y.S. Kim*, HCCN 3517; Hongcheon, Bukbang-myeon, Experimental forest of Kangwon National University, alt. c. 1080 m, 37°48'48.69"N, 127°51'04.14"E, 28 Aug. 2008, *R. Ryoo KG 254*, BRNM 714752.

Notes — *Marasmius aurantioferrugineus* is a very distinct species characterised by a large, orange-ferrugineous pileus, a rather long and wide stipe, large clavate, fusoid to sublacrimoid basidiospores, and the absence of pleurocystidia.

Among species with a similarly coloured pileus, *M. heinemannianus*, described from Africa, has larger cheilocystidia ((16–) 22–61.5 × 6.2–12.5 µm) and well-developed pleurocystidia (Antonín 1998, 2007). *Marasmius veigasii* has lamellae and stipe concolorous with pileus, basidiospores c. 16 × 4 µm and absent cystidia; *M. pseudocollinus* has a smaller, only 8–31 mm broad pileus, a smaller stipe (20–38 × 1.5–2.5(–4) mm), smaller basidiospores (6.5–7.5 × 3.3–3.5 µm) and absent cheilocystidia; *M. silvicola* has differently shaped and smaller basidiospores (4.5–8.3 × 2.5–4.2 µm; Desjardin et al. 2000 (5–)6–7 × 2–3.5 µm) and present pleurocystidia (Singer 1976).

Marasmius aurantioferrugineus is only known from East Asia (China, Japan, and Republic of Korea) and the Russia Far East (Primorsky Territory; Bulakh & Covorova 2000).

2. *Marasmius brunneospermus* Har.Takah., Mycoscience 40, 6: 477. 1999. — Fig. 1b, 3

Basidiocarps single. Pileus 20–50 mm broad, conical-hemispherical when young, then broadly conical or convex with obtuse, then applanate to slightly depressed centre and invo-

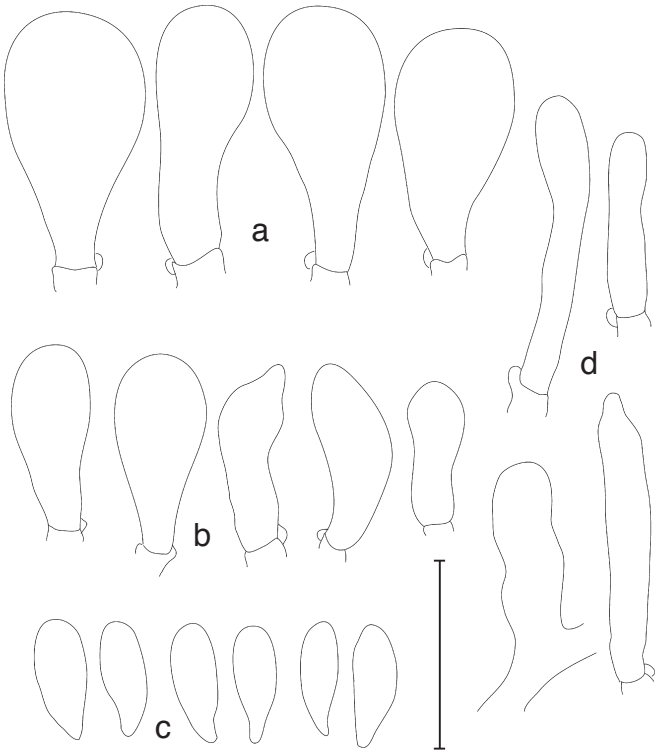

Fig. 2 *Marasmius aurantioferrugineus*. a. Pileipellis cells; b. cheilocystidia; c. basidiospores; d. caulocystidia. — Scale bar = 20 µm.

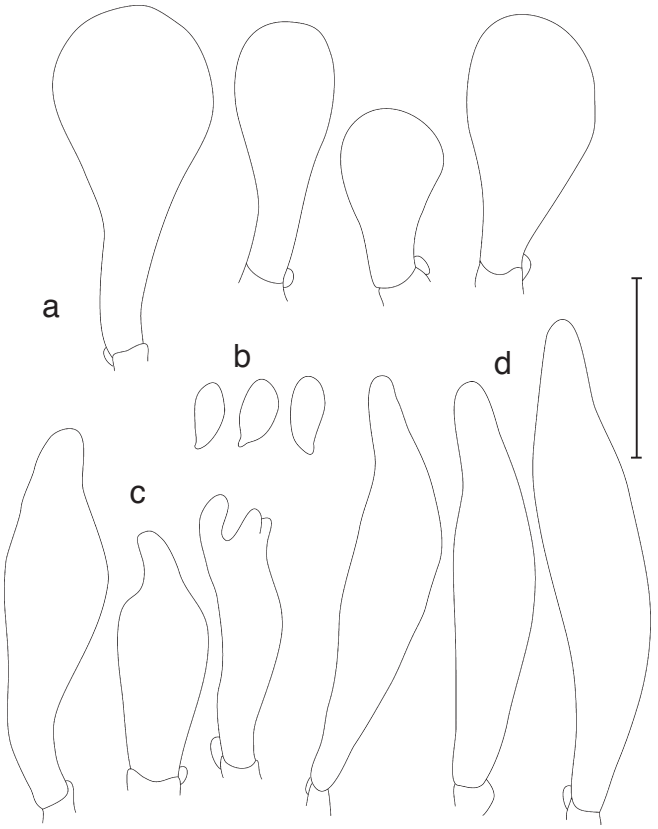

Fig. 3 *Marasmius brunneospermus*. a. Pileipellis cells; b. basidiospores; c. cheilocystidia; d. pleurocystidia. — Scale bar = 20 µm.

lute, then inflexed to straight margin, hygrophanous, glabrous, smooth to slightly (pitted) rugulose, either yellowish white (between 3–4A3) or light brown (slightly paler than 6C–D), then dark brown centre (7F7) and light brown (paler than 6C–D4) margin. Lamellae moderately close to distant, L = 22–24, l = 2–3(–4), emarginate and attached with a small tooth to almost free, slightly sinuate, yellowish white (3–4A3), then brownish orange (± 5B3, paler than 6C5), with concolorous, uneven, finely pubescent edge. Stipe 30–60 × 2.5–6 mm, cylindrical, subcylindrical to clavate towards base (up to 10 mm), entirely finely tomentose, then ± glabrescent, tough but fragile, sometimes twisted, either yellowish white (3–4A3) and then concolorous with lamellae (brownish orange) and pale ochraceous towards base, or pale whitish brownish at apex and then greyish brownish (6D4–5); basal tomentum white or whitish and sometimes forming a mycelial math around stipe base. Context whitish to pale cream in pileus, concolorous with surface under pileipellis, hollow in stipe, with faintly fungoid smell and mild taste. *Basidiospores* 6.0–8.0 × 3.0–4.0 µm, average = 7.4 × 3.4 µm, E = (1.5–)1.8–2.4, Q = (1.9–)2.1–2.2, ellipsoid, ellipsoid-fusoid or (sub)cylindrical, sometimes subphaseoliform, smooth, hyaline, both thin- and thick-walled. Basidia 28–32 × 6.5–7.0 µm, 4-spored, clavate. Basidioles 17–35 × 3.0–8.0 µm, cylindrical, clavate or subfusoid. Cheilocystidia 21–42 × 7.0–10(–14) µm, variable in form, clavate, fusoid, subcylindrical, sublageniform, irregular, rostrate or branched, thin- to ± slightly thick-walled. Pleurocystidia (28–)46–75 × (6.0–)9.0–15 µm, fusoid, subcylindrical, sublageniform, sometimes rostrate or pimpled, with refractive contents, thin-walled. Trama hyphae cylindrical or subinflated, thin- to slightly thick-walled, hyaline, up to 15 µm wide. Pileipellis a hymeniderm composed of cells 18–41 × 12–26 µm, clavate or (sub)vesiculose, sometimes pedicellate, thin- to slightly thick-walled, smooth, with pale greyish brownish walls in KOH. Pileocystidia scattered, 26–65 × 8.0–15 µm, (sub)cylindrical or (broadly) fusoid, often rostrate, rostrum sometimes irregular, sometimes with one septum, obtuse, thin-walled, irregular. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, smooth or minutely incrusted, up to 6.0 µm wide hyphae; medulla hyphae minutely incrusted, up to 20 µm wide. Caulocystidia numerous, 13–55 × 6.0–15 µm, variable in shape, fusoid, clavate, cylindrical, lageniform, sometimes irregular or rostrate, thin- to slightly thick-walled**.** Clamp connections present in all tissues.

Chemical reactions — Basidiospores non-dextrinoid, pileipellis and caulocystidia non-dextrinoid to slightly dextrinoid, pileocystidia and other tissues distinctly dextrinoid.

Habitat — On detritus of *Pinus densiflora*, *Acer* sp., and *Magnolia* sp. in an arboretum or a park, detritus of *Larix* sp. in a mixed forest with *Pinus multiflora*, and *Corylus* sp. on calcareous soil along a rivulet.

Specimens examined. Republic of Korea, Seoul, Hongreung Arboretum, alt. c. 130 m, 37°35'40"N, 127°02'44"E, 18 July 2007, *V. Antonín 07.80 & R. Ryoo*, BRNM 714568; Seoul, Hongreung Arboretum, alt. c. 175 m, 37°35'44"N, 127°02'39.44"E, 24 July 2008, *R. Ryoo KG 237*, BRNM 714670; Danyang, Sobaeksan National Park, Saebat valley, 36°59'20"N, 128°27'40"E, 18 July 2007, *J.G. Han*, *V. Antonín 07.48*, BRNM 714569; Hongcheon, city park, alt. c. 200 m, 37°40'55"N, 127°52'17"E, 16 July 2009, *H.D. Shin*, *V. Antonín 09.122*, BRNM 714895; Suwon, the former campus of the Seoul National University, alt. c. 65 m, 37°16'07"N, 126°59'15"E, 21 July 2009, *H.D. Shin*, *V. Antonín 09.148*, BRNM 718805. — Japan, Kanagawa, Yamato, 27 May 1998, *H. Takahashi*, holotype KPM–NC 0005011.

Notes — *Marasmius brunneospermus* is characterised by having moderately large basidiocarps with a pale coloured pileus, rather small basidiospores, well-developed cheilo- and pleurocystidia and a brown spore print. Our collections agree well with Takahashi's description and photos (Takahashi 1999) with the exceptions of the presence of pileocystidia and spore print colour. Pileocystidia are, however, scattered and indistinct in all specimens and may represent aberrant forms of pileipellis cells. Takahashi (1999) described and photographed a spore print as brown, but our collections have pale yellow-orange coloured basidiospores. Because our fungi agree with the

type specimen not only macro- and microscopically but also using molecular methods, the spore print colour described by Takahashi may be caused under the influence of growing conditions of the fungi. The collection from the Hongreung Arboretum (KG 237) differs in having ellipsoid or fusoid-ellipsoid (never cylindrical or phaseoliform) basidiospores of the same size but different E (1.5–2.1) and Q (1.9) ratio. However, this character falls within the variability of *M. brunneospermus*.

The presence of a brown spore print represents a unique character in *Marasmius*. Among other white-spored species with well-developed pleurocystidia and vestured stipe, *M. silvicola*, known from Argentina and Java, Indonesia, has a dark reddish orangish brown pileus when moist fading to brownish orange or brownish yellow and a more robust stipe, 80–140 × 5–10 µm (Desjardin et al. 2000); *M. muramwyanensis*, from Africa, has a membranaceous, centrally brown-beige and marginally beige or greyish orange pileus and smaller basidiospores, 5.0–6.2 × 2.9–3.7 µm (Antonín 2007). *Marasmius lilacinus*, from the USA, differs by having a lilaceous tinged pileus and different basidiospores (6.5–8 × 4–5 µm), while *M. nigrodiscus*, also from the USA, by differently shaped cheilocystidia, larger pleurocystidia (45–120 × 7–18 mm), and filamentous caulocystidia (Halling 1983).

Marasmius brunneospermus has been found only in East Asia (Japan, Takahashi 1999; Republic of Korea) to date.

3. *Marasmius fusicystidiosus* Antonín, R. Ryoo & H.D. Shin, *sp. nov.* — MycoBank MB515578; Fig. 4

Pileo 30–50 mm lato, plano cum centro leviter depresso, leviter sulcato, rubro-ochraceo-brunneo. *Lamellis* luteo-albidis vel aurantiaco-albidis, acie concolore. *Stipite* usque 110 × 3 mm, cylindraceo, basim bulboso-clavato, apice luteo-albido, ad basim pallide brunneo. *Basidiosporis* (8.0–)8.5–10 × 3.5–4.0 µm, fusiformibus, subcylindraceis, hyalinis. *Cheilocystidiis* 12–23 × 5.0–12 µm, clavatis, fusiformibus, subcylindraceis, saepe irregularibus, lobatis vel subcoralloideis, tenuitunicatis. *Pleurocystidiis* 43–77 × 6.0–13 µm, fusiformibus, iterum pedicellatis, saepe rostratis, tenuitunicatis. *Pileipellis* hymeniformis, e cellulis clavatis vel pyriformibus, 20–29 × 12–18 µm, laevibus. *Pileocystidiis* et *caulocystidiis* absentibus. Hyphis dextrinoideis, fibulatis.

Holotypus. Republic of Korea, insula Jeju, Jocheon-eup, Seonheul-ri, 5. VII. 2008, *V. Antonín 08.58* (holotypus in herbario BRNM 714567 asservatur).

Basidiocarps single. Pileus 30–50 mm broad, applanate with plane to slightly depressed centre and straight margin, hygrophanous, translucently striate, smooth at centre, slightly sulcate up to 2/3, glabrous, lustrous when moist and then very slightly sticky, reddish ochre-brown (6–7C5) at centre, slightly paler towards margin. Lamellae moderately close, L = c. 30, l = 2–3, emarginate and attached with tooth, slightly nodulose at base, yellowish white to orange-white (± 4–5A2) with concolorous, ± smooth edge. Stipe up to 110 × 3 mm, cylindrical, slightly broadened at apex, bulbose-clavate (8 mm) at base, non-insititious, fistulose, slightly striate at apex (descending lamellae teeth), slightly fibrillose otherwise, slightly fibrillose-tomentose (apex), concolorous with lamellae at apex, light brown (± 6D5) otherwise; with rich whitish basal tomentum. Context concolorous with pileus surface (in pileus) and stipe (in stipe) surface colour, hollow in stipe, without any special smell. *Basidiospores* (8.0–)8.5–10 × 3.5–4.0 µm, average = 8.9 × 3.7 µm, E = 2.1–2.8, Q = 2.4, fusoid, navicular, subcylindrical, smooth, thin-walled, hyaline; slightly thick-walled spores also present. Basidia 25–28 × 6.5–7.5 µm, 4-spored, clavate. Basidioles 15–30 × 3.0–7.0 µm, cylindrical, clavate or subfusoid. Cheilocystidia 12–23 × 5.0–12 µm, variable in shape, clavate, fusoid, subcylindrical, often irregular, lobate to subcoralloid, thin-walled. Pleurocystidia 43–77 × 6.0–13 µm, fusoid, sometimes pedicellate, often pimpled, thin-walled, refractive. Trama hyphae formed by cylindrical or fusoid, thin- to slightly thick-walled, often minutely incrusted, hyaline, up to 25 µm wide cells. Pileipellis a hymeniderm composed of cells 20–29 × 12–18 µm, clavate or pyriform, thin- to slightly thick-walled, smooth, pale yellowish in KOH. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, smooth, up to 8.0 µm wide hyphae. Caulocystidia absent; scattered (sub)erect, ± cylindrical, obtuse, thin-walled terminal cells present. Clamp connections present in all tissues.

Chemical reactions — Basidiospores and hymenium non-dextrinoid, pileipellis non-dextrinoid or slightly dextrinoid, and caulocystidioid cells and trama dextrinoid.

Habitat — On detritus in a mixed forest (*Pinus densiflora*, *Quercus* spp. and *Cryptomeria* sp.).

Specimen examined. Republic of Korea, Jeju, Jocheon-eup, Seonheul-ri, alt. c. 95 m, 33°31'01"N, 126°42'27"E, 5 July 2008, V. Antonín 08.58, holotype BRNM 714567.

Notes — *Marasmius fusicystidiosus* is a distinct species macroscopically similar to *M. brunneospermus*. It differs mainly by the size and shape of basidiospores and size of cheilocystidia.

Among other species with well-developed pleurocystidia, *Marasmius calvus*, from Sri Lanka, has a centrally pale fawn and marginally fuscous brown pileus, narrower basidiospores (8–10.5 × 2.7–3.5 µm) and cheilocystidia similar to pleurocystidia (Pegler 1986, Desjardin et al. 2000); *M. cystidiosus*, known from the USA, has cheilocystidia that are of a different shape, similar to the pleurocystidia (Gilliam 1976, Halling 1983). *Marasmius silvicola*, known from several countries in South America and from Java, Indonesia, differs by smaller basidiospores ((5–)6–7 × 2–3.5 µm; Singer 1976: 4.5–8.3 × 2.5–4.2 µm) and the presence of caulocystidia (Desjardin et al. 2000); *M. goossensiae*, from tropical Africa, differs by a cream coloured pileus with fuligineous or ochraceous brown centre and smaller basidiospores, 6.2–7.9(–9.2) × 3.5–4.2 µm; and *M. muramwyanensis*, also from tropical Africa, differs by smaller basidiospores (5.0–6.2 × 2.9–3.7 µm), differently shaped pleurocystidia and the presence of caulocystidia (Antonín 2007). *Marasmius phlebodiscus*, described from Papua New Guinea, has a wrinkled pileus and smaller basidiospores, 5–6.5 × 3–3.5 µm (Desjardin & Horak 1997), and *M. riparius*, from Argentina, has a context with a slight unpleasant smell of rotten cabbage, broader basidiospores (8.2–10 × 4.8–5.5 µm) and smaller pleurocystidia (40–44 × 8–9 µm), that are similarly shaped to cheilocystidia (Singer 1976).

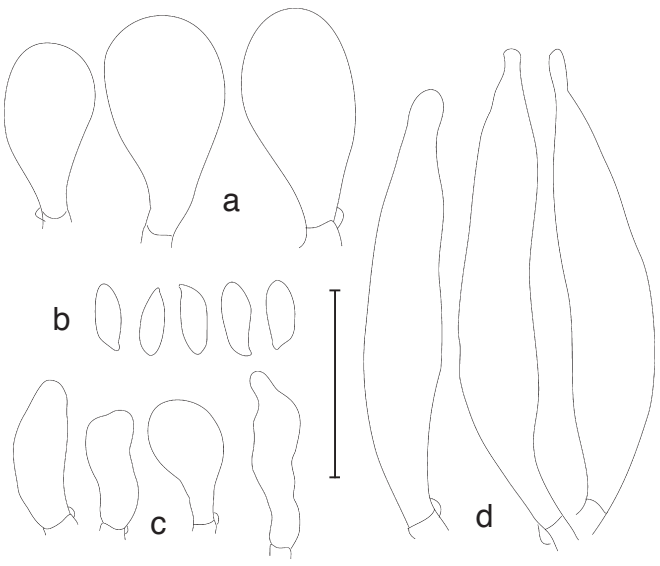

Fig. 4 *Marasmius fusicystidiosus*. a. Pileipellis cells; b. basidiospores; c. cheilocystidia; d. pleurocystidia. — Scale bar = 20 µm.

4. *Marasmius maximus* Hongo, Mem. Fac. Lib. Arts Educ. Shiga Univ., Nat. Sci. 12: 39. 1962. — Fig. 1d, 5

Basidiocarps in groups. Pileus 25–65 mm broad, convex-conical with broad obtuse umbo and inflexed margin, then plano-convex to applanate with slightly undulate margin and low obtuse central umbo, with finally ± straight margin, centre smooth or slightly rugulose, otherwise radially sulcate, especially in older specimens, glabrous, crenulate at margin, hygrophanous, slightly translucently striate at margin when young, ochre-brown (not in K-W) at centre, otherwise pale brownish to pale ochraceous. Lamellae distant, L = 14–25, l = 2–3, emarginate and attached with very small tooth to ± free, broad, rather thick, intervenose when old, whitish to pale cream-yellow (3–4A2) with concolorous, ± smooth edge. Stipe 52–85 × 2–6 mm, cylindrical to slightly broadened at base, non-insititious, tough-elastic, tomentose with tomentum later cracking and forming ± large tomentose scales, concolorous with lamellae or slightly darker at apex, pale brown at base in young specimens, then brown to dark brown (7E–F7) towards base in older basidiocarps. Context whitish, under surface with pileipellis colour, with a pleasant fungoid smell and mild taste. *Basidiospores* 7.0–10.25 × 4.5–6.0 µm, average = 8.7 × 5.2 µm, E = 1.4–2.0, Q = 1.6–1.8, (broadly) ellipsoid-fusoid, fusoid, smooth, hyaline. Basidia 35–48 × 7.0–9.5 µm, 4-spored, clavate. Basidioles 23–45 × 3.0–9.0 µm, cylindrical, clavate or subfusoid. Cheilocystidia (15–)20–30(–40) × 4.0–11 µm, variable in shape, clavate, fusoid, subcylindrical, mostly irregular, lobate, branched to coralloid, thin-walled. Pleurocystidia absent. Trama hyphae consisting of cylindrical, thin- to slightly thick-walled, hyaline, up to 10 µm wide cells. Pileipellis a hymeniderm composed of cells 17–30(–40) × (7.5–)10–18 µm, clavate or pyriform, regular, irregular or with scattered projection(s), thin- to slightly thick-walled, smooth, hyaline to pale yellowish in KOH; subpileipellis hyphae often incrusted. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, smooth, up to 6.0(–8.0) µm wide hyphae. Caulocystidia numerous, forming a compact layer, interwoven, 20–55 × 6.0–11 µm, cylindrical, narrowly clavate, subfusoid, often irregular or branched, thin- to less frequently slightly thick-walled. Clamp connections present in all tissues.

Chemical reactions — Pileipellis, hymenium and basidiospores non-dextrinoid, caulocystidia non-dextrinoid or dextrinoid, other tissues distinctly dextrinoid.

Habitat — On soil in grass of a meadow and a wayside, on leaves under *Forsythia koreana*, and on needles of *Pinus densiflora*.

Specimens examined. Republic of Korea, Jeju, alt. c. 20 m, 33°30'46"N, 126°30'53"E, 4 July 2008, *V. Antonín 08.54 & R. Ryoo*, BRNM 714570; Jeju, Udo-myeon, alt. c. 90 m, 33°29'34"N, 126°30'53"E, 4 July 2008, *V. Antonín 08.56 & R. Ryoo*, BRNM 714571; Seoul, Bukhansan National Park, Jungreung stream, alt. c. 532 m, 37°37'13.86"N, 126°59'38.65"E, 13 July 2008, *R. Ryoo KG 224*, BRNM 714672; Seoul, Sangam World Cup Park, alt. c. 95 m, 37°34'15.25"N, 126°53'48.84"E, 14 July 2008, *R. Ryoo KG 229*, BRNM 714671; Seoul, Korean Forest Research Institute, Hongreung Arboretum, alt. c. 130 m, 37°35'40"N, 127°02'44"E, 10 July 2009, *V. Antonín 09.65 & R. Ryoo*, BRNM 714896; Seoul, Korean Forest Research Institute, Hongreung Arboretum, alt. c. 130 m, 37°35'40"N, 127°02'44"E, 13 July 2009, *V. Antonín 09.91 & R. Ryoo*, BRNM 714897; Hongcheon, city park, alt. c. 200 m, 37°40'55"N, 127°52'17"E, 16 July 2009, *H.D. Shin*, *V. Antonín 09.121*, BRNM 714898; Seoul, Korea University, Science Campus, alt. c. 75 m, 37°35'09"N, 127°01'33"E, 18 July 2009, *V. Antonín 09.124 & R. Ryoo*, BRNM 718781; Chiaksan National Park, Wonju, between N.P. Office and Guryongsa, alt. 310–360 m, 37°24'17"N, 128°03'00"E, 19 July 2009, *V. Antonín 09.130*, *H.D. Shin & R. Ryoo*, BRNM 718787.

Notes — *Marasmius maximus* is a distinct species macroscopically similar to *M. oreades*. It differs by the character of the stipe vesture, size of basidiospores and presence of cheilocystidia.

Another species with developed cheilocystidia and a distinct stipe vesture, *M. silvicola*, known from Argentina and Java, Indonesia, has a dark reddish orangish brown pileus when moist, fading to brownish orange or brownish yellow, and smaller basidiospores, (5–)6–7 × 2–3.5 µm (Desjardin et al. 2000; 4.5–8.3 × 2.5–4.2 µm according to Singer 1976). *Marasmius heinemannianus*, described from Africa and having very similar basidiocarps, has a reddish brown pileus, larger basidiospores (10.8–14.5 × (4.2–)4.6–6.0(–6.6) µm), larger cheilocystidia ((16–)22–61.5 × 6.2–12.5 µm) and well-developed pleurocystidia (Antonín 1998, 2007). Among other African species, *M. arborescens* has a smaller, 10–20(–28) mm broad, white to whitish pileus, larger basidiospores ((6.9–)8–11.5 × 3.0–4.0(–4.2) µm) and grows in dense fascicles. *Marasmius lacteoides* differs by a smaller, 8–30 mm broad, whitish yellowish pileus and smaller basidiospores (6.3–8.5(–10) × 3.5–4.5 mm); *M. muramwyanensis* by a membranaceous pileus, only up to 45 mm broad, smaller basidiospores (5.0–6.2 × 2.9–3.7 µm) and the presence of well-developed pleurocystidia (Antonín 2007).

Marasmius maximus is only known from East Asia (Japan, Hongo 1962; Republic of Korea).

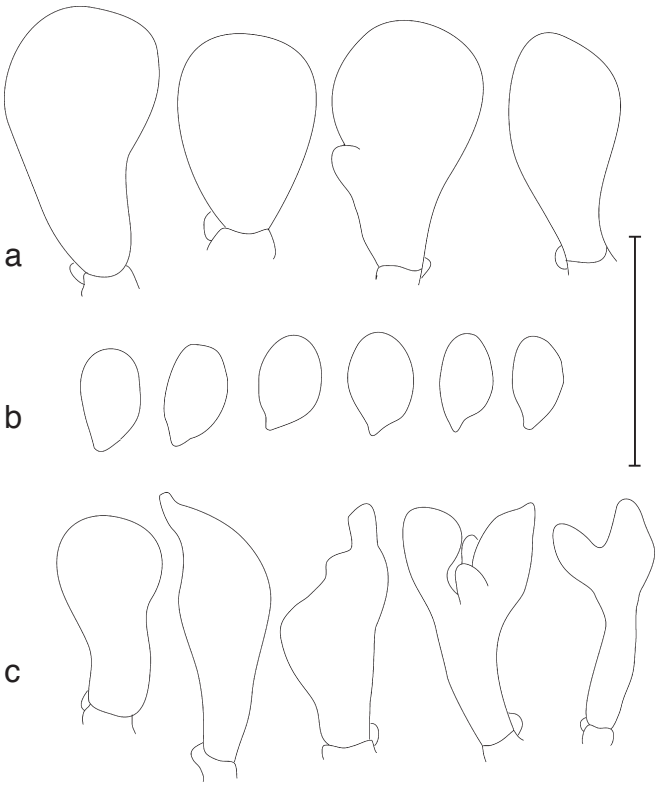

Fig. 5 *Marasmius maximus*. a. Pileipellis cells; b. cheilocystidia; c. basidiospores. — Scale bar = 20 µm.

5. *Marasmius nivicola* Har.Takah., Mycoscience 41: 541. 2000. — Fig. 1e–g, 6

Basidiocarps single or in groups. Pileus 5–40 mm broad, conical-convex to convex with obtuse centre or with indistinct umbo with small umbilicus when young, soon becoming plane, then umbilicate when old, margin involute, then ± straight and uplifted when old, except for centre ± radially rugulose, then entirely rugulose when old, weakly striate at margin, hygrophanous, translucently striate, more distinct when old, glabrous, white-off, whitish to yellowish white or pale yellow (2–3A3, 4A–B3) with brownish or whitish greyish tinge at centre when old. Lamellae ± distant to moderately close, L = (10–)16–27, l = 2–3, adnate or slightly emarginate with small tooth, later without it, up to 1 mm wide, distinctly anastomosed already when young, always

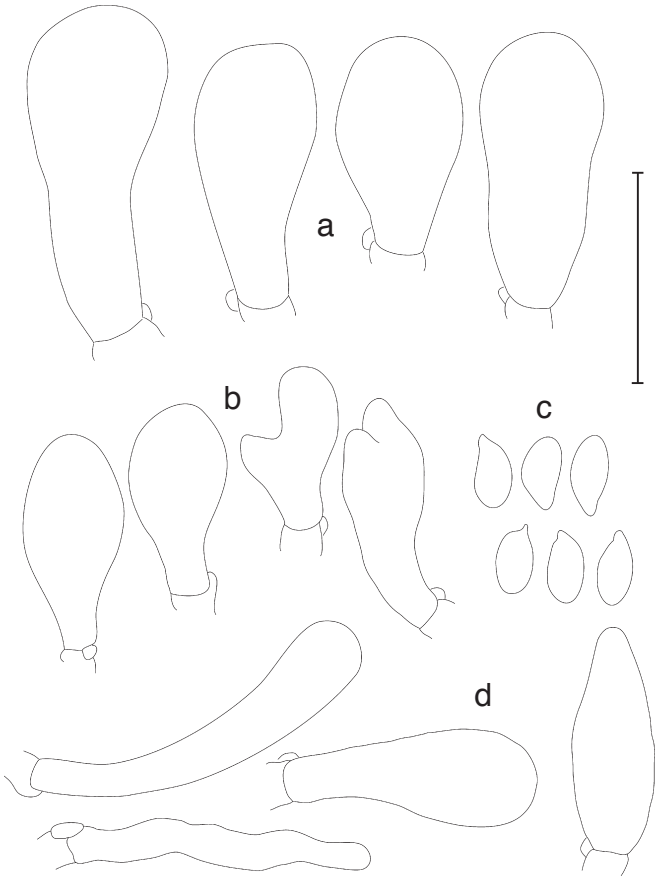

Fig. 6 *Marasmius nivicola*. a. pileipellis cells; b. cheilocystidia; c. basidiospores; d. caulocystidia. — Scale bar = 20 µm.

irregular to branched with distinct tuberculate anastomoses when old, white, pale yellow (3–4A3), greyish cream to pale cream, with concolorous, apparently smooth to finely pubescent edge. Stipe (12–)20–70 × 1–2(–4) mm, cylindrical, laterally compressed especially when old, slightly tapering towards base, slightly tomentose-pubescent or furfuraceous especially in upper half, white to cream (concolorous with lamellae) at apex, through brownish orange (6C7) becoming brownish grey (6C2), orange-brown or reddish brown (8D–E8) towards base; basal tomentum rich, hairy or tomentose and forming a ± solid mycelial mat around stipe base, whitish to pale ochraceous. Context whitish, in cortex with colour of surface, hollow in stipe, with fungoid smell and bitterish taste. *Basidiospores* 6.5–8.0 × 3.7–5.0 µm, average = 7.2 × 3.6 µm, E = 1.6–2.3, Q = 1.7–2.0, ellipsoid, ellipsoid-fusoid, sublacrimoid or (sub)amygdaloid, smooth, hyaline, thin-walled. Basidia 24–29 × 6.5–8.5 µm, 4-spored, clavate. Basidioles 13–33 × 3.0–9.0 µm, cylindrical, clavate or subfusoid. Cheilocystidia (12–)16–31 × (5.0–)6.0–11 µm, clavate, clavate-fusoid, subcylindrical, sometimes irregular or branched, thin-walled. Pleurocystidia absent. Trama hyphae cylindrical or subinflated, thin- to slightly thick-walled, minutely incrusted, hyaline, up to 20 µm wide. Pileipellis a hymeniderm composed of cells 15–35 × 10–20 µm, clavate, pyriform, fusoid, subutriform or subvesiculose, sometimes pedicellate, rarely irregular, smooth, ± thin-walled, hyaline to pale yellowish in KOH. Pileocystidia absent. Stipitipellis a cutis of cylindrical, parallel, thick-walled (up to 0.5(–0.75) µm thick), incrusted, up to 6.0(–10) µm wide hyphae with greyish yellowish walls in KOH. Caulocystidia 18–42 × (3.5–)5.0–12 µm, adpressed to erect, clavate, subcylindrical, fusoid, sometimes irregular or with projections, thin- to slightly thick-walled, with hyaline to pale greyish or yellowish walls in KOH. Clamp connections present in all tissues.

Chemical reactions — Basidiospores, pileipellis, some caulocystidia and hymenium non-dextrinoid, other tissues dextrinoid.

Habitat — On detritus and twigs of *Pinus multiflora*, *Larix sibirica*, *Quercus mongolica* and *Quercus* sp., on calcareous soil along a rivulet and in a mixed forest (dominated by *Quercus* sp. div., *Pinus densiflora* and *Larix sibirica*).

Specimens examined. Republic of Korea, Dnayang, Sobaeksan National Park, Darian river valley between Darian pokpo (falls) and N.P. Northern office, 36°59'20"N, 128°27'40"E, 14 July 2007, *V. Antonín (07.51)*, *J.G. Han*, *R. Ryoo*, *H.D. Shin & M.J. Park*, BRNM 714572; Dnayang, Sobaeksan National Park, Darian river valley between Darian pokpo (falls) and N.P. Northern office, 36°59'20"N, 128°27'40"E, 14 July 2007, *V. Antonín (07.53) & H.D. Shin*, BRNM 714573; Chuncheon, Dongsan-myeon, Bongmyeong-ri, Experimental forest of the Kangwon National University, 37°46'46"N, 127°48'59"E, alt. c. 212 m, 22 July 2007, *V. Antonín 07.101*, BRNM 714574; Hoengseong, Mt Maebongsan, alt. c. 230–270 m, 37°29'25"N, 127°51'04"E, 20 July 2007, *V. Antonín 07.143*, BRNM 718800; Suwon, the former campus of the Seoul National University, alt. c. 65 m, 37°16'07"N, 126°59'15"E, 21 July 2009, *H.D. Shin*, *V. Antonín 09.149*, BRNM 718806; Gapcheon, Mt Homyeongsan, alt. c. 235 m, 37°32'12"N, 128°06'22"E, 27 July 2009, *V. Antonín 09.167 & R. Ryoo*, BRNM 718824. — Japan, Kanagawa prefecture, Yamato-shi, 20 June 1999, *H. Takahashi*, holotype KPM – NC 0006038.

Notes — *Marasmius nivicola* is characterised by having a whitish, yellowish white or pale yellow pileus, distinctly intervenose lamellae (already when young), present cheilo- and caulocystidia and absent pleurocystidia.

Marasmius pellucidus, known from Indonesia, Malaysia, New Caledonia, Sri Lanka and Singapore, has a thin-fleshed pileus, a longer ((20–)40–150 × (1–)2–3 mm), pruinose stipe and slightly smaller basidiospores, (6–)6.5–8(–8.5) × (2.5–)3–4 µm (Wannathes et al. 2004).

Marasmius nivicola has been found only in East Asia (Japan, Takahashi 2000; Republic of Korea) to date.

6. *Marasmius purpureostriatus* Hongo, J. Jap. Bot. 33: 344. 1958. — Fig. 1a, 7

Basidiocarps single. Pileus 17 mm broad, conical, except for ± smooth centre distinctly and deeply sulcate, with straight and crenulate margin, striped, centre and striae violet brown (11E4), sulcae whitish. Lamellae distant, L = 12; l = 0(–1), emarginate with very small tooth to free, fusoid, pale grey (11B–C1), with pale purplish tinged, finely pubescent edge. Stipe 74 × 1 mm, cylindrical, slightly broadened above, subbulbose at base, non-insititious, smooth, glabrous, silky lustrous, concolorous with lamellae at apex, up to reddish brown or violet brown (9–10E5) towards base; rich basal tomentum ochre-yellow. Context membranaceous, without any distinct smell. *Basidiospores* 21–25 × 5.0–6.5 µm, average = 22.6 × 5.8 µm, E = 3.4–4.6, Q = 3.95, clavate, fusoid or lacrimoid, sometimes septate, smooth, hyaline, both non-dextrinoid, thin- and dextrinoid thick-walled. Basidia 38–45 × 10–11 µm, 4-spored, clavate. Basidioles 22–50 × up to 12 µm, subcylindrical, clavate or fusoid. Cheilocystidia (15–)20–35 × 10–15 µm, broadly clavate, fusoid, utriform, sometimes irregular or with projection(s), thin-walled. Pleurocystidia absent. Trama hyphae made up of cylindrical or fusoid cells, thin- to slightly thick-walled, hyaline, up to 15 µm wide. Pileipellis a hymeniderm composed of cells 21–32 × 12–18 µm, clavate, pyriform or vesiculose, ± regular, thin-walled, smooth, subhyaline in KOH. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, smooth, up to 5.0 µm wide hyphae with olivaceous brown walls in KOH. Caulocystidia absent. Clamp connections present in all tissues.

Chemical reactions — Pileipellis, hymenium and basidiospores non-dextrinoid except for thick-walled spores, which are dextrinoid, other tissues distinctly dextrinoid.

Habitat — On detritus in a mixed forest (*Pinus densiflora*, *Quercus* spp., *Cryptomeria* sp.).

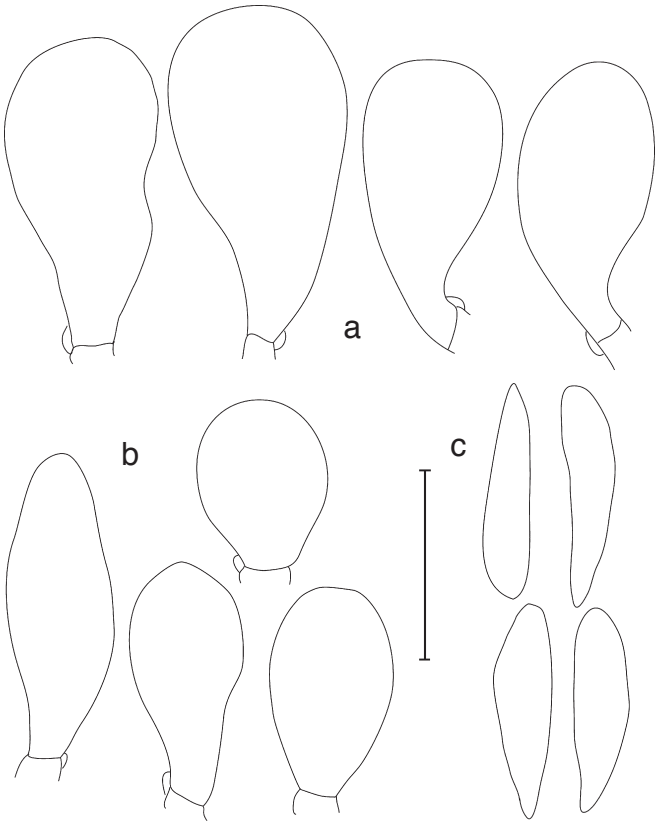

Fig. 7 *Marasmius purpureostriatus*. a. Pileipellis cells; b. basidiospores; c. cheilocystidia. — Scale bar = 20 µm.

Specimens examined. Republic of Korea, Jeju, Jocheon-eup, Seonheul-ri, alt. c. 95 m, 33°31'01"N, 126°42'27"E, 5 July 2008, *R. Ryoo & V. Antonín 08.57*, BRNM 714566. — Japan, Otsu City, Ishujama, Hiratsu-cho, 7 May 1957, *T. Hongo 1609*, isotype ZT 3221; Nara City, 24 April 1958, *T. Hongo*, ex herb. Hongo 1749, L 0650197.

Notes — *Marasmius purpureostriatus* is a very distinct species especially characterised by a striate pileus, glabrous stipe, large basidiospores and broadly clavate, fusoid, utriform, sometimes irregular cheilocystidia.

The most similar species is *Marasmius pseudopurpureostriatus* Wannathes et al., recently described from Thailand. It differs by having a larger pileus (14–38 mm diam) with paler colours, a broader stipe (62–80 × 1.5–3 mm) and slightly smaller basidiospores (20–25 × 5–6.2 µm) with a mean length 22.8 µm (Wannathes et al. 2009b). However, our collection of *M. purpureostriatus* has the same spore size, but our molecular studies proved that our collection belongs to this species.

Among other species with smooth pileus cells and striate pileus, *M. viridis*, from Papua New Guinea, differs by an olivaceous pileus, *M. musisporus*, also from Papua New Guinea, has a purplish lilac pileus with yellow striae, a reddish brown stipe and distinctly larger basidiospores, 30–40 × 4.5–5.0 µm in size (Desjardin & Horak 1997). *Marasmius ditopotramus*, described from Bolivia, has a pileus and stipe without any purplish tinge and smaller basidiospores, 7–9 × 4.5–4.8 µm (Singer 1976). The African species *M. violaceoides* has a violaceous, violet brown or brown pileus with pale violaceous striae, whitish to pale greyish orange lamellae, narrower basidiospores (15.5–22.3 × 3.3–5.0 µm) and shorter cheilocystidia (14–24 × (4.2–)6.2–9.2 µm). Other African species: *M. zenkeri*, has a pileus up to 100 mm broad, pale lilac lamellae, a robust ((40–)120–170 × 2–12 mm) fuligineous, dark reddish brown or chestnut brown stipe, and large cheilocystidia (14–50 × 10–15 µm); *M. bekolacongoli* has yellow coloured or tinged pileus striae, yellow-white to pale lemon-yellow lamellae, a more robust (50–150 × 2.5–6(–10) mm) stipe without purplish tinge and different basidiospores (17.5–24.5(–26) × (3.8–)4.2–5.4 µm, Q = 5.1); *M. brunneolus* has a pileus without any purplish tinge, a more robust stipe (70–180 × 3–6 mm) also without any purplish tinge and slightly different basidiospores (15.5–25.5 × 3.8–5.4 µm, Q = 4.4–4.6); and *M. staudtii* differs especially by having well-developed pleurocystidia (Antonín 2007).

Marasmius purpureostriatus has been collected in East Asia (Japan, Hongo 1958; Malaysia, Thailand, Tan et al. 2009, Wannathes et al. 2009a; Republic of Korea) and Papua New Guinea (Desjardin & Horak 1997, Tan et al. 2009).

7. *Marasmius wynneae* Berk. & Broome, Ann. Mag. Nat. Hist., ser. III, 3: 358. 1859. — Fig. 8

Basidiocarps single or in (rich) clusters. Pileus (6–)10–50 mm, hemispherical to broadly conical with more or less distinct papilla or slightly depressed centre when young, expanding to convex or applanate with low, obtuse umbo or slightly depressed centre, with involute then deflexed or straight, finally sometimes slightly reflexed margin, hygrophanous, slightly translucently striate up to half the radius when moist, white or grey-ochraceous when young, then milky white, grey, or grey-violaceous, usually with paler margin, pallescent on drying, smooth, glabrous or rugulose to subsulcate in old specimens. Lamellae distant, L = 16–29, l = 2–3, free to emarginate with small decurrent tooth, segmentiform to ventricose, rather thick, intervenose when old, white to cream or grey, sometimes with violaceous tinge, with entire to eroded, concolorous edge. Stipe 20–85 × 1–4.5 mm, cylindrical or slightly compressed, without or rarely with a shallow longitudinal groove, sometimes curved at base, slightly broadened at apex, often attenuated towards base, sometimes slightly twisted, very variable in colour, from entirely white to white at apex with short brown or brown-orange

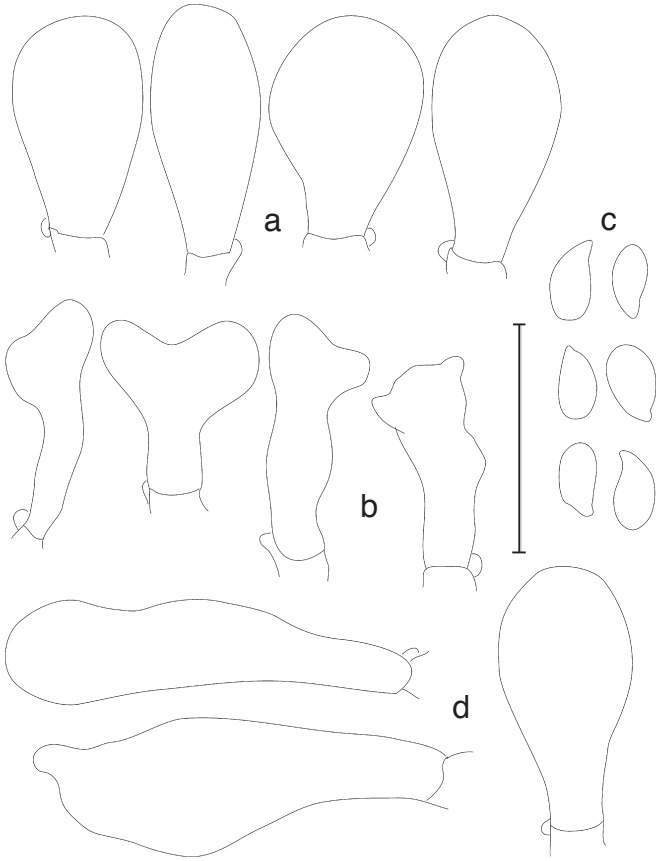

Fig. 8 *Marasmius wynneae*. a. Pileipellis cells; b. cheilocystidia; c. basidiospores; d. caulocystidia. — Scale bar = 20 µm.

zone towards dark red-brown below, or almost entirely brown to orange-brown with red-brown tinge at base only, sometimes entirely red-brown when old, scatteredly flocculose-squamulose, with abundant white basal tomentum, fistulose. Context concolorous with surface in cortex of pileus and stipe, whitish in pileus. Smell pleasant (fungoid or like bitter almonds) to slightly unpleasantly acid. Taste mild, after longer mastication slightly astringent as in *Xerocomus badius* (according to Antonín & Noordeloos 2009). *Basidiospores* 6.5–8.0 × 3.7–4.5 µm, average = 7.3 × 4.1 µm, E = 1.7–2.0, Q = 1.8, ellipsoid, sublacrimoid, smooth, hyaline, thin-walled. Basidium (one found) 24 × 6.5 µm, 4-spored, clavate. Basidioles up to 30 × 4.0–8.0 µm, cylindrical, clavate or (sub)fusoid. Cheilocystidia 15–29 × 6.0–11 µm, clavate, capitate and pedicellate, smooth, mostly irregular, lobate or branched, rarely regular, thin-walled. Pleurocystidia absent. Trama hyphae cylindrical or subinflated, ± thin-walled, smooth or minutely incrusted, hyaline, up to 15 µm wide. Pileipellis a hymeniderm composed of cells 14–27 × (8.0–)10–17 µm, clavate, pyriform, subvesiculose, sometimes irregular, smooth, thin-walled. Pileocystidia absent. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, up to 5.0 µm wide hyphae. Caulocystidia 22–48 × 7.0–14 µm, adpressed to erect, clavate, subcylindrical, fusoid or capitate, sometimes irregular or with projection(s), thin- to slightly thick-walled. Clamp connections present in all tissues.

Chemical reactions — Basidiospores, pileipellis and hymenium non-dextrinoid, other tissues dextrinoid.

Habitat — On fallen needles of a coniferous tree.

Specimen examined. Republic of Korea, Yangpyeong, Yongmun-myeon, Sinjum-ri, Mt Yongmun, 30 June 1993, *Y.S. Kim*, HCCN – G86.

Notes — *Marasmius wynneae* is characterised by a white, grey-ochraceous, milky white, grey, or grey-violaceous pileus and stipe, a mostly distinctly squamulose stipe, small basidiospores, and irregularly shaped cheilocystidia. The only known collection from the Republic of Korea was found in the HCCN herbarium (Suwon), which fully agrees with European material. For details about synonyms, name and taxonomy, see Antonín & Noordeloos (2010).

Marasmius wynneae is a widely distributed species in Europe and has also been recorded from northern Africa (Malençon & Bertault 1975). In East Asia, it is known only from the Republic of Korea.

Phylogenetic analysis

Based on nuclear ribosomal large subunit (LSU) and internal transcribed spacer (ITS) rDNA sequences obtained in this study and from GenBank, the phylogenetic relationships of species in genus *Marasmius* sect. *Globulares* were inferred from MCMC analyses. LSU and ITS sequences were aligned and the ends trimmed to create a dataset of 760 and 651 base pairs, respectively. MrBayes was used to compute a 50 % majority rule consensus for 10^6 generations with a tree saved every 100th generation. The first 1 000 trees were discarded and the remaining trees obtained estimates for the posterior probabilities of group. The phylogenetic trees is shown in Fig. 9 (LSU) and Fig. 10 (ITS).

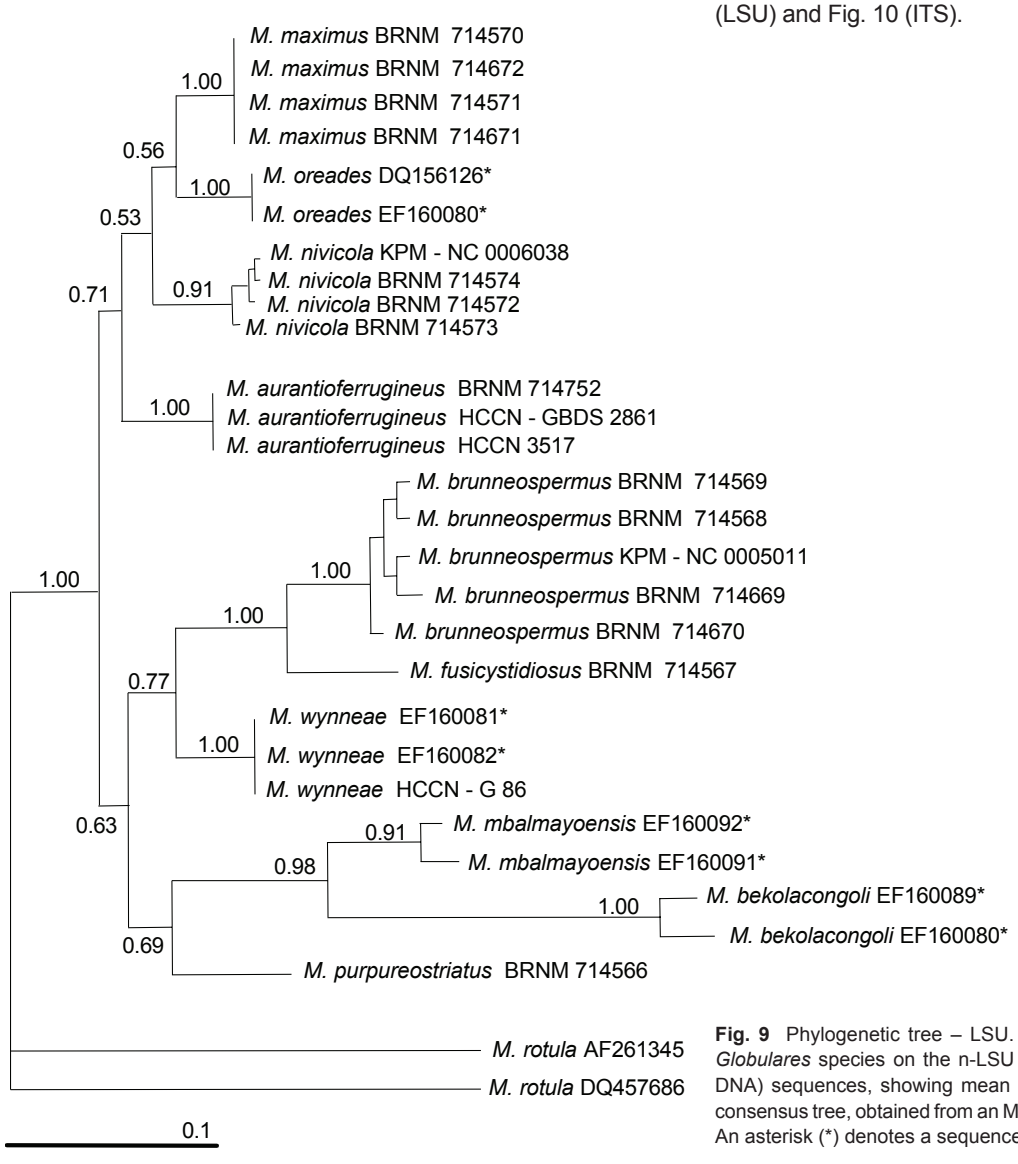

Fig. 9 Phylogenetic tree – LSU. Phylogenetic tree for *Marasmius* sect. *Globulares* species on the n-LSU rDNA (nuclear large subunit ribosomal DNA) sequences, showing mean branch lengths of a 50 % majority rule consensus tree, obtained from an MCMC analysis of one million generations. An asterisk (*) denotes a sequence from GenBank.

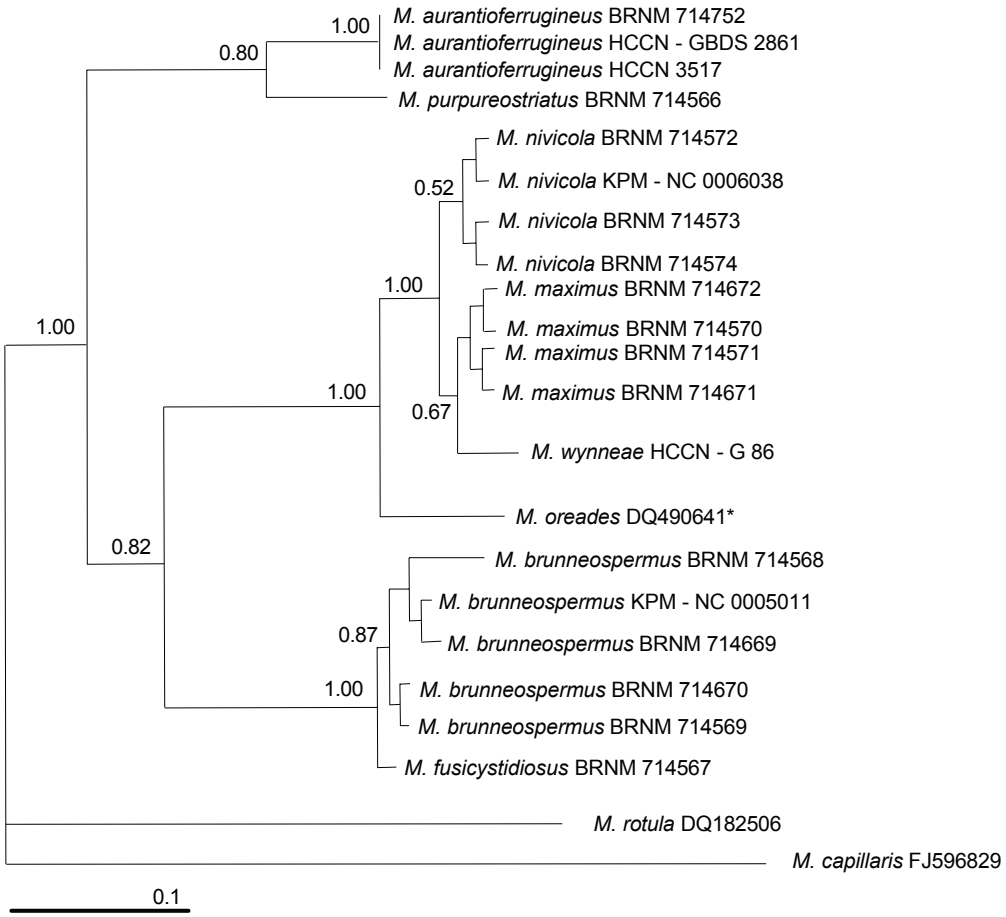

Fig. 10 Phylogenetic tree – ITS. Phylogenetic tree for *Marasmius* sect. *Globulares* species inferred from a Bayesian analysis of the complete ITS region (ITS1, 5.8S rDNA, and ITS2), showing mean branch lengths of a 50 % majority rule consensus tree, obtained from an MCMC analysis of one million generations. An asterisk (*) denotes a sequence from GenBank.

The circumscription of seven species based on morphological characteristics is concordant with those suggested by LSU and ITS sequences similarity. The new species *Marasmius fusicystidiosus* forms a distinct branch sister of *M. brunneospermus* in the LSU and ITS rDNA analyses. *Marasmius brunneospermus* and *M. nivicola* specimens collected in Korea form monophyletic groups with the respective type specimens of *M. brunneospermus* (KPM-NC 0005011) and *M. nivicola* (KPM-NC 0006038).

DISCUSSION

Phylogenetic data inferred from LSU and ITS sequences support the recognition of species delimited by macro- and micromorphological characteristics. In this study, LSU and ITS rDNA sequences datasets aid in differentiating morphologically similar species. The result of this study are concordant with phylogenetic data of *Marasmius* in previous studies of Tan et al. (2009) and Wannathes et al. (2009a).

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