

Wood-rotting Fungal Flora of Kanghwa Island

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Through ten field surveys in Kanghwa Island from August of 1997 to March of 2002, total 107 specimens of wood-rotting fungi belonging to the Aphyllophorales were collected and identified to the species. They taxonomically amounted to 10 families, 31 genera, and 48 species. Among them, one family, Steccherinaceae, and four genera, *Australohydnum*, *Castanoporus*, *Dacryobolus* and *Haplotrichum* were confirmed as new to Korea. Five unrecorded species, *Australohydnum dregeanum*, *Castanoporus castaneus*, *Dacryobolus karstenii*, *Haplotrichum conspersum* and *Hyphoderma odontiiforme* were registered here with descriptions.

KEYWORDS: Aphyllophorales, Kanghwa Island, Unrecorded taxa, Wood-rotting fungi

The study of wood-rotting fungi is fundamental to the understanding of fungal diversity in forests. They mostly belong to the Aphyllophorales (Hymenomycetes, Basidiomycota) and are generally considered as saprobes that inconspicuously recycle massive amounts of wood stuff, thus significantly contributing to the carbon recycling in nature (Jung, 1987). Their decomposition role in the recycling of wood and wood debris in forest ecosystems necessarily attracted mycologists' attention on the survey of wood-rotting fungi.

The Kanghwa Island is located along the west coast of the Kimpo Peninsula and has an area of 302.4 km² with a circumference of 99 km. Westerlies bring moist weather and fine sand particles to the island from the Chinese Continent across the Yellow Sea and the island has a mixed climate of continental and oceanic types. Thus, the island seems to be an important zone for mycofloral and phytogeographical studies. The dominant woods are oak (*Quercus*) forests and chestnut (*Castanea crenata*) forests interspersed with red pine (*Pinus densiflora*) forests. These forest environments provide rich native habitats with sufficient substrate for wood-rotting fungi. However, mycofloral studies on wood-rotting fungi of this island have not been properly accomplished yet. This study was done to meet such a need by regularly surveying the island, listing collected fungal species, discovering unrecorded taxa, and finding the mycofloral importance and phylogeographical significance of this unique island.

Materials and Methods

The fruiting bodies of wood-rotting fungi were collected



Fig. 1. Study areas in the Kanghwa Island. Sampling site numbers of all specimens were indicated in parentheses right after SFC specimen numbers in the text.

from the Kanghwa Island from August of 1997 to March of 2002. The map of the survey areas is shown in Fig. 1. Regular and planned survey trips were conducted and, collecting sites, habitats, hosts, substrates and fruitbody informations were noted as field records and pictures were taken as photographic data. All samples brought to the laboratory were observed for morphological studies under the microscope and then dried on a warm dryer. Completely dried specimens were deposited in the herbarium of Seoul National University Fungus Collection (SFC). For the description of specimens, sections were mounted in 3% KOH solution and mildly heated to rehydrate tis-

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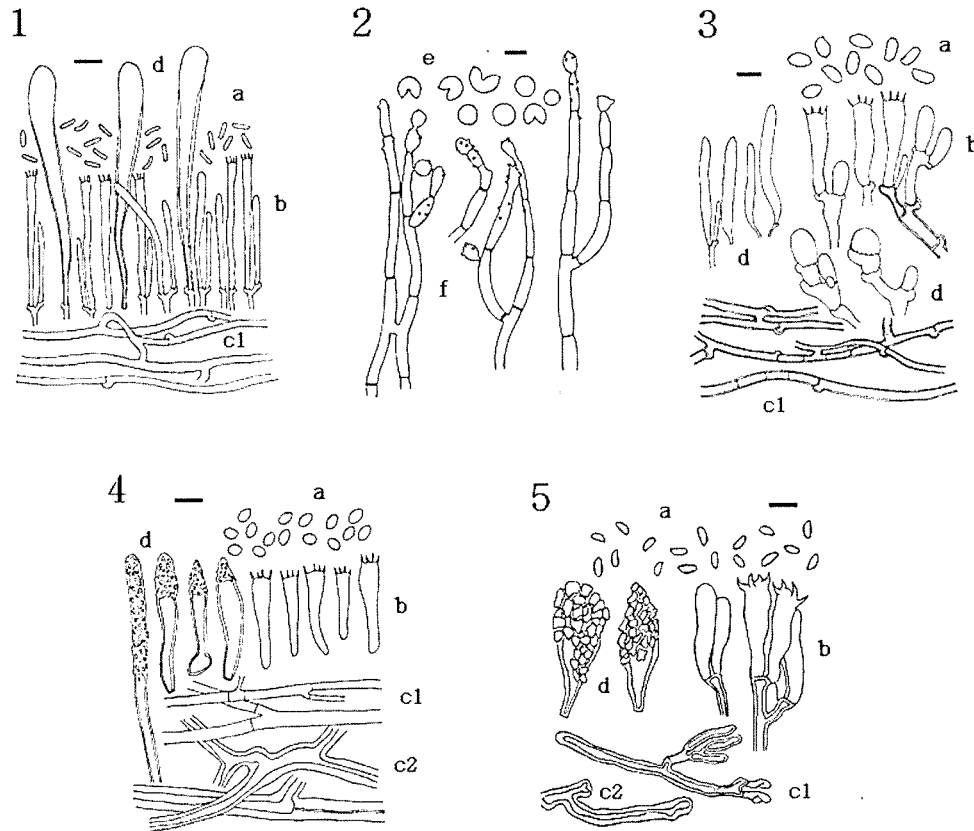


Fig. 2. Microscopic structures of unrecorded species. (1) *Dacryobolus karstenii*, (2) *Haplotrichum conspersum*, (3) *Hyphoderma odontiiforme*, (4) *Australohydnum dregeanum*, and (5) *Castanoporus castaneus*. a. basidiospores; b. basidia; c1. generative hyphae; c2. skeletal hyphae; d. cystidia; e. conidia; f. conidiophores. Bars = 10 μ m.

sues and dissolve crystalline mass away for better observation (Jung, 1987). Prepared sections were treated with 1% phloxine to stain tissues and sealed with enamel to preserve for later observation. Microscopic characters were sketched using a drawing tube, and more than 10 measurements were made for each character (Fig. 2).

For the general taxonomy and descriptions of identified taxa, the Donkian concept (Donk, 1964) was adopted for the Aphyllophorales. The classification systems of Eriksson (1958), Eriksson and Ryvarden (1973–1976), Eriksson *et al.* (1978–1984), Lim (2001) and Parmasto (1968) were referred for corticioid fungi. Studies of Gilbertson and Ryvarden (1986, 1987), Ryvarden and Gilbertson (1993, 1994) and Ryvarden and Johansen (1980) were referred for polypores. For the literature search of the higher fungal flora, Jung (1992, 1994, 1995, 1996a, 1996b), Lim *et al.* (1999), Lim and Jung (1999, 2000, 2001) and Lee *et al.* (2002, 2004) were consulted. Phylogenetic positions and clades according to Lim (2001) were indicated in the remarks of unrecorded species that were described in this study.

Family *Cantharellaceae* J. Schröter **괴짜리버섯과**

1. *Cantharellus friesii* Quélet **호박피꼬리버섯**

Specimen examined: SFC 990924-05 (Site 3)

Habitat: On the branch of *Quercus*

Family *Coniophoraceae* Ulbrich **마른버짐버섯과**

2. *Coniophora arida* (Fries) P. Karsten **큰버짐버섯**

Specimen examined: SFC 991008-28 (Site 3)

Habitat: On the trunk of *Pinus rigida*

Family *Corticaceae* Herter **고약버섯과**

3. *Athelia bombacina* Persoon **막부후고약버섯**

Specimen examined: SFC 010517-02 (Site 7)

Habitat: On the trunk of *Pinus densiflora*

4. *Cylindrobasidium evolvens* (Fries) Jülich. **담자고약버섯**

Specimen examined: SFC 010316-06 (Site 5)

Habitat: On the trunk of *Zelkova serrata*

Dacryobolus Fries, Summa veg. Scand. 2: 404, 1849
후추고약버섯속 (신칭)

Type species: *Dacryobolus sudans* (Albertini & Schweinitz) Fries

5. *Dacryobolus karstenii* (Bresadola) Oberwinkler ex Parmasto, Consp. Syst. Cort. 98, 1968 **큰후추고약버섯 (신칭)**

Basidiomes fully resupinate, becoming confluent, membranous to coriaceous, up to 3 mm thick; hymenophore

smooth, white to dark cream; margin abrupt.

Hyphal system dimitic; generative hyphae thin-walled, hyaline, 1.7~2.8 μm thick with clamps, some hyphae thick-walled and sparsely septate; leptocystidia very long, 50~85 $\times$ 8.5~10 μm , protruding up to 50 μm , apically thin-walled, gradually thickening toward the base; basidia narrowly clavate, with 4 sterigmata, 35~45 $\times$ 2.3~3.2 μm , with a basal clamp; basidiospores allantoid, smooth, 5.5~6.8 $\times$ 1.4~1.7 μm , non-amyloid.

Specimen examined: SFC 981128-08 (Site 6)

Habitat: On the underside of barkless *Pinus densiflora* lying on the ground

Remarks: *Dacryobolus karstenii* is characterized by long thick-walled leptocystidia and smooth resupinate basidiocarps on dead or fallen branches of conifer trees. This species is associated with a brown cubical rot (Ginns and Lefebvre, 1993). Its phylogenetic position is nested in the Polyporoid clade and showed that this species was closely related to brown rot fungi such as *Fomitopsis*, *Antrodia* and *Daedalea* (Lim, 2001).

Haplotrichum Link, Linn. Spec. Pl., ed. 4, 6: 52, 1824
무성솜털고약버섯속 (신칭)

Type species: *Haplotrichum capitatum* (Persoon) Link
6. *Haplotrichum conspersum* (Link) Holubová-Jechová, Česká Mykol. 30: 4, 1976 큰무성솜털고약버섯 (신칭)

Teleomorph: *Botryobasidium conspersum* J. Eriksson

Basidiomes fully resupinate, loosely appressed, downy, arachnoid, thin, filamentous; hymenophore smooth, cottony, ochre-yellow to brown, soft.

Hyphal system monomitic; generative hyphae simple-septate, up to 12 μm thick; cystidia absent; conidiophores with transverse septa, with many bud scars; basidia and basidiospores not observed; conidia globose, 12.8~15 μm diam.

Specimen examined: SFC 990123-15 (Site 3)

Habitat: On the underside of *Pinus densiflora* lying on the ground

Remarks: This species is the anamorph of *Botryobasidium conspersum* Erikss. and is phylogenetically nested in the Botryobasidioid clade (Lim, 2001).

7. *Hyphoderma odontiiforme* Boidin & Berthier, Cah. Maboké 4(1): 43, 1966 침목재고약버섯 (신칭)

Basidiomes fully resupinate, adnate; hymenophore white to cream or yellowish, odontoid; margin concolorous.

Hyphal system monomitic, generative hyphae thick-walled, nodose-septate with frequent simple septa between clamps, 2.3~6 μm diam; cystidia of two types, leptocystidia fusoid to subcylindrical, tapering to the apex, with a basal clamp, 63~94 $\times$ 8~10 μm , stephanocysts rarely present, globose, with a basal clamp, 14.2~16.6 $\times$ 9.4~11.4 μm ; basidia clavate, with 4 sterigmata, 32~35 $\times$ 6.8~9.7 μm , with a basal clamp; basidiospores suballantoid to cylindrical, smooth, thin-walled, 8~9 $\times$ 3.5~4.6 μm , non-amyloid.

Specimens examined: SFC 980129-01 (Site 2), SFC 980201-17 (Site 3)

Habitat: On dead wood of *Quercus* sp. and *Castanea crenata*

Remarks: This species is easily confused with *Hyphodontia* species due to its odontoid surface but characterized by large gloecystidia and stephanocysts. Its phylogenetic placement is not clear but occurred near the *Hyphoderma* and *Hypochnicium* within the Polyporoid clade (Lim, 2001).

8. *Hyphoderma radula* (Fries) Donk 줄목재고약버섯

Specimen examined: SFC 990527-03 (Site 4)

Habitat: On the bark of a hardwood tree

9. *Hyphoderma setigerum* (Fries) Donk 목재고약버섯

Specimens examined: SFC 990527-01 (Site 4), SFC 990527-02 (Site 4), SFC 991008-26 (Site 3), SFC 991008-27 (Site 3), SFC 010517-14 (Site 7)

Habitat: On the branches of *Pinus* and *Quercus*

10. *Laeticorticium roseum* (Persoon) Donk 장미고약버섯

Specimen examined: SFC 990228-08 (Site 4)

Habitat: On the fallen branch of *Salix*

11. *Phanerochaete calotricha* (P. Karsten) J. Eriksson & Ryvarden 깃털유색고약버섯

Specimen examined: SFC 991008-20 (Site 3)

Habitat: On the branch of *Pinus rigida*

12. *Phanerochaete filamentosa* (Berkeley & M.A. Curtis) Burdsall 끈유색고약버섯

Specimens examined: SFC 990228-24 (Site 4), SFC 990527-04 (Site 4), SFC 020307-09 (Site 8)

Habitat: On the trunks of *Pinus densiflora*

13. *Phanerochaete laevis* (Fries) J. Eriksson & Ryvarden 균열유색고약버섯

Specimen examined: SFC 990228-09 (Site 4)

Habitat: On the branch of a hardwood tree

14. *Phanerochaete sordida* (P. Karsten) J. Eriksson & Ryvarden 유색고약버섯

Specimens examined: SFC 010316-15 (Site 5), SFC 020307-01 (Site 8)

Habitat: On the fallen branch of *Quercus*

15. *Phanerochaete xerophila* Burdsall 마른유색고약버섯

Specimen examined: SFC 010316-30 (Site 1)

Habitat: On the branch of *Quercus aliena*

16. *Phlebia chrysocrea* (Berkeley & M.A. Curtis) Burdsall 황금아교고약버섯

Specimens examined: SFC 991008-08 (Site 3), SFC

010316-13 (Site 5)

Habitat: On the fallen branch of *Quercus***Family Steccherinaceae Parmasto, Consp. Syst. Cort. 169, 1968 바늘버섯과 (신칭)***Australohydnum* Jülich, Persoonia 10: 138, 1978 수피버섯속 (신칭)Type species: *Australohydnum griseofuscescens* (Reichardt) Jülich17. *Australohydnum dregeanum* (Berkeley) Hjortstam & Ryvarden, Syn. Fung. 4: 61, 1990 자색수피버섯 (신칭)

Basidiomes resupinate on the underside of the substrate, semipileate to pileate on vertical and laterally extending substrates, imbricate, up to 6 cm wide, up to 2.5 cm long; upper surface hairy, hispid from tomentum, violet when fresh and brown when old, zonate; hymenophore merulioid, daedaloid to reticulate-porose, white to cream-colored.

Hyphal system dimitic; generative hyphae hyaline in KOH, simple-septate, thin-walled, frequently branched, 3.4~5.1 μm thick; skeletal hyphae predominant, sinuous to straight, frequently branched, thick-walled, 5~8 μm thick; cystidia conspicuous, abundant, thick-walled, heavily incrustated like lamprocystidia, 39~102 $\times$ 6.2~9.2 μm ; basidia clavate, with 4 sterigmata, 25~31 $\times$ 5.1~6.9 μm , simple-septate at the base; basidiospores elliptical, smooth, hyaline, 5~6 $\times$ 3.1~3.7 μm , non-amyloid.

Specimen examined: SFC 981115-09 (Site 3)

Habitat: On dead wood of *Quercus*

Remarks: Macroscopically, this species resembles *Punctularia strigoso-zonatus*, but the latter species has smooth hymenophore. Conspicuously incrustated cystidia and simple-septate hyphae are the diagnostic characters of *A. dregeanum*. The phylogenetic position of this species is the *Phanerochaete* group in the Polyporoid clade (Lim, 2001).

18. *Steccherinum laeticolor* (Berkeley & M.A. Curtis) Banker 털바늘버섯

Specimen examined: SFC 010316-05 (Site 5)

Habitat: On the branch of *Pinus densiflora*19. *Steccherinum ochraceum* (Persoon) Gray 바늘버섯

Specimen examined: SFC 991008-16 (Site 3)

Habitat: On the fallen branch of *Robinia pseudoacacia*20. *Steccherinum rhois* (Schweinitz) Banker 솔바늘버섯

Specimens examined: SFC 981128-13 (Site 6), SFC 990527-06 (Site 4)

Habitat: On the fallen branches of hardwood trees

Family Hymenochaetaceae Imazeki & Toki 소나무비늘버섯과21. *Hymenochaete intricata* (Lloyd) T. Ito 기와소나무비늘버섯

Specimens examined: SFC 980129-04 (Site 2), SFC

990228-03 (Site 4)

Habitat: On dead wood of hardwood trees

22. *Hymenochaete yasudai* Imazeki 무늬소나무비늘버섯

Specimens examined: SFC 991008-11 (Site 3), SFC 010316-28 (Site 5)

Habitat: On the fallen branches of *Pinus densiflora*23. *Phellinus gilvus* (Schweinitz) Patouillard 마른진흙버섯

Specimens examined: SFC 970816-04 (Site 5), SFC 010316-08 (Site 5)

Habitat: On the trunks of *Celtis***Family Meruliaceae P. Karsten 아교버섯과**24. *Meruliopsis corium* (Persoon) Ginns 환가죽아교버섯

Specimen examined: SFC 990123-03 (Site 3)

Habitat: On the branch of a hardwood tree

Family Polyporaceae Corda 구멍장이버섯과25. *Bjerkandera fumosa* (Persoon) P. Karsten 흰둘레줄버섯

Specimen examined: SFC 990228-01 (Site 4)

Habitat: On the trunk of a hardwood tree

Castanoporus Ryvarden, Syn. Fung. 5: 120, 1991 밤털구멍버섯속 (신칭)Type species: *Castanoporus castaneus* (Lloyd) Ryvarden26. *Castanoporus castaneus* (Lloyd) Ryvarden, Syn. Fung. 5: 121, 1991 밤털구멍버섯 (신칭)= *Merulius castaneus* Lloyd, Mycol. Writ. 4: 555, 1916= *Cystidiophorus merulioideus* Bondartsev & Ljub., Bot. Mater. 16:126, 1963

Basidiomes annual, resupinate; pore surface cinnamon to salmon pink, darkening to purple when dry; pores irregular, irpicoid, often incomplete, 1~2 per mm or wider; tubes up to 2 mm long; margin cinnamon, wide up to 3 mm broad.

Hyphal system monomitic, H-shaped, thick-walled, up to 5.5 μm wide, with lumens of irregularly narrow contents, often encrusted, scarcely branched; cystidia conical, pedunculate, slightly thick-walled, usually encrusted at the apex, 47~58 $\times$ 14~21 μm ; basidia clavate, 23~27 $\times$ 5.5~7 μm , with four sterigmata; basidiospores broadly allantoid, slightly thick-walled, smooth, hyaline, 5.5~6.8 $\times$ 1.7~3 μm .

Specimen examined: SFC 010316-12 (Site 5)

Habitat: On the branch of *Pinus*

Remarks: This species occurs almost exclusively on *Pinus* and is easy to recognize by the host and the cinnamon, irpicoid, and resupinate basidiocarps.

27. *Cerrena consors* (Berkeley) K.S. Ko & H.S. Jung 송곳니털구름버섯

Specimens examined: SFC 990123-18 (Site 3), SFC 990924-09 (Site 3), SFC 010316-01 (Site 5)

Habitat: On the fallen branches of *Quercus variabilis*

28. *Daedaleopsis confragosa* (Bolton) J. Schröter 도장버섯
Specimens examined: SFC 990228-19 (Site 4), SFC 010316-25 (Site 1)
Habitat: On the branches of *Castanea*
29. *Daedaleopsis styrcina* (Hennings & Shirai) Imazeki 매죽도장버섯
Specimens examined: SFC 970816-02 (Site 5), SFC 990228-02 (Site 4), SFC 010316-07 (Site 5)
Habitat: On the trunks of *Styrax japonicum*
30. *Daedaleopsis tricolor* (Bulliard) Bondartsev & Singer 삼색도장버섯
Specimens examined: SFC 970816-03 (Site 6), SFC 981128-17 (Site 6), SFC 990123-04 (Site 3), SFC 990228-06 (Site 4), SFC 010316-20 (Site 5)
Habitat: On the branches of *Salix*
31. *Ganoderma lucidum* (Curtis) P. Karsten 불로초
Specimens examined: SFC 990924-10 (Site 3), SFC 990924-15 (Site 3), SFC 010316-14 (Site 5), SFC 010517-10 (Site 7)
Habitat: On hardwood trees, particularly common on *Quercus*
32. *Gloeoporus dichrous* (Fries) Bresadola 겹무른구멍장이버섯
Specimen examined: SFC 010316-11 (Site 5)
Habitat: On the trunk of *Quercus aliena*
33. *Irpex lacteus* (Fries) Fries 기계층버섯
Specimens examined: SFC 970816-01 (Site 5), SFC 990123-02 (Site 3), SFC 990228-04 (Site 4), SFC 991008-15 (Site 3), SFC 010517-12 (Site 7), SFC 020307-05 (Site 8)
Habitat: On dead wood of hardwood trees
34. *Lenzites betulina* (Linnaeus) Fries 조개껍질버섯
Specimens examined: SFC 981128-16 (Site 6), SFC 990123-11 (Site 3), SFC 990228-07 (Site 4)
Habitat: On the branches of *Alnus japonica*
35. *Microporus vernicipes* (Berkeley) Imazeki 매꽃버섯부치
Specimens examined: SFC 970816-03 (Site 5), SFC 010316-23 (Site 5)
Habitat: On the fallen branches of *Acer palmatum*
36. *Oligoporus caesius* (Schrader) Gilbertson & Ryvarden 푸른손등버섯
Specimen examined: SFC 991008-24 (Site 3)
Habitat: On the trunk of *Pinus rigida*
37. *Schizopora paradoxa* (Schrader) Donk 좁구멍버섯
Specimens examined: SFC 990123-07 (Site 3), SFC 990123-13 (Site 3), SFC 990123-14 (Site 3), SFC 990228-05 (Site 4), SFC 990527-05 (Site 4), SFC 991008-06 (Site 3), SFC 010316-02 (Site 5), SFC 010517-03 (Site 7)
Habitat: On the fallen branches of *Quercus acutissima*
38. *Trametes suaveolens* (Linnaeus) Fries 송편버섯
Specimen examined: SFC 010316-27 (Site 1)
Habitat: On the branch of *Castanea crenata*
39. *Trametes versicolor* (Linnaeus) Pilát 구름버섯
Specimens examined: SFC 991008-22 (Site 3), SFC 020307-02 (Site 5), SFC 020307-06 (Site 5), SFC 020307-08 (Site 5)
Habitat: On the trunks of *Quercus*
40. *Trichaptum abietinum* (Persoon) Ryvarden 옷솔버섯
Specimens examined: SFC 990924-11 (Site 3), SFC 991008-12 (Site 3), SFC 010316-09 (Site 5), SFC 010517-05 (Site 7), SFC 020307-03 (Site 8)
Habitat: On the branches and trunks of *Pinus densiflora*
41. *Trichaptum bifforme* (Fries) Ryvarden 테옷솔버섯
Specimens examined: SFC 990123-12 (Site 3), SFC 991008-19 (Site 3), SFC 010316-19 (Site 5)
Habitat: On the trunks of *Quercus variabilis*
- Family Schizophyllaceae Quélet 치마버섯과**
42. *Schizophyllum commune* Fries 치마버섯
Specimens examined: SFC 990123-08 (Site 3), SFC 010316-17 (Site 5)
Habitat: On the branches of *Quercus*
- Family Stereaceae Pilát 꽃구름버섯과**
43. *Stereum hirsutum* (Willdenow) Persoon 꽃구름버섯
Specimens examined: SFC 990228-18 (Site 4), SFC 010316-18 (Site 5), SFC 020307-02 (Site 8)
Habitat: On the branches of *Quercus*
44. *Stereum complicatum* (Fries) Fries 복합꽃구름버섯
Specimen examined: SFC 990924-07 (Site 3)
Habitat: On the branch of a hardwood tree
45. *Stereum ochraceoflavum* (Schweinitz) Saccardo 배착꽃구름버섯
Specimen examined: SFC 020307-01 (Site 8)
Habitat: On the trunk of *Quercus*
46. *Stereum peculiare* Parmasto, Boidin & Dinghra 겹질꽃구름버섯
Specimens examined: SFC 980129-02 (Site 2), SFC 981128-05 (Site 6), SFC 990123-05 (Site 3), SFC 990527-10 (Site 4), SFC 990924-01 (Site 3), SFC 010316-10 (Site 5), SFC 010517-01 (Site 7), SFC 020307-04 (Site 8)

Habitat: On the branches of *Quercus* and hardwood trees

47. *Stereum subtomentosum* Pouzar 갈색털꽃구름버섯

Specimen examined: SFC 991008-18 (Site 3)

Habitat: On the branch of *Quercus acutissima*

Family Thelephoraceae Chevallier 굴독버섯과

48. *Thelephora terrestris* Ehrhart 사마귀버섯

Specimen examined: SFC 990924-14 (Site 3)

Habitat: On the ground of *Pinus* forest

Conclusions

The species diversity of the wood-rotting fungi was investigated from Kanghwa Island. Total 107 collections belonging to the Aphyllophorales (Hymenomycetes, Basidiomycota) were identified to the species according to recent classification systems. The checklist amounted to 48 species belonging to 10 families, Cantharellaceae, Coniophoraceae, Corticiaceae, Steccherinaceae, Hymenochaetaceae, Meruliaceae, Polyporaceae, Schizophyllaceae, Stereaceae and Thelephoraceae of the Aphyllophorales. Among them, especially *Stereum peculiare*, *Hyphoderma setigerum*, *Trichaptum abietinum*, *Irpex lacteus* and *Schizopora paradoxa* were dominant throughout the island. Five species, *Australohydnum dregeanum*, *Castanoporus castaneus*, *Dacryobolus karstenii*, *Haplotrichum conspersum* and *Hyphoderma odontiforme*, were confirmed as new to Korea. Although the species richness of fungi was limited in number in comparison with those of inland national parks, a wide spectrum of wood-rotting fungi was discovered from this area and indicated the unique aphyllophoroid fungal flora of Kanghwa Island. Considering the geographical conditions that lie between Korean Peninsula and Chinese Continent and the fungal floral uniqueness with diverse unrecorded fungal taxa, this island seems to be an important zone for phylogeographical studies.

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