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Taxonomic study on Korean Aphyllophorales (III)
- on some unrecorded corticioid fungi -

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한국산 민주름버섯목의 분류학적 연구 (III)
- 수종 미기록 고약버섯류에 대하여 -

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ABSTRACT: Fleshy fungi were collected during field trips to mountain areas throughout the country from October in 1994 to June in 1995. Through the observation and identification of specimens belonging to the wood-rotting fungi of the Aphyllophorales, one genus, *Phlebiopsis*, and six species, *Athelia bombacina, Ceraceomyces sublaevis, Hyphoderma sibiricum, Hyphodontia arguta, Phlebiopsis gigantea*, and *Radulomyces confluens* were confirmed as new corticioid fungi to Korea and are registered here with descriptions.

KEYWORDS: Aphyllophorales, Taxonomic study, Unrecorded fungi

From the beginning of October in 1994 to the end of June in 1995, wood-rotting fungi were collected during 28 field trips to twelve national parks, two provincial parks, and six local mountain areas throughout middle and southern parts of the country for eight months. The national parks were Gaya-san, Gyerong-san, Naejang-san, Byensanbando, Bughan-san, Sogri-san, Odae-san, Weolag-san, Weolchul-san, Juwang-san, Jiri-san, and Chiag-san National Parks. The provincial parks were Chuiseo-san and Chilgap-san Provincial Parks, and the local mountain areas were Godae-san, Gwanag-san, Myungji-san, Bongwhasan, Palbong-san, and Jungdae-san areas. Through regular and intensive collection activities for higher fungi, 634 specimens of wood-rotting fungi were collected, among which more than 90% of specimens belonged to the Aphyllophorales of the Basidiomycotina and the systematic identification and taxonomy of them were accomplished for the discovery of unrecorded or native species of Korean Aphyllophorales.

In consequence, a total of 9 families, 49 genera, and 92 species of the Aphyllophorales were temporarily identified through the observation of morphological and microscopic fruitbody characters. For the observation of specimens, laboratory techniques of Largent *et al.* (1977) and microscopic methods of Jung (1987) were employed. Following the second report on the taxonomic study on Korean Aphyllophorales (Jung, 1996), one genus, *Phlebiopsis* of the Corticiaceae, and six species, *Athelia bombacina, Ceraceomyces sublaevis,*

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Hyphoderma sibiricum, Hyphodontia arguta, Phlebiopsis gigantea, and *Radulomyces confluens* of the Corticiaceae were confirmed as new corticioid fungi to Korea from the present study and are registered here with Korean names and English descriptions.

Taxonomy

For the taxonomy of the Aphyllophorales, Donkian concept (1964) was adopted, and the classification system of Eriksson (1958) and Eriksson *et al.* (1973-1984) was used for the corticioid fungi of the present study. The colored illustrations of Breitenbach and Kränzlin (1986) and the description keys of Jülich and Stalpers (1980) were also very useful for the detailed descriptions of specimens and were frequently consulted for identification.

Jung (1994) once reported the fungal flora of Korean wood-rotting fungi based on the specimens collected from 15 national parks, 7 local areas, and 2 islands for two years from the spring of 1990. In the report, he listed 98 genera, 217 species, and 1 variety for the wood-rotting fungal flora belonging to the Aphyllophorales. And then, in his first and second reports (Jung, 1995, 1996) on the taxonomic study on Korean Aphyllophorales published year after year, he renewed the previous list by adding 2 genera 7 species and 1 genus 6 species, respectively. Including these 3 genera and 13 species as well as 1 unrecorded genus and 6 unrecorded species counted here, currently confirmed wood-rotting fungi of the Korean Aphyllophorales amount to 17 families, 102 genera, 236 species, and 1 variety.

Corticiaceae 고약버섯과

***Athelia* Pers. emend Donk, Fungus 27: 12, 1957 부후고약버섯속**

Fruitbody annual, resupinate, thin, pellicular, easily separable from the substrate; hymenial surface white to whitish, smooth; hyphal system monomitic; hyphae nodose- or simple-septate, basal hyphae commonly thick-walled and wider, often encrusted; basidia clavate, with 2-4 sterigmata; basidiospores ellipsoid or cylindrical, smooth, hyaline, inamyloid.

Type species: *Athelia epiphylla* Pers.

Remarks: This genus consists of the species characterized by thin pellicular fruitbodies and non-amyloid spores. They are made of thin and loose texture which render microscopic characters easy to observe and demonstrate.

1. *Athelia bombacina* Pers., Mycol. Europ. 1: 85, 1822 막부후고약버섯 (신칭)

Fruitbody resupinate, effused, confluent, thin, loosely attached to the substrate, soft, finely membranous; hymenial surface white to silky dull, even, smooth; margin clearly bounded.

Hyphal system monomitic; hyphae 2-4 μm wide, thin-walled, nodose-septate, sometimes encrusted with fine crystals, branching from or near septa, loosely interwoven; cystidia none; basidia 18-22×5.5-7 μm, slenderly clavate, with 4 sterigmata; basidiospores 4.5-6×2.5-3 μm, ellipsoid.

Habitat: on rotten wood of *Quercus*

Remarks: The SNU specimen has apparently larger basidia than those recorded as 10 to 15 μm in length in literature (Eriksson and Ryvarden, 1973; Breitenbach and Kränzlin, 1986). *Athelia fibulata* is similar to the present species but has somewhat larger spores and *A. epiphylla* is also close to the present species but has infrequent scattered clamps on basal hyphae.

Specimens: along the trail to Naeweon-sa, Bughan-san, Jeongreung-dong, Seongbug-gu, Seoul, SNU 941015-52.

***Ceraceomyces* Jül., Willd. Beih. 7: 146, 1972 밀고약버섯속**

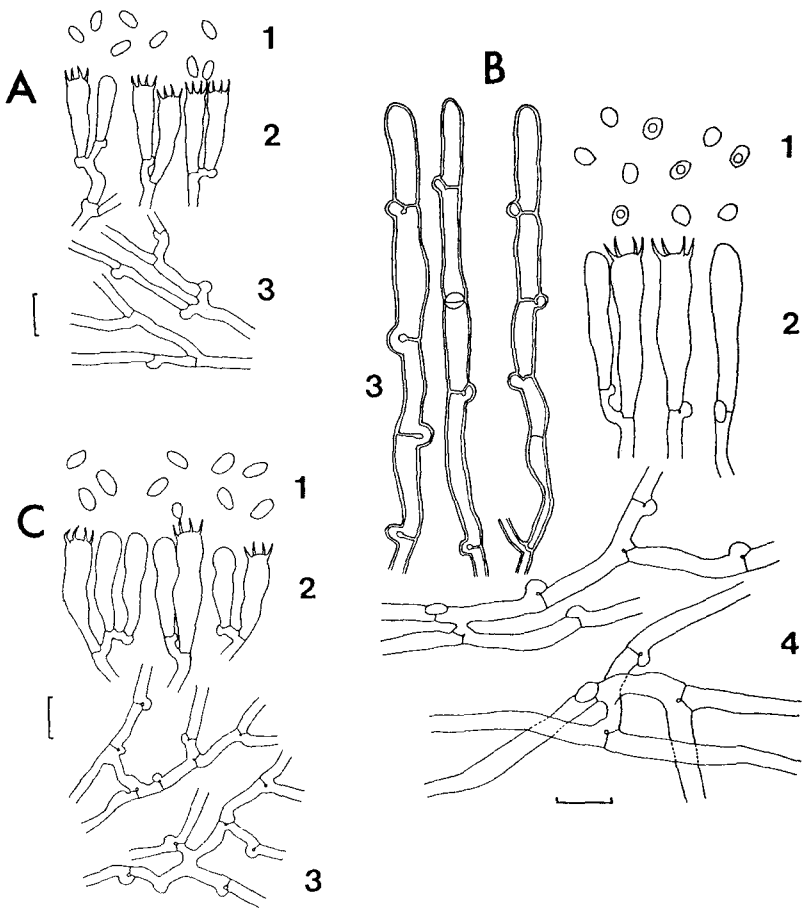

Fig. 1. Microscopic structures of unrecorded fungi of the Aphyllophorales (bar = 10 μm)
A. *Athelia bombacina*: 1) basidiospores, 2) basidia, 3) hyphae
B. *Ceraceomyces sublaevis*: 1) basidiospores, 2) basidia, 3) cystidia, 4) hyphae
C. *Hyphoderma sibiricum*: 1) basidiospores, 2) basidia, 3) hyphae

Fruitbody annual, resupinate, pellicular, thin and loose, becoming thick and ceraceous in age, separable from the substrate; hymenial surface white, yellow, to violaceous, smooth or meruloid; hyphal system monomitic; hyphae nodose-septate, thin- or somewhat thick-walled; basidia narrowly clavate, normally with 4 sterigmata; basidiospores subglobose to ellipsoid, smooth, hyaline, inamyloid.

Type species: *Ceraceomyces tessulatus* (Cooke) Jül.

Remarks: This genus is closely related with *Athelia* but has a thickening hymenium as new basidia are continuously produced beyond old basidia into a palisade, compared with *Athelia* in which the hymenium remains thin.

2. *Ceraceomyces sublaevis* (Bres.) Jül., Willd. Beih. 7: 147, 1972 참밀고약버섯 (신칭)

Fruitbody resupinate, effused, confluent, thin and pellicular, becoming membranous and ceraceous, separable in pieces; hymenial surface whitish to cream-colored, smooth to somewhat meruloid, slightly fissured when dry; margin white, finely fibrillose.

Hyphal system monomitic; hyphae 2.5-4.5 μm wide, thin-walled, nodose-septate; septocystidia 80-90×5-7 μm, uncommon, cylindrical, blunt, septate 3 to 4 times with large clamps, projecting 15-30 μm; basidia 25-30×5-7 μm, slenderly clavate, with 4 sterigmata; basidiospores 3.5-4×3 μm, drop-shaped, with an oil drop.

Habitat: on a fallen twig of an unknown hardwood

Remarks: This fungus is easily identified under the microscope due to its unique characters of septate cystidia and drop-shaped spores. However, the cystidia seem to be rather uncommon and requires a close observation. The SNU specimen has rather larger cystidia than those in descriptions (Eriksson and Ryvarden, 1973; Breitenbach and Kränzlin, 1986).

Specimens: along the trail to Naeweon-sa, Bughan-san, Jeongreung-dong, Seongbug-gu, Seoul, SNU 941015-25.

***Hyphoderma* Wallr. emend Donk, Fungus 27: 13, 1957 목재고약버섯속**

Fruitbody annual, resupinate, adnate, thin to considerably thick, mostly ceraceous; hymenial surface whitish to yellowish, smooth, tuberculate, to hydnoid; hyphal system monomitic; hyphae nodose-septate, thin- to thick-walled, distinct, richly branched; cystidia commonly present, various in shape and nature, projecting or enclosed; basidia usually large, constricted or sinuous, with 4 large sterigmata; basidiospores comparatively large, ellipsoid to allantoid, smooth, hyaline, inamyloid, with oil drops.

Type species: *Hyphoderma setigerum* (Fr.) Donk

Remarks: *Hyphoderma* is a large representative genus and is known to be a heterogeneous group which can be further subdivided in the future (Eriksson and Ryvarden, 1975). But, with a little experience, it can be easily recognized due to its size, shape, and nature of spores and basidia.

3. *Hyphoderma sibiricum* (Parm.) Erikss. et Strid, Cort. N. Eur. 3: 535, 1975 틈목재고약버섯 (신칭)

Fruitbody resupinate, effused, confluent, thin, less than 0.1 mm thick, ceraceous; hymenial surface whitish to cream-colored, smooth; margin finely fibrillose or not differentiated.

Hyphal system monomitic; hyphae 2-3.5 μm wide, thin-walled, nodose-septate, richly branched; cystidia none, but hyphal ends present between basidia; basidia 25-30×6-7.5 μm, subclavate to oblong-clavate, slightly constricted, with oil drops in the protoplasm, with 4 sterigmata; basidiospores 5.5-7×3-4 μm, ellipsoid, adaxially straight or somewhat convex.

Habitat: on a fallen twig of *Alnus*

Remarks: This fungus has no particular characters except for basidia and spores and is reported to occur on conifers (Eriksson and Ryvarden, 1975). The SNU specimen has basidia and spores of slightly smaller dimensions and was found on a hardwood.

Specimens: along the trail to Naeweon-sa, Bughan-san, Jeongreung-dong, Seongbug-gu, Seoul, SNU 941015-65.

***Hyphodontia* John Erikss., Symb. bot. Ups. 16(1): 101, 1958 돌기고약버섯속**

Fruitbody annual, resupinate, adnate, soft but fibrous when fresh, friable to tough when dry, not detachable; hymenial surface whitish, cream-colored, ochraceous, to brownish, smooth, tuberculate, to odontioid; hyphal system monomitic; hyphae nodose-septate with small clamps, somewhat thick-walled, distinct, richly branched from clamps or opposite clamps, rather loosely intertwined; cystidia or cystidioles always present, varying in shape and nature, born in the subiculum or at the basidial level, sometimes septate several times; basidia small to medium, subclavate to subcylindrical, more or less con-

stricted in the middle, with 2-4 sterigmata; basidiospores ellipsoid to subglobose or allantoid, smooth, hyaline, inamyloid.

Type species: *Hyphodontia pallidula* (Bres.) John Erikss.

Remarks: *Hyphodontia* is a large well-known genus and is easily recognized by the features of hyphae, cystidia, and basidia which are always unique for each species, and the texture of the fruitbody is constantly fibrous due to the thickened hyphal walls.

4. *Hyphodontia arguta* (Fr.) John Erikss., Symb. bot. Ups. 16(1): 104, 1958 침돌기고약버섯 (신칭)

Fruitbody resupinate, effused, thin, forming incomplete floccose patches when young, becoming more or less continuous when mature; hymenial surface whitish, cream-colored, to pale ochraceous, odontioid, aculei 0.5-1.5 mm long, conical to cylindrical but varying in shape on aging or sloping; margin thinning out, becoming abrupt with age.

Hyphal system monomitic; hyphae 1.5-3 μm wide, somewhat thick-walled, nodose-septate, cyanophilic; lagenocystidia 25-35×2.5-3 μm, subulate, usually with incrusted tips, leptocystidia 45-50×3.5-5 μm, cylindrical, rather thick-walled; basidia 18-22×3.5-4.5 μm, slenderly clavate, with 4 sterigmata; basidiospores 4-5×3-3.5μm, oval to broadly ellipsoid, with droplets, cyanophilic.

Habitat: on the trunk bark of a dead *Prunus*

Remarks: This fungus is close to *H. alutaria* but has a distinctly odontioid surface compared with the smooth to somewhat verrucose surface of *H. alutaria*. There is a series of odontioid fungi in *Hyphodontia*, all of which can be differentiated only microscopically.

Specimens: along the trail to Naeweon-sa, Bughan-san, Jeongreung-dong, Seongbug-gu, Seoul, SNU 941015-17.

***Phlebiopsis* Jül., Persoonia 10: 137, 1978 좀아교고약버섯속 (신칭)**

Fruitbody annual, resupinate, adnate or loosening at the margin, ceraceous when fresh, crustose when dry; hymenial surface whitish, grayish, to pale buff, smooth, tuberculate, or with projections; hyphal system monomitic; hyphae simple-septate, rarely nodose-septate in the subiculum, thin-walled in the hymenium, otherwise thick-walled, densely united; cystidia abundant, conical, richly encrusted in the upper part, thick-walled; basidia slenderly clavate, with 4 sterigmata; basidiospores narrowly ellipsoid to oblong, smooth, hyaline, inamyloid.

Type species: *Phlebiopsis gigantea* (Fr.) Jül.

Remarks: *Phlebiopsis* is similar to *Phlebia* in appearance but is more closely related with *Phanerochaete* in microscopic characters like subiculum, spores, and cystidia. But, compared with the texture of *Phanerochaete*, it has a very hard one due to its thick-walled compact hyphal system.

5. *Phlebiopsis gigantea* (Fr.) Jül., Persoonia 10: 137, 1978 좀아교고약버섯 (신칭)

Fruitbody resupinate, effused, up to 0.5 mm thick, ceraceous and soft when fresh, membranous-crustose and tough when dry, closely adnate, loosening and rolling back at the margin; hymenial surface watery subhyaline when wet, gray-whitish to pale buff, somewhat verrucose-tuberculate, becoming smooth when dry; margin distinctly bounded.

Hyphal system monomitic; hyphae 2.5-5.5 μm wide, thin-walled in the hymenium, becoming thick-walled and wider in the subiculum, simple-septate, rarely nodose-septate in the subiculum; lamprocystidia 50-65×9-11 μm, conical, encrusted in the upper half, thick-walled, projecting; basidia 25-29×4.5-5.5 μm, slenderly clavate, with 4 sterigmata; basidiospores 5-6×2.5-3 μm, ellipsoid.

Habitat: on the base bark of a dead *Pinus*

Remarks: This corticioid fungus has morphological characters changing greatly de-

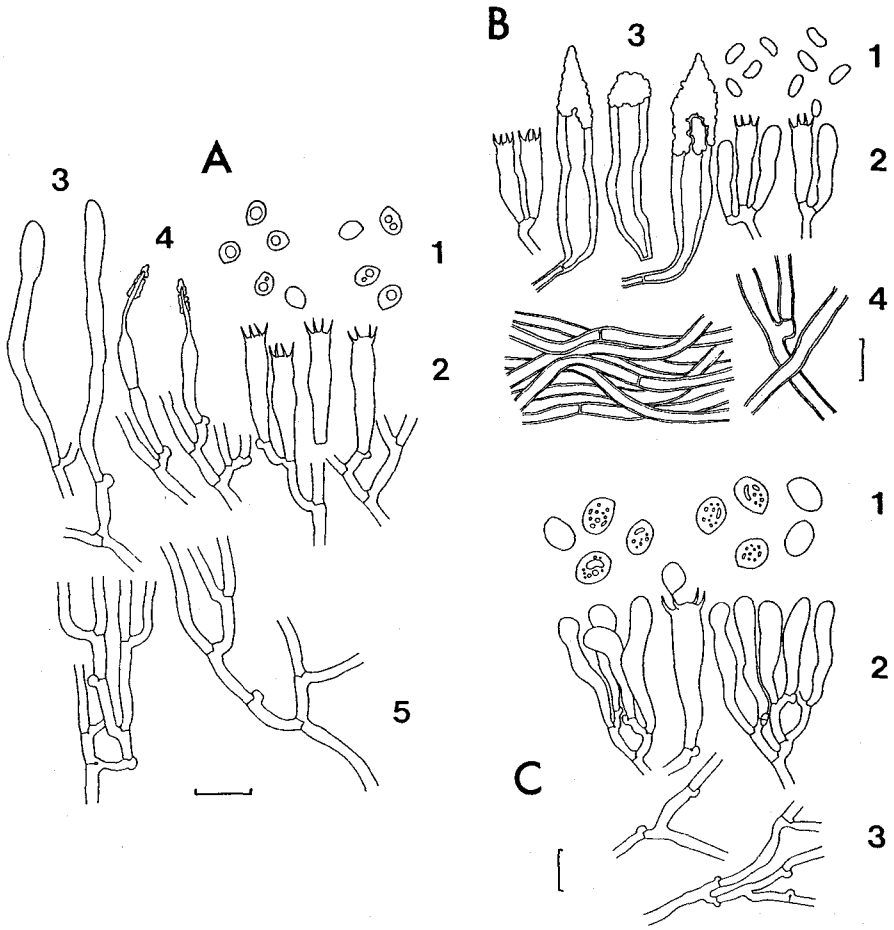

Fig. 2. Microscopic structures of unrecorded fungi of the Aphyllophorales (bar = 10 μm)
A. *Hyphodontia arguta*: 1) basidiospores, 2) basidia, 3) leptocystidia, 4) lagenocystidia, 5) hyphae
B. *Phlebiopsis gigantea*: 1) basidiospores, 2) basidia, 3) lamprocystidia, 4) hyphae
C. *Radulomyces confluens*: 1) basidiospores, 2) basidia, 3) hyphae

pending on the fruitbody dryness and needs to be observed with care. Fresh fruitbodies change from subhyaline to gray-whitish in color and from ceraceous *Phlebia*-like to crustose *Scopuloides*-like in consistency as they come to dry.

Specimens: along the trail to Naeweon-sa, Bughan-san, Jeongreung-dong, Seongbug-gu, Seoul, SNU 941015-23.

***Radulomyces* M.P. Christ., Dansk bot. arkiv 19(2): 230, 1960 이빨버섯속**

Fruitbody annual, resupinate, closely adnate, ceraceous, hygrophanous when wet; hymenial surface whitish, grayish, to pale buff, sometimes violaceous in the living state, smooth, tuberculate, or raduloid; hyphal system monomitic; hyphae nodose-septate, mostly thin-walled, densely interwoven; cystidia none; basidia clavate, sinuously constricted, with 4 sterigmata; basidiospores broadly ellipsoid to subglobose, smooth, hyaline, inamyloid, with oil drops.

Type species: *Radulomyces confluens* (Fr.)

M.P. Christ.

Remarks: *Radulomyces* has been placed in the Hydnaceae in Korea but has a typical corticioid nature and needs to be replaced under the Corticiaceae. The genus is characterized by the hygrophanous nature of the fruitbody caused by the interhyphal density of the subhymenium filled with water (Eriksson *et al.*, 1981), the compact hymenium and its constricted basidia, and the spores with rich oil contents.

6. *Radulomyces confluens* (Fr.) M.P. Christ., Dansk bot. arkiv 19(2): 230, 1960 이빨버섯

Fruitbody resupinate, effused, confluent, ceraceous, hygrophanous when moist, tightly adnate when fresh, partly detachable from the substrate as a membrane when dry; hymenial surface cream-colored to grayish, with a rosaceous to violaceous tint, becoming whitish, grayish, to ochraceous when dry, tuberculate when moist, somewhat smoothened and fissured when dry; margin fimbriate when young, then distinctly bounded.

Hyphal system monomitic; hyphae 2-3 μm wide, thin-walled, slightly thickened in the subiculum, nodose-septate, richly branched; cystidia none, hyphidia-like hyphal ends present; basidia 35-40×6-8 μm, clavate and sinuous, with oil contents, with 4 sterigmata; basidiospores 8-10×6.5-7.5 μm, broadly ellipsoid to subglobose, with rich oil drops.

Habitat: on a dead twig of a living *Prunus*

Remarks: This species is known to be very variable in many aspects (Breitenbach and Kränzlin, 1986). The color and appearance of the fruitbody vary a lot according to the conditions of the fruitbody and the shape of spores also varies from broadly ellipsoid to almost globose. *R. molaris* has been reported in Korea but has a raduloid hymenium with irregular teeth.

R. confluens is the type species of the genus and should be named "이빨버섯" in accordance with the generic name according to the rules of the Korean Code Committee of Mycological Nomenclature (한국말 버섯이름 통일안위원회, 1978). As the Korean name "이빨버섯" for the currently listed *R. molaris* is against the rules, *R. molaris* needs to be renamed and is proposed as "긴이빨버섯" here.

Specimens: on the campus between Professors' Hall and Beodeul-gol, Seoul National University, Gwanag-san, Shinrim-dong, Gwanag-gu, Seoul, SNU 950501-5.

Conclusion

From twelve national parks, two provincial parks, and six local mountain areas throughout the country for eight months from October in 1994 to June in 1995, total 634 specimens of wood-rotting fungi were regularly searched and collected through 28 field trips and identified to the species according to recent classification systems. Fungi belonging to the Aphyllophorales of the Basidiomycotina which took more than 90% were systematically studied for the discovery of unrecorded or native species and temporarily came to list 9 families, 49 genera, and 92 species.

Among these species, one genus, *Phlebiopsis*, and six species, *Athelia bombacina, Ceraceomyces sublaevis, Hyphoderma sibiricum, Hyphodontia arguta, Phlebiopsis gigantea*, and *Radulomyces confluens* were confirmed as new taxa to Korea. When unrecorded fungi of the first and second reports on the taxonomic study on Korean Aphyllophorales published in 1995 and 1996 and those of the present study are added to the previous list prepared by Jung through the second fungal floral study of Korean wood-rotting fungi in 1994, total confirmed wood-rotting fungi of the Korean Aphyllophorales amount to 17 families, 102 genera, 236 species,

and 1 variety.

Among the unrecorded species of the present study, *A. bombacina* was found on *Quercus*, *C. sublaevis* on an unknown hardwood, *H. sibiricum* on *Alnus*, *H. arguta* and *R. confluens* on *Prunus*, and *P. gigantea* on *Pinus*. Most of them were collected from the suburbs of Seoul like Bughan-san and Gwanag-san. Although there had been no significant surveys of Seoul areas before and Seoul areas had been polluted by city industries and influenced by hikers' recreational impacts, the suburbs of Seoul and its surrounding areas of Gyunggi Province showed a unique fungal flora of great diversity and were confirmed as very ideal localities for the floral study of the Aphyllophorales in relation to the city pollution.

적 요

1994년 10월부터 1995년 6월까지 8개월 동안 우리나라의 중부와 남부의 전역을 통하여 도합 28차례에 걸쳐 12개 국립공원, 2개 도립공원, 및 6개 일반 산악지역을 위시한 우리나라의 전역을 중심으로 정기적인 고등균류 탐색을 실시하여 도합 634 점의 목재부후균류를 채집하고 그중 90% 이상을 차지하는 담자균류 민주름버섯류에 대한 체계적인 동정과 분류를 시도하여 국내 민주름버섯류의 미기록종과 고유종의 발굴을 수행하고 도합 9과 49속 92종의 민주름버섯목 균류를 일차적으로 확인하였다.

동정된 균류중 1속 6종은 국내 미기록으로 확인되었고 해당 미기록속은 *Phlebiopsis* (좀아교고약버섯속, 신칭)이며, 해당 미기록종은 고약버섯과의 *Athelia bombacina* (막부후고약버섯, 신칭), *Ceraceomyces sublaevis* (참밀고약버섯, 신칭), *Hyphoderma sibiricum* (틈목재고약버섯, 신칭), *Hyphodontia arguta* (침돌기고약버섯, 신칭), *Phlebiopsis gigantea* (좀아교고약버섯, 신칭), 및 *Radulomyces confluens* (이빨버섯)이다.

1994년 정학성은 한국균학회지에 게재한 한국산 목재부후균류의 분포상에 대한 연구 제 2보를 통하여 국내 목재부후균류의 민주름버섯류를 98속 217종 1변종으로 확인한바 있으며, 이어 1995년도에 게재한 한국산 민주름버섯목의 분류학적 연구 제 1보에서 발표한 2속 7종 미기록과 1996년도에 게재한 제 2보에서 발표한 1속 6종 미기록과 함께 본 연구의 1속 6종 미기록을 합산하면 한국산 목재부후 민주름버섯류는 도합 17과 102속 236종 1변종으로 집계되었다.

이들 미기록종중 막부후고약버섯은 상수리나무, 참밀고약버섯은 미확인 활엽수, 틈목재고약버섯은 오리나무, 침돌기고약버섯과 이빨버섯은 벚나무, 좀아교고약버섯은 소나무에서 발견되었다. 이들 미기록종은 서울 근교의 북한산과 관악산에서 채집되었으며 과거 서울 근교에서 조사된 균류의 분포 기록이 미비한 점과 대도시의 공해와 등산객의 행락에 의한 오염에도 불구하고 다양하고 특이한 균류의 분포상이 발견되는 점으로 미루어보아 서울 근교와 서울 주변의 경기도 일대는 도시오염과 관련하여 민주름버섯류의 분포상 조사에 매우 적합한 지역으로 판단된다.

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