

Taxonomic study on Korean Aphylophorales (5) - on some unrecorded genera and species -

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(Received September 12, 2006)

A total of 149 species and 209 strains of Korean Aphylophorales in Seoul National University Fungus Collection (SFC) were analyzed by taxonomic and phylogenetic methods. Among those examined fungal specimens, 9 genera *Abundisporus*, *Antrodiella*, *Cyphellopsis*, *Dendrothele*, *Dichomitus*, *Laxitextum*, *Piloderma*, *Skeletocutis* and *Tubulicrinis*, and 23 species, *Abundisporus fuscopurpureus*, *Antrodiella semisupina*, *Auriporia pileata*, *Cantharellus subalbidus*, *Clavulina cinerea*, *Cyphellopsis confusa*, *Dendrothele acerina*, *Dichomitus campestris*, *Haplotrichum aureum*, *Heterobasidion annosum*, *Hyphoderma argillaceum*, *Hyphodontia tropica*, *Inonotus dryophilus*, *Ischnoderma benzoinum*, *Laxitextum bicolor*, *Phanerochaete radicata*, *Phellinus lonicericola*, *Piloderma byssinum*, *Skeletocutis nivea*, *Tomentella terrestris*, *Trametes elegans*, *Trametes tenuis*, and *Tubulicrinis accedens* were confirmed as new to Korea and registered here with descriptions.

KEYWORDS: Korean Aphylophorales, Unrecorded genera, Unrecorded species

The Aphylophorales of Korea is still poorly known and only a small part of about 1,200 aphylophoroid fungi has been described (Alexopoulos *et al.*, 1996). Until recently, the total number of species of the Aphylophorales reported in Korea is 411, assigned in 144 genera and 23 families (Lee and Jung, 2005). Many of Korean Aphylophorales have been reported by Jung (1992, 1994, 1995, 1996a, 1996b) and, subsequently, by Lim and Jung (1999, 2001), Lim *et al.* (1999, 2000), and Lee *et al.* (2002, 2004).

Recently, molecular techniques are becoming more important and common as means to study taxonomic and phylogenetic relationships of fungi. The ribosomal RNA gene was most commonly used for molecular phylogenetic analyses because it is a ubiquitous gene that all organisms have, forming a mosaic pattern of conserved and variable regions and making phylogenetic analyses possible at many taxonomic levels (Li *et al.*, 1985).

Through the specimen examination of Seoul National University Fungus Collection (SFC), 149 species and 209 strains of Korean Aphylophorales were analyzed by taxonomic and phylogenetic methods. When the identified fungi were listed according to taxa, total 9 genera and 23 species of aphylophoroid fungi were confirmed as unrecorded taxa to Korea.

Materials and Methods

Fungal specimens were regularly collected from Songnisan National Park in 2002, Deogyusan National Park in

2003, and Jirisan National Park in 2004–2005. Those planned investigations were conducted and, collecting sites, habitats, hosts, substrates, and fruitbody information such as morphology, color, hymenial surface or marginal zone were noted after taking photographs on the spot. Collected materials were brought to the laboratory and completely dried over mild heat up to several days. Dried specimens were deposited in the Seoul National University Fungus Collection (SFC).

Along with other specimens that had been deposited before 2002, the dried specimens were examined and 149 species and 209 strains of Korean Aphylophorales were analyzed. To describe color names, the color book of Korerup and Wanscher (1978) was referred. The measurements and drawings were made from slide preparations mounted with 3% potassium hydroxide (Hawksworth *et al.*, 1995) and stained with aqueous phloxine (Largent *et al.*, 1977). The iodine reaction was most commonly noticed using the Melzer's reagent (Gilbertson and Ryvarden, 1986). Microscopic examinations of specimens were observed with an optical microscope.

For the general taxonomy and descriptions of identified taxa, Donkian concept (Donk, 1964) was adopted for the Aphylophorales. Studies of Gilbertson and Ryvarden (1986, 1987), Ryvarden and Gilbertson (1993, 1994) and Ryvarden and Johansen (1980) were referred for polypores. The classification system of Eriksson (1958), Eriksson and Ryvarden (1973, 1975, 1976), Eriksson *et al.* (1978, 1981, 1984), Parmasto (1968), and Lim (2001) were referred for corticioid fungi. For the search of the higher fungal flora, Jung (1992, 1994, 1995, 1996a,

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1996b), Lim *et al.* (1999), Lim and Jung (1999, 2001) and Lee *et al.* (2002, 2004) were consulted. To follow modern systematics and latest scientific names, CABI Bioscience Database of Fungal Name (<http://www.index-fungorum.org/Names/Names.asp>) was referred.

To provide new information on phylogenetic relationships of Korean aphyllophoroid and related fungi of the homobasidiomycetes, the ITS1-5.8S-ITS2 and partial nuclear rDNA from 209 examined materials and about 600 sequences retrieved from the GenBank were phylogenetically analyzed together (Lee, 2006).

Family *Cantharellaceae* J. Schröt. 피꼬리버섯과

1. *Cantharellus subalbidus* A.H. Sm. & Morse, *Mycologia* 39: 510 (1947) (Figs. 1-1, 3-1) 노란피꼬리버섯 (신칭)

Basidiocarps divided into stipe and pileus; pileus green-

ish yellow when young, rounded with an undulating enrolled margin, 1~3 cm across, funnel-shaped; lower surface crowded with anastomosing and decurrent ridges, some ridges forked, yellowish; stipe cylindrical, solid.

Hypal system monomitic; generative hyphae hyaline, thin-walled, branched, 3~8 μm thick; basidia cylindrical, 35~45 \times 7~7.5 μm ; basidiospores hyaline, ellipsoid to subglobose, smooth, 9~10 \times 5 μm .

Specimen examined: On soil, Mt. Jiri (SFC 040825-131).

Remarks: This cantharelle is characterized by its greenish yellow-colored basidiocarps. Its phylogenetic placement is in the cantharelloid clade (Lee, 2006).

Family *Clavulinaceae* (Donk) Donk 창싸리버섯과

2. *Clavulina cinerea* (Bull.) J. Schröt., *Krypt.-Fl.*

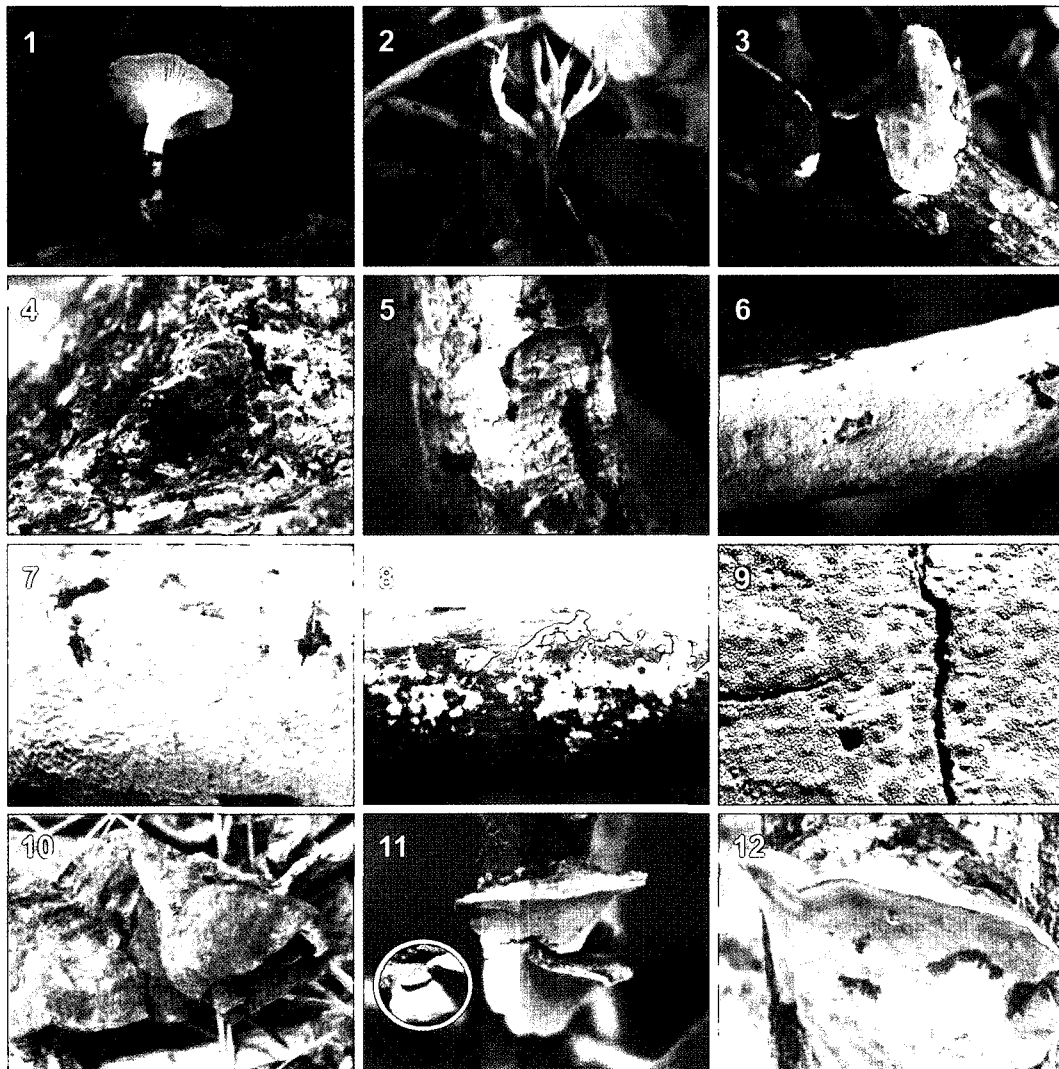


Fig. 1. Basidiocarps of unrecorded species. (1) *Cantharellus subalbidus*, (2) *Clavulina cinerea*, (3) *Dendrothele acerina*, (4) *Haplotrichum aureum*, (5) *Hyphoderma argillaceum*, (6) *Hyphodontia tropica*, (7) *Phanerochaete radicata*, (8) *Piloderma byssinum*, (9) *Cyphellopsis confusa*, (10) *Inonotus dryophilus*, (11) *Phellinus lonicericola*, (12) *Abundisporus fuscopurpureus*.

Schlesien, III Pilze (Breslau) 3(1): 443 (1888) (Figs. 1-2, 3-2) 회색뿔싸리버섯 (신칭)

Basidiocarps up to 9 cm tall and 5 cm wide, moderately branched, arising from a common base; individual branches often sinuous, tending to produce a flattened or crested apical growth; tips pointed or rounded; surface smooth to slightly wrinkled, gray to grayish-brown.

Hyphal system monomitic; generative hyphae 10~13 μm wide; basidia clavate, 25~37 \times 6~7 μm ; basidiospores hyaline, subglobose to ovoid, smooth, 7~8 \times 5.5~6 μm .

Specimen examined: On soil, Mt. Jiri (SFC 040723-22).

Remarks: This species is macroscopically similar to *Clavulina coralloides* that has highly branched tips or teeth. Its phylogenetic placement is in the cantharelloid clade (Lee, 2006).

Family Corticiaceae Herter 고약버섯과

Dendrothele Höhn. & Litsch., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 116: 819 (1907) 분필고약버섯속 (신칭)

Basidiocarps resupinate, mostly orbicular, crustose, thin, closely adnate, smooth or somewhat verrucose, white, grayish, to ochraceous; hyphal system monomitic; generative hyphae thin-walled, septate with or without clamps; cystidia generally few; dendrohyphidia generally numerous; basidia clavate; basidiospores ellipsoid to oblong, smooth.

Type species: *Dendrothele papillosa* Höhn. & Litsch.

3. *Dendrothele acerina* (Pers.) P.A. Lemke, *Persoonia* 3(3): 366 (1965) (Figs. 1-3, 3-3) 단풍분필고약버섯 (신칭)

Basidiocarps resupinate, consisted of irregularly rounded spots of 5~10 mm in size, isolated or confluent, crustose, thin, tightly attached to the substrate; surface whitish to gray-whitish, mostly smooth, chalky; margin rather verrucose, closely appressed to the substrate and distinctly bounded.

Hyphal system monomitic; generative hyphae, dendrohyphidia, and basidia difficult to observe due to abundant crystals; basidiospores hyaline, ellipsoid, smooth, 13~14 \times 7.5~8 μm .

Specimen examined: On a dead fallen branch of *Acer*, Mt. Jiri (SFC 040512-17).

Remarks: This fungus is characterized by large basidiospores and occurs exclusively on *Acer*.

4. *Haplotrichum aureum* (Link) Hol.-Jech., *Česká Mykol.* 30(1): 4 (1976) (Figs. 1-4, 3-4) 붉은무성솜털고약버섯 (신칭)

Teleomorph = *Botryobasidium aureum* Parmasto

Basidiocarps fully resupinate, loosely attached to the substrate, forming thin, tomentose patches; hymenial surface smooth, cottony, dull, reddish-orange.

Conidiophores with transverse septa, hyaline, hypha-like, up to 15 μm wide, with capitate outgrowths; conidia hyaline, lemon-shaped, 15~17 \times 12~14 μm .

Specimen examined: On the trunk of *Quercus mongolica*, Mt. Songni, (SFC 021010-23).

Remarks: The species is the anamorph of *Botryobasidium aureum* and is often confused with *Haplotrichum conspersum*, but the latter species has ovoid conidia. Its phylogenetic placement is in the cantharelloid clade (Lee, 2006).

5. *Hyphoderma argillaceum* (Bres.) Donk, *Fungus, Wageningen* 27: 14 (1957) (Figs. 1-5, 3-5) 진흙목재고약버섯 (신칭)

Basidiocarps fully resupinate, attached tightly to the substrate, forming thin waxy patches; hymenial surface finely pubescent, whitish to cream-colored when fresh, then gray to gray-whitish; margin thin; consistency waxy, soft.

Hyphal system monomitic; generative hyphae hyaline, thin-walled, 7 μm wide, septate with clamps, moderately branched; leptocystidia fusoid to subcylindrical with a basal clamp, 63~94 \times 8~10 μm ; basidia narrowly clavate, 19~30 \times 5.2~6 μm ; basidiospores hyaline, ellipsoid to cylindrical, smooth, 7~10 \times 3.5~4.5 μm .

Specimen examined: On a trunk of *Carpinus laxiflora*, Mt. Jiri (SFC 040512-08).

Remarks: Its phylogenetic position is in the phanerochaetoid-steccherinoid clade (Lee, 2006).

6. *Hyphodontia tropica* Wu S. H., *Mycotaxon* 76: 62 (2000) (Figs. 1-6, 3-6) 미로돌기고약버섯 (신칭)

Basidiocarps effused, adnate, membranous, 0.3 mm thick; hymenial surface cream, pinkish cream, or buff; pores round, 5 per mm.

Hyphal system dimitic; generative hyphae septate with clamps, 2~4 μm wide, apically somewhat capitate; skeletal hyphae thick-walled, 4~5 μm wide; cystidia hyaline, capitate, 20~40 \times 5~6 μm ; basidia suburniform, 13~15 \times 4~5 μm ; basidiospores broadly ellipsoid, thin-walled, smooth, 4~4.5 \times 3~3.5 μm .

Specimen examined: On a branch of *Quercus*, Mt. Deogyu (SFC 031017-43).

Remarks: This is macroscopically similar to *Schizopora paradoxa*, but the latter has slightly larger pores (4/mm). Its phylogenetic placement is in the hymenochaetoid clade (Lee, 2006).

7. *Phanerochaete radicata* (Henn.) Nakasone, C.R. Bergman & Burds., *Sydowia* 46(1): 46 (1994) (Figs. 1-7, 3-7) 주름유색고약버섯 (신칭)

Basidiocarps fully resupinate, tightly attached to substrate; hymenial surface smooth, wrinkled, white to cream-colored, ochraceous later, somewhat fissured when

dry; margin whitish, filamentous; consistency waxy, soft.

Hyphal system monomitic; generative hyphae 7~8 μm wide, septate without clamps; cystidia cylindrical, thick-walled, smooth or slightly encrusted, $80 \times 6\text{--}8 \mu\text{m}$; basidia narrowly clavate, $25\text{--}30 \times 5 \mu\text{m}$; basidiospores thin-walled, ellipsoid, smooth, $6\text{--}7.5 \times 4\text{--}5 \mu\text{m}$.

Specimen examined: On a fallen branch of deciduous tree, Ulleung Island (SFC 900807-47).

Remarks: This species is characterized by its cream-colored, wrinkled hymenium. Its phylogenetic position is in the phanerochaetoid-steccherinoid clade (Lee, 2006).

Piloderma Jülich, *Ber. bayer. bot. Ges.* 81: 415 (1969) 양털고약버섯속 (신칭)

Basidiocarps resupinate, generally fragile, soft, usually loosely attached and easily detached; hymenium cobweb-like at first, becoming smooth; rhizomorphs often present at the margin; hyphal system monomitic; generative hyphae thin-walled, septate without clamps, incrustated with crystals, richly branched; basidia clavate; basidiospores globose to ellipsoid, smooth.

Type species: *Piloderma bicolor* (Peck) Jülich

8. *Piloderma byssinum* (P. Karst.) Jülich, *Ber. bayer. bot. Ges.* 81: 418 (1969) (Figs. 1-8, 3-8) 흰양털고약버섯 (신칭)

Basidiocarps fully resupinate, loosely attached to the substrate, forming thin, membranous patches several centimeters in extent, cottony; hymenial surface smooth, white; margin irregularly fringed with fine white rhizomorphs; rhizomorphs penetrating the substrate, white, sometimes only poorly developed; consistency cottony, soft.

Hyphal system monomitic; generative hyphae thin-walled, incrustated with crystals, 5~7 μm wide, richly branched; basidia clavate, $20\text{--}25 \times 4.5\text{--}5.5 \mu\text{m}$; basidiospores hyaline, ellipsoid, smooth, $3.0\text{--}4.5 \times 2.5\text{--}3.5 \mu\text{m}$.

Specimen examined: On a branch of hardwood, Mt. Deogyu (SFC 030828-100).

Remarks: This fungus is characterized by its basidiocarps with membranous patches, white hymenia and margin fringed with white rhizomorphs.

Family *Cyphellaceae* Lotsy 컵버섯과

Cyphellopsis Donk, *Medded. Nedl. Mycol.* Ver. 18-20: 128 (1931) 갈색컵버섯속 (신칭)

Basidiocarps minute, top-shaped, sessile, tomentose, ochraceous to brownish, crowded; hyphal system monomitic; generative hyphae thin-walled, with a capitate end; basidia suburniform; basidiospores hyaline to yellowish or brownish, cylindrical to kidney-shaped, smooth.

Type species: *Cyphellopsis anomala* (Pers.) Donk

9. *Cyphellopsis confusa* D.A. Reid, *Persoonia* 3(1): 110 (1964) (Figs. 1-9, 3-9) 민자루갈색컵버섯 (신칭)

Basidiocarps spinning top-shaped, 0.3~0.5 mm high,

sessile, tomentose, ochre-cinnamon brownish, densely crowded in cushion-shaped colonies.

Hyphal system monomitic; generative hyphae thin-walled, ending in a somewhat capitate globose, swollen apex; basidia suburniform, $25\text{--}28 \times 4\text{--}5 \mu\text{m}$; basidiospores hyaline to yellowish or brownish, cylindrical to kidney-shaped, smooth, $8.5\text{--}9.7 \times 2.4\text{--}2.8 \mu\text{m}$.

Specimen examined: On the trunk of *Acer*, Mt. Juwang (SFC 040115-10).

Remarks: This species is characterized by its small, brown, cup-shaped basidiocarps. Its phylogenetic position is in the euagarics clade (Lee, 2006).

Family *Hymenochaetaceae* Imazeki & Toki 소나무비늘버섯과

10. *Inonotus dryophilus* (Berk.) Murrill, *Bull. Torrey bot. Club* 31(11): 597 (1904) (Figs. 1-10, 3-10) 마른시루뻐버섯 (신칭)

Basidiocarps sessile, bracket-like to unguate, up to 5 \times 6 cm; upper surface buff to reddish-brown, finely tomentose; pore surface white-gray to reddish-brown, rough; pores angular, 1~3 per mm.

Hyphal system dimitic; generative hyphae simple-septate, 3~3.5 μm wide; basidia clavate, $11\text{--}18 \times 6\text{--}8 \mu\text{m}$; basidiospores ellipsoid to ovoid, brownish, smooth, $5.3\text{--}6.3 \times 3\text{--}4 \mu\text{m}$.

Specimen examined: On a branch of *Prunus sargentii*, Mt. Jiri (SFC 980601-12).

Remarks: The reddish-brown surface and lack of setae are distinctive characters for this species. Its phylogenetic position is in the hymenochaetoid clade (Lee, 2006).

11. *Phellinus lonicericola* Parmasto, *Folia Cryptog. Estonica, Fasc.* 38: 53-61 (2001) (Figs. 1-11, 3-11) 병꽃진흙버섯 (신칭)

Basidiocarps perennial, mostly unguate, occasionally dimidiate, up to 8 cm wide, woody hard; upper surface brownish, matted to glabrous, concentrically zonate and shallowly sulcate, radially rimose and cracking; pore surface brown, dull brown to dark brown, yellowish brown; pores 7~10 per mm, with thin dissepiments; margin distinctly sterile.

Hyphal system monomitic; generative hyphae thin- to thick-walled, septate without clamps; setae clavate, thick-walled, subulate, $30 \times 8 \mu\text{m}$; basidiospores hyaline, ellipsoid to subglobose, smooth, $3.5 \times 3 \mu\text{m}$.

Specimen examined: On a trunk of *Weigela subsessilis*, Mt. Worak (SFC 981217-35).

Remarks: *Phellinus lonicericola* occurs on a shrub like *Weigela* and could be confused with *P. baumii*, but the latter occurs usually on tall hardwood trees like *Quercus* and has larger basidiospores. Its phylogenetic position is in the hymenochaetoid clade (Lee, 2006).

Family Polyporaceae Corda 구멍장이버섯과

Abundisporus Ryvar den, *Belgian Journal of Botany* 131(2): 154 (1999) 자색구멍버섯속 (신칭)

Basidiocarps effused-reflexed to pileate, annual to perennial; pileal surface glabrous, mostly sulcate, brown to fuscous; pores small to medium, round to angular; context brown; hyphal system di-trimitic; generative hyphae septate with clamps; skeletal hyphae usually straight; binding hyphae present or absent; cystidia absent; basidia subclavate; basidiospores yellowish to brownish, ellipsoid to truncate.

Type species: *Abundisporus fuscopurpureus* (Pers.) Ryvar den

12. *Abundisporus fuscopurpureus* (Pers.) Ryvar den, *Belgian Journal of Botany* 131(2): 154 (1999) (Figs. 1-12, 3-12) 자색구멍버섯 (신칭)

Basidiocarps partly resupinate, perennial, closely adnate, thin in the resupinate part, vinaceous brown to fuscous, forming a thick false pileus along upper edges; pileal surface narrow, smooth, often faintly sulcate, developing a hard dark crust; margin distinct, entire, obtuse, usually pinkish when fresh; pores 4~5 per mm, round, pale pink; tubes 1~3 mm long; context vinaceous brown, soft corky, becoming hard.

Hyphal system dimitic, generative hyphae septate with clamps, 2~3 μm wide; skeletal hyphae straight to moderately branched, 3~5 μm wide; basidia broadly clavate, 15~17 \times 6~7 μm ; basidiospores yellowish, broadly ellipsoid, 3~4 \times 2~2.5 μm .

Specimens examined: On a fallen branch of *Quercus serrata*, Mt. Deogyu (SFC 030927-10, SFC 031028-02).

Remarks: This poroid species is easy to recognize by its pinkish and light basidiocarps. Its phylogenetic position is in the core polyporoid clade (Lee, 2006).

Antrodiella Ryvar den & I. Johans., *Prelim. Polyp. Fl. E. Afr.* (Oslo): 256 (1980) 아교구멍버섯속 (신칭)

Basidiocarps annual to perennial, resupinate to pileate, soft to coriaceous, translucent when young, hard when dry; pore surface pale ochraceous to straw-colored; hyphal system di-trimitic; generative hyphae septate with clamps; skeletal hyphae thick-walled; binding hyphae present or absent; cystidia present or absent; basidia subclavate; basidiospores hyaline, smooth.

Type species: *Antrodiella semisupina* (Berk. & M.A. Curtis) Ryvar den

13. *Antrodiella semisupina* (Berk. & M.A. Curtis) Ryvar den, in Ryvar den & Johansen, *Prelim. Polyp. Fl. E. Afr.* (Oslo): 261 (1980) (Figs. 2-1, 4-1) 아교구멍버섯 (신칭)

Basidiocarps annual, resupinate to pileate, often laterally fused over the effused pore surface, up to 4 mm thick, hard and resinous, slightly translucent, white to

cream; pileal surface smooth, white to cream, with narrow, darker concentric zones, with a sharp and undulating margin; pore surface white to ochraceous; pores angular, 5 per mm.

Hyphal system trimitic; generative hyphae hyaline, septate with clamps, 1.5~2 μm wide; skeletal hyphae thick-walled, 3.5 μm wide; binding hyphae hyaline, irregular and twisted with short branches, thick-walled, 2.5~3 μm wide; basidia broadly clavate, 14~17 \times 5~7 μm ; basidiospores hyaline, ellipsoid, smooth, 4.5 \times 2~2.5 μm .

Specimen examined: On a fallen branch of *Magnolia sieboldii*, Mt. Jiri (SFC 040825-167).

Remarks: This poroid species of white color is recognized by shiny, slightly translucent fruitbody. Its phylogenetic placement is in the phanerochaetoid-steccherinoid clade (Lee, 2006).

14. *Auriporia pileata* Parmasto, *Mycotaxon* 11(1): 173 (1980) (Figs. 2-2, 4-2) 붉은황금구멍버섯 (신칭)

Basidiocarps resupinate; hymenophore poroid, soft; pore surface deep yellow-orange when fresh, drying brownish orange; pores circular to angular, 3 per mm.

Hyphal system monomitic; generative hyphae septate with clamps, thin-walled, 2~4 μm wide; cystidia fusiform, apically encrusted or smooth, 25~30 \times 8~10 μm ; basidia narrowly clavate, 17~20 \times 5~6 μm ; basidiospores hyaline, ellipsoid, smooth, 6.3~7 \times 3.5~4 μm .

Specimen examined: On a branch of hardwood, Odong Island, Yeosu (SFC 050527-18).

Remarks: The thick-walled encrusted cystidia and the yellow color of basidiocarps are diagnostic characters for this species. Parmasto (1980) described that *A. aurea*, *A. aurulenta* and *A. pileata* occur in America, Europe and Asia, respectively. Its phylogenetic position is in the fomitopsidoid clade (Lee, 2006).

Dichomitus D.A. Reid, *Revta Biol., Lisb.* 5: 149 (1965) 방석구멍버섯속 (신칭)

Basidiocarps annual to perennial, resupinate to effused-reflexed, white, cream to grayish; pores small to large, angular to round; hyphal system dimitic; generative hyphae septate with clamps; binding hyphae arboriform with tapering ends; cystidia absent; basidia clavate; basidiospores hyaline, cylindrical to ellipsoid.

Type species: *Dichomitus squalens* (P. Karst.) D.A. Reid

15. *Dichomitus campestris* (Quél.) Domański & Orlicz, *Acta Soc. Bot. Pol.* 35: 627 (1966) (Figs. 2-3, 4-3) 흰방석구멍버섯 (신칭)

Basidiocarps annual to perennial, resupinate to cushion-shaped, oblong to oval, up to 15 mm wide; pore surface whitish, cream-colored to ochraceous; pores angular, 3~4 per mm; context cream-colored.

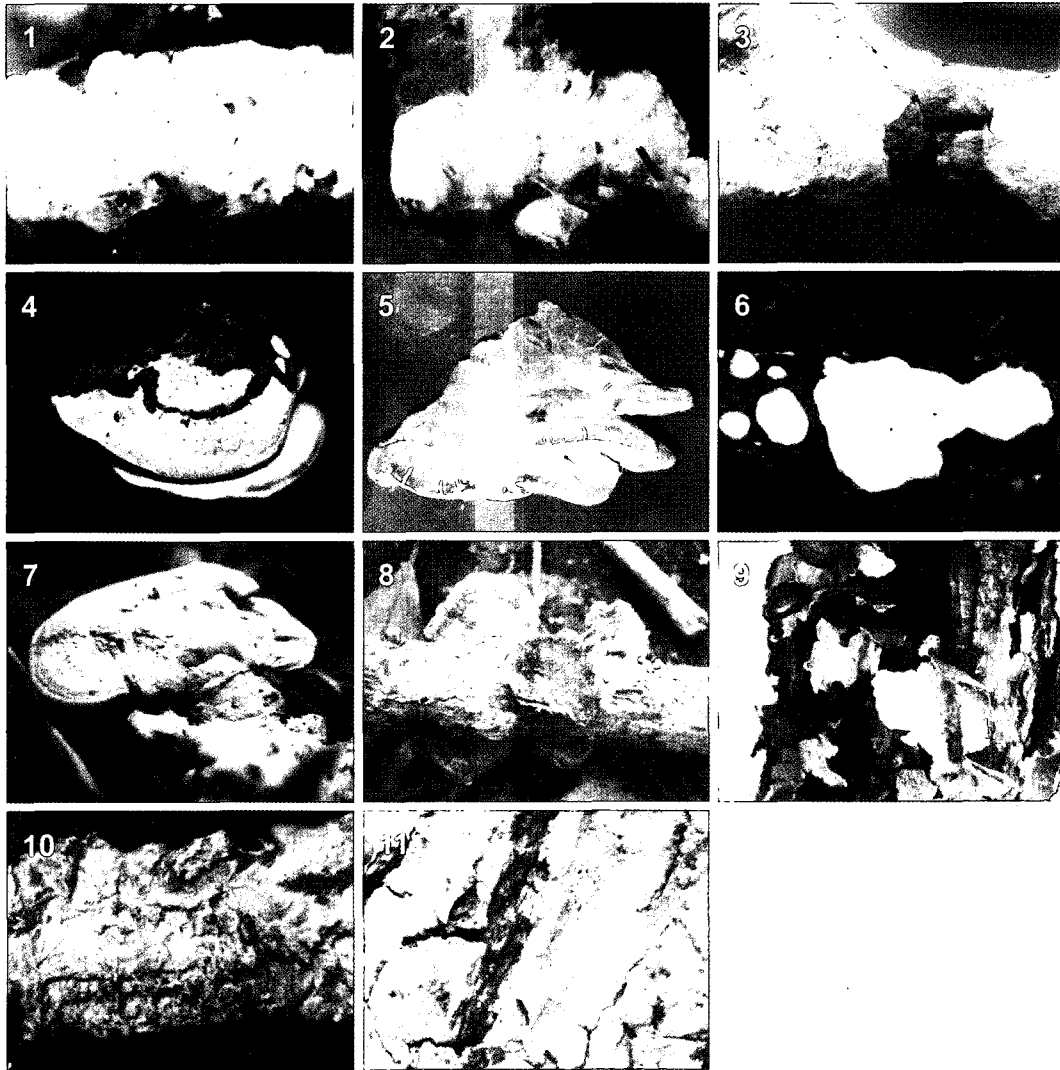


Fig. 2. Basidiocarps of unrecorded species. (1) *Antrodiella semisupina*, (2) *Auriporia pileata*, (3) *Dichomitus campestris*, (4) *Heterobasidion annosum*, (5) *Ischnoderma benzoinum*, (6) *Skeletocutis nivea*, (7) *Trametes elegans*, (8) *Trametes tenuis*, (9) *Laxitextum bicolor*, (10) *Tomentella terrestris*, (11) *Tubulicrinis accedens*.

Hyphal system dimitic; generative hyphae septate with clamps, thin-walled, $1.8\text{--}2\ \mu\text{m}$ wide; binding hyphae hyaline, thin-walled, dichotomously branched with tapering ends, $3\text{--}3.3\ \mu\text{m}$ wide; basidia clavate, $18\text{--}20 \times 6\text{--}7.5\ \mu\text{m}$; basidiospores ellipsoid, with oil drops, thin-walled, smooth, $9\text{--}11 \times 5\text{--}6.5\ \mu\text{m}$.

Specimen examined: On a branch of *Quercus variabilis*, Mt. Songni (SFC 020515-10).

Remarks: *Dichomitus campestris* is easy to recognize by its cushion-shaped basidiocarps and large spores. Its phylogenetic position is in the core polyporoid clade (Lee, 2006).

16. *Heterobasidion annosum* (Fr.) Bref., *Unters. Gesamtgeb. Mykol.* 8: 154 (1888) (Figs. 2-4, 4-4) 뿌리버섯 (신칭)

Basidiocarps sessile, perennial, effuso-reflexed, often

imbricate, commonly fusing laterally, applanate; upper surface smooth to subtomentose, at first white, then pale ochraceous; lower surface poroid, cream white to deep cream, sometimes tinged pinkish; pores 3 per mm; flesh corky, woody.

Hyphal system dimitic; generative hyphae thin-walled, $3\text{--}4\ \mu\text{m}$ wide, septate without clamps; skeletal hyphae thick-walled, $5\text{--}7\ \mu\text{m}$ wide; basidia clavate, $17\text{--}19 \times 5\text{--}7\ \mu\text{m}$; basidiospores subglobose, finely verrucose, $4.5\text{--}6 \times 4\text{--}5\ \mu\text{m}$.

Specimens examined: At the base of *Pinus rigida*, Mt. Halla, Mt. Songni (SFC 020827-18, SFC 020927-11).

Remarks: This species is often confused with *Fomitopsis pinicola* and pileate *Antrodiella*. However, *H. annosum* is differentiated from those species due to its subglobose and finely verrucose basidiospores. Its phylogenetic placement is in the russuloid clade (Lee, 2006).

17. *Ischnoderma benzoinum* (Wahlenb.: Fr.) Karst. *Acta Soc. Fauna Fl. Fenn.* 2:32 (1881) (Figs. 2-5, 4-5) 갈색떡 버섯 (신칭)

Basidiocarps imbricate, broadly attached, up to 15 cm wide, 8 cm thick at the base; upper surface finely tomentose and dark brown, exposing crust when dried; pore surface pale brown; pores angular to circular, 4-6 per mm; context corky, ochraceous to brown.

Hyphal system dimitic; generative hyphae septate with clamps, moderately branched, 4-10 μm in diam; skeletal hyphae thick-walled, 3-10 μm in diam; basidia clavate, 12-18 × 4.5-6 μm, with a basal clamp; basidiospores cylindrical, thin-walled, smooth, 5-7 × 1.5-2 μm.

Specimen examined: On a branch of *Prunus sargentii*. Mt. Worak (SFC 020113-01).

Remarks: This species is macroscopically similar to *I. resinosum*. They are separated by the context color which is ochraceous to brown in *I. benzoinum* but whitish to wood-colored in *I. resinosum* (Gilbertson and Ryvar den, 1986; Ryvar den and Gilbertson, 1993). Its phylogenetic position is in the phanerochaetoid-steccherinoid clade (Lee, 2006).

Skeletocutis Kotl. & Pouzar, *Ěeská Mykol.* 12: 103 (1958) 각질구멍버섯속 (신칭)

Basidiocarps annual to perennial, resupinate to pileate, white, cream, olivaceous, to buff, resinous when dry; pores usually small; context cartilaginous; hyphal system di-trimitic; generative hyphae septate with clamps; skeletal hyphae hyaline, straight; binding hyphae hyaline, twisted; cystidia absent; basidia clavate; basidiospores hyaline, allantoid, cylindrical, to ellipsoid.

Type species: *Skeletocutis amorpha* (Fr.) Kotl. & Pouzar

18. *Skeletocutis nivea* (Jungh.) Jean Keller, *Persoonia* 10: 353 (1979) (Figs. 2-6, 4-6) 흰각질구멍버섯 (신칭)

Basidiocarps annual, resupinate to pileate, up to 1 cm thick, tough and coriaceous when fresh, resinous hard when dry; margin white, finely tomentose, smooth, white at first, cream, with olivaceous shades on aging, azonate; pore surface white, light cream, to olivaceous brownish; pores very small, round to angular, almost invisible to the naked eyes, 6-8 per mm; context cartilaginous, white.

Hyphal system trimitic; generative hyphae hyaline, septate with clamps, 1.5-2.5 μm wide; skeletal hyphae hyaline, straight, thick-walled, up to 3-4 μm wide; binding hyphae hyaline, sinuous and twisted, 3-4 μm wide; basidia narrowly clavate, 15-19 × 2.5-3.5 μm; basidiospores hyaline, allantoid, thin-walled, smooth, 4-4.5 × 1-1.2 μm.

Specimen examined: On a branch of *Quercus aliena*, Mt. Deogyu (SFC 030920-44).

Remarks: This species may be recognized by the tiny

pores and cream-colored pore surface. Microscopically, the tiny spores, if observed, are diagnostic. Its phylogenetic position is in the core polyporoid clade (Lee, 2006).

19. *Trametes elegans* (Spreng.) Fr., *Epicrisis systematis mycologici* (Uppsala): 492 (1838) (Figs. 2-7, 4-7) 미로송편버섯 (신칭)

= *Lenzites elegans* (Spreng.) Pat., *Essai Tax. Hyménomyc.*: 89 (1900)

Basidiocarps annual to perennial, sessile or with a short stipe-like base, attached laterally or centrally; pileus up to

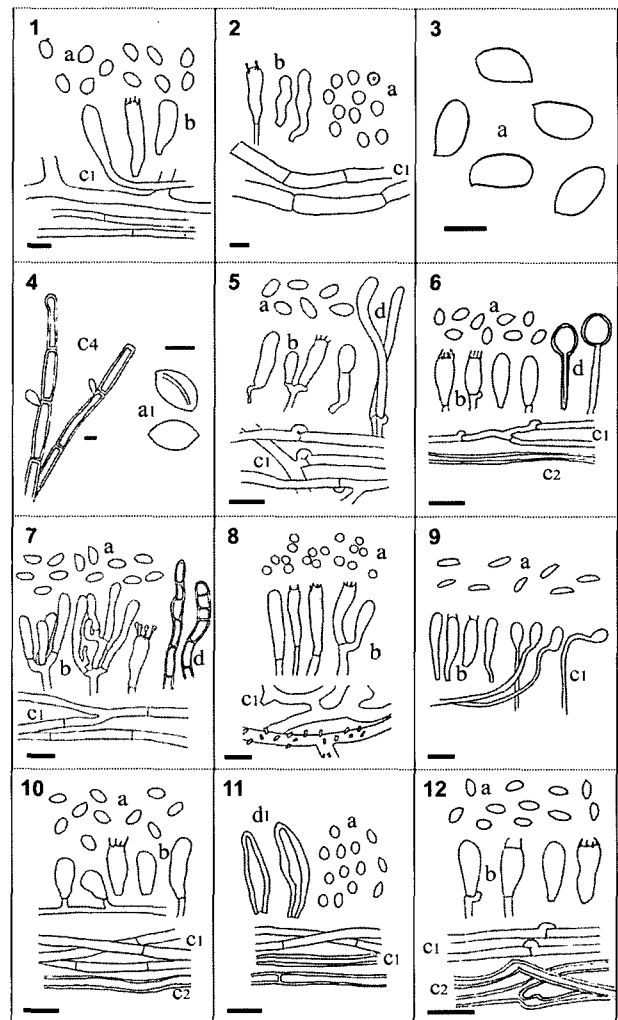


Fig. 3. Microscopic features of unrecorded species. (1) *Cantharellus subalbidus*, (2) *Clavulina cinerea*, (3) *Dendrothele acerina*, (4) *Haplotrichum aureum*, (5) *Hyphoderma argillaceum*, (6) *Hyphodontia tropica*, (7) *Phanerochaete radicata*, (8) *Piloderma byssinum*, (9) *Cyphellopsis confusa*, (10) *Inonotus dryophilus*, (11) *Phellinus lonicericola*, (12) *Abundisporus fuscopurpureus*. a. basidiospores; a1. conidia; b. basidia; c1. generative hyphae; c2. skeletal hyphae; c3. binding hyphae; c4. conidiophores; d. cystidia; d1. setae. Bars = 10 μm.

20 cm wide, woody, flabelliform or circular; upper surface white to gray or almost buff ochraceous, finely tomentose, soon glabrous, smooth or concentrically sulcate; lower surface very variable, poroid, partly sinuous-daedaloid, cream-colored; pores rounded, 3~4 per mm.

Hyphal system trimitic; generative hyphae hyaline, thin-walled, septate with clamps, $2.5 \mu\text{m}$ wide; skeletal hyphae dominant, thick-walled, $4\text{--}5 \mu\text{m}$ wide; binding hyphae hyaline, thick-walled, $3.5 \mu\text{m}$ wide, irregularly branched; basidiospores hyaline, cylindrical to oblong ellipsoid, thin-walled, smooth, $5\text{--}6 \times 2.2\text{--}2.5 \mu\text{m}$.

Specimen examined: On a trunk of *Quercus*, Mt. Halla (SFC 020827-04).

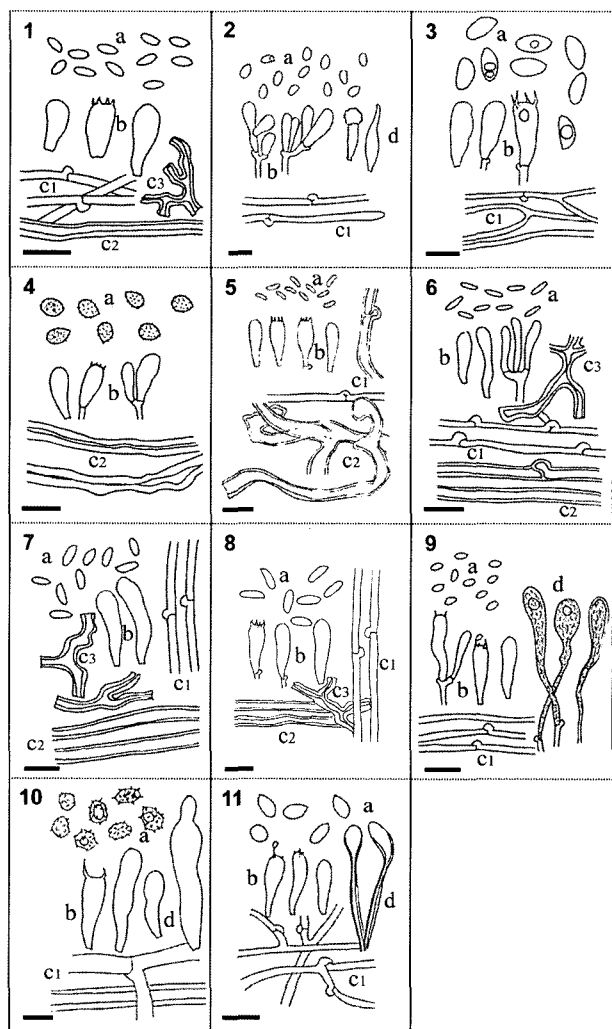


Fig. 4. Microscopic features of unrecorded species. (1) *Antrodiella semisupina*, (2) *Auriporia pileata*, (3) *Dichomitus campestris*, (4) *Heterobasidion amosum*, (5) *Ischnoderma benzoinum*, (6) *Skeletocutis nivea*, (7) *Trametes elegans*, (8) *Trametes tenuis*, (9) *Laxitextum bicolor*, (10) *Tomentella terrestris*, (11) *Tubulicrinis accedens*. a. basidiospores; b. basidia; c1. generative hyphae; c2. skeletal hyphae; c3. binding hyphae; d. cystidia. Bars = $10 \mu\text{m}$.

Remarks: This species is easy to recognize because of the daedaloid or sinuous pores and the frequent variable hymenophore in a same specimen. Its phylogenetic position is in the core polyporoid clade (Lee, 2006).

20. *Trametes tenuis* (Hook.) Corner, *Beihefte zur Nova Hedwigia* 97: 170 (1989) 육각구멍송편버섯 (신칭)

= *Hexagonia tenuis* Speg. (Figs. 2-8, 4-8)

Basidiocarps annual to perennial, solitary or in clusters, pileate, broadly or narrowly attached to the substrate or almost stipitate, thin, flexible and coriaceous when dry; pilei dimidiate, flabelliform to semicircular; upper surface concentrically zoned, ochraceous to dark brown; pore surface with grayish to ashy bluish tint; pores angular to hexagonal, very variable, mostly 2 per mm.

Hyphal system trimitic; generative hyphae hyaline, septate with clamps, thin-walled, $2\text{--}3 \mu\text{m}$ wide; skeletal hyphae thick-walled, $3\text{--}5 \mu\text{m}$ wide; binding hyphae hyaline, thick-walled, $5\text{--}6 \mu\text{m}$ wide, branched; basidia clavate, $25\text{--}30 \times 7\text{--}9 \mu\text{m}$; basidiospores hyaline, cylindrical, smooth, $10 \times 3.5 \mu\text{m}$.

Specimens examined: On a fallen branch of *Quercus mongolica*, Mt. Songni (SFC 021010-22); on a deciduous tree, Mt. Jiri (SFC 040825-06).

Remarks: Because of its large hexagonal pores, this species is easy to recognize in the field. Its phylogenetic position is in the core polyporoid clade (Lee, 2006).

Family Stereaceae Pilát 꽃구름버섯과

Laxitextum Lentz, U.S. Dept. Agric. Monogr. 24: 18 (1956)비늘꽃구름버섯속 (신칭)

Basidiocarps resupinate to subpileate; upper surface brown, tomentose, somewhat zonate; hymenial surface white when fresh, smooth; hyphal system monomitic; generative hyphae thin-walled, septate with clamps; gloeocystidia numerous, subulate, projecting; basidiospores subglobose to ellipsoid, amyloid.

Type species: *Laxitextum bicolor* (Pers.) Lentz

21. *Laxitextum bicolor* (Pers.) Lentz, U.S. Dept. Agric. Monogr. 24: 19 (1956) (Figs. 2-9, 4-9)비늘꽃구름버섯 (신칭)

Basidiocarps 20~50 mm broad, subpileate, overlapped by effused-reflexed edges; upper surface pale brown to dark brown, sometimes wrinkled with faint lines, slightly zonate; hymenial surface white when fresh, pale buff or pale pinky buff on drying, smooth, glabrous.

Hyphal system monomitic; generative hyphae thin-walled, $2\text{--}3 \mu\text{m}$ wide, septate with clamps; gloeocystidia numerous, fusiform, subulate, $35\text{--}40 \times 8\text{--}10 \mu\text{m}$, projecting; basidiospores ellipsoid, amyloid, $3.5 \times 2\text{--}2.2 \mu\text{m}$.

Specimen examined: On a trunk of *Pinus rigida*, Mt. Deogyu (SFC 030424-17).

Remarks: *Laxitextum bicolor* could be differentiated

from *Stereum* by brown and white color and soft consistency. Its phylogenetic position is in the russuloid clade (Lee, 2006).

Family *Thelephoraceae* Chevall. 굴뚝버섯과

22. *Tomentella terrestris* (Berk. & Broome) M.J. Larsen, *Mycologia Mem.* (St. Paul) 4: 105 (1974) (Figs. 2-10, 4-10) 흑색응단버섯 (신칭)

Basidiocarps resupinate, loosely attached to the substrate, forming continuous patches, densely tomentose; hymenophore surface smooth or irregularly tuberculate, reddish brown, light brown when dry; consistency fibrous-tomentose.

Hyphal system monomitic; generative hyphae thin- to thick-walled, septate with clamps, branched, 8~9 μm wide; ventricose clavate elements present; basidia 30~45 \times 8~9 μm ; basidiospores ellipsoid, verrucose, 10~11 \times 7~9 μm .

Specimen examined: On a fallen branch of hardwood, Ganghwa Island (SFC 990924-14).

Remarks: This resupinate species is easily recognized in the field by its light brown, fibrous-tomentose basidiocarps. Its phylogenetic position is in the thelephoroid clade (Lee, 2006).

Family *Tubulicrinaceae* Jülich, *Bibl. Mycol.* 85: 392 (1982) 먼지곰약버섯과 (신칭)

Tubulicrinis Donk, *Fungus, Wageningen* 26: 13 (1956) 먼지곰약버섯속 (신칭)

Basidiocarps resupinate, effused, adnate, often inconspicuous, farinose to porulose, thin, rarely becoming thick; hymenial surface generally smooth, often appearing somewhat pilose, white, cream, with grayish tints, to ochraceous; hyphal system monomitic; generative hyphae septate with clamps; cystidia conspicuous, protruding, cylindrical or conical, with a blunt, capitate, or subulate apex; basidia clavate; basidiospores hyaline, somewhat allantoid, ellipsoid, subglobose, to globose.

Type species: *Tubulicrinis glebulosus* (Fr.) Donk

23. *Tubulicrinis accedens* (Bourdot & Galzin) Donk, *Fungus, Wageningen* 26: 14 (1956) (Figs. 2-11, 4-11) 흰먼지곰약버섯 (신칭)

Basidiocarps fully resupinate, effused, tightly attached to the substrate, forming thin patches; hymenial surface smooth, finely farinose, gray whitish; consistency fugacious.

Hyphal system monomitic; generative hyphae septate with clamps, branched, cystidia conspicuous, protruding, cylindrical with a capitate end, thick-walled, very long, 5~6 μm wide; basidia narrowly clavate, 18~20 \times 4~5.3 μm ; basidiospores hyaline, ellipsoid, smooth, 6.2~8.5 \times 3.8~4.5 μm .

Specimen examined: On a fallen branch of *Quercus*,

Mt. Deogyu (SFC 030928-43).

Remarks: This corticioid species of white color is easily recognized by its capitate cystidia. Its phylogenetic position is in the trechisporoid clade (Lee, 2006).

Conclusion

Upon investigation of the specimens which were deposited in Seoul National University Fungus Collection (SFC), 209 strains of Korean Aphyllphorales were analyzed by taxonomic and phylogenetic methods. Their phylogenetic positions were confirmed and their identities were verified by morphological and molecular analyses. Among them, total 23 species were newly recorded to Korea and these were *Abundisporus fuscopurpureus*, *Antrodiella semisupina*, *Auriporia pileata*, *Cantharellus subalbidus*, *Clavulina cinerea*, *Cyphellopsis confusa*, *Dendrothele acerina*, *Dichomitus campestris*, *Haplotrichum aureum*, *Heterobasidion annosum*, *Hyphoderma argillaceum*, *Hyphodontia tropica*, *Inonotus dryophilus*, *Ischnoderma benzoinum*, *Laxitextum bicolor*, *Phanerochaete radicata*, *Phellinus lonicericola*, *Piloderma byssinum*, *Skeletocutis nivea*, *Tomentella terrestris*, *Trametes elegans*, *Trametes tenuis*, and *Tubulicrinis accedens*. Descriptions and photographs of macro- and microscopic features and new information on phylogenetic relationships of those unrecorded Korean aphyllphoroid fungi were recorded here.

Acknowledgements

This work was supported by Korea National Park Authorities and by a grant (no. 052-052-040) from Core environmental Technology Development Project for Next Generation funded by the Ministry of Environment of the Korean Government. Jin Sung Lee was supported by BK21 Research Fellowship from the Ministry of Education and Human Resources Development before the graduation from Department of Biological Sciences, College of Natural Sciences, Seoul National University.

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