

## Taxonomic Study on *Volvariella* in Korea

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Diversities of Korean species belonging to the genus *Volvariella* have been studied through forty five dried specimens collected throughout the Korean peninsula for 28 years, from 1972 to 2000, and preserved in NIAST's herbarium. We have found one unrecorded species of the genus *Volvariella* in Korea: *V. villosavolva* (Lloyd) Sing, *Stirp Taylori* Korean common names were designated. Ten species of the genus *Volvariella* including the recorded Korean species of *Volvariella* have been identified and the keys to the species were constructed.

**KEYWORDS:** Genus *Volvariella*, *V. villosavolva*, *V. volvacea* var. *nigricans*

*Volvariella* Sp. belongs to the family Pluteaceae, order Agaricales, Hymenomycetidae, Eubasidiomycetes, Basidiomycotina, Eumycota (Kirk *et al.*, 2001). Most species of *Volvariella* are characterized by 1) the stipe which has a volva at the base and no annulus, 2) lamellae free to the stipe, usually crowded to distance, 3) fruiting bodies rapidly decayed, 4) spore print pink to brownish fresh, 5) spores thin-walled to somewhat thick-walled, and 6) growing on humus soils or on well decayed wood except for *Volvariella surrecta*, which is known to be related with one species of *Clitocybe* belonging to Tricholomataceae. Most species of this genus are worldly distributed and thirty one species have been recorded (Singer, 1986).

In Korea, genus *Volvariella* was first reported as one genus belonging to subfamily *Rhodospora*, family Agaricaceae without further descriptions (Lee, 1957). Subsequently genus *Volvariella* was positioned to the family Amanitaceae (Lee *et al.*, 1957), and then *Volvaria* to the subfamily *Rhodospora*, and the family Agaricaceae (Lee 1973). This genus name and systematic position was ambiguous in the early days of mushroom taxonomy research in Korea. In 1978, the Korean Mycological Society Committee for Korean Name of Mushrooms recommended that the genus *Volvariella* be positioned in the family Amanitaceae. Lee (1985) transferred this genus to family Volvariaceae. However, the genus *Volvariella* was proposed to belong to the family Pluteaceae according to the Singer's conceptions (Kim *et al.*, 1987). Later Lee (1988) reported that the *Volvariella* belonged to the family Amanitaceae as first noted. However Korean mycologists, according to the Singer's conceptions, recorded genus

*Volvariella* as belonging to the family Pluteaceae.

As a species belonging to the genus *Volvariella*, *Volvaria volvacea* was first reported in Korea (Lee, 1957), and later recorded (Lee and Choung, 1972). *Volvariella volvacea* has been used as a synonym of *Volvaria volvacea* (Korean Mycological Committee for Korean Name of Mushroom, 1978; Kim *et al.*, 1987; Lee, 1975, 1981, 1988, 1990a, 1990b). *Volvaria bombycina* which was first recorded by Lee & Lee (1958) now is reported as a synonym of *Volvariella bombycina*. Since then this scientific name has been used by Lim (1968), Lee & Choung (1972), Cho (1975), and Korean Mycological Committee for Korean Name of Mushroom (Kim *et al.*, 1978).

In Korea, other species belonging to genus *Volvariella* have been tentatively reported as follows : *V. volvacea* var. *nigricans* (Lee, 1992), *V. hypopithys* (Kim *et al.*, 1984; Lee, 1992), *V. pusilla* (Kim *et al.*, 1985; Lee, 1988, 1990, 1992), *V. taylori* (Kim *et al.*, 1986; Lee, 1992), *V. speciosa* var. *speciosa* (Park and Cho, 1992) and *V. surrecta* (Seok and Kim, 1994).

To study the diversity of Korean species of *Volvariella*, forty five specimens preserved in mycological herbarium of National Institute of Agricultural Science and Technology (NIAST), Suwon, Korea, were examined. Ten species from 30 materials were identified, described, and illustrated. The keys to the species were given.

### Taxonomy

For the observation of the macroscopic and microscopic features of basidiomes, measurements of the fruitbody, characters of the pileus, lamellae, stipe, volva and other characters of taxonomic value were investigated by the

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method of Singer (1986), Moser (1978), Hongo (1957, 1987) Orton (1986) and Vellinga *et al.* (1990). Value of fruiting body, pileus, and spores were measured. The color terms used here are those from Komerup & Wanscher (1978) and also from Munsell notation. For the identification and classification of *Volvariella*, the concept and system of Singer (1987) were adapted.

The monographs, illustrations and colored illustrations of Orton (1986), Vellinga *et al.* (1990), Imazeki and Hongo (1987) and other literatures were employed for the detailed descriptions and identification. All specimens examined are deposited in NIAST's herbarium.

*Volvariella* Speg. in An. Mus. nac. Hist. nat. B. Aires 6: 119. 1899.

*Volva* Adans., Fam. Pl. 2: 12. 1763.

*Volvarius* Roussel, Fl. calvados, Ed. 2: 59. 1806.

*Agaricus* trib. *Volvaria* Fr., Syst. mycol. 1: 277. 1821

*Volvaria* (Fr.) Kumm., Führ. Pilzk.: 23.1871 (non *Volvaria* DC., 1805)

*Volvariopsis* Murrill in Mycologia 3: 280. 1911.

SELECTED LITERATURE - P.D. Orton in Bull. mens. Soc. linn. Lyon 43 (NO. spéc.): 313-326. 1974; P.D. Orton in Br. Fung. Fl. 4: 61-74. 1986; Shaffer in Mycologia 49: 545-579. 1957.

Basidiocarp pluteoid with saccate velum universals, pileus from conical or convex to applanate, lamellae free, pink or brownish pink with age, with paler flocculose edge, stipe central, cylindrical: velum universals forming membranous saccate volva at base of stipe, velum partial absent, spore print pink to brownish pink.

Spores ellipsoid, rather thick-walled, pinkish, smooth, without germ pore, non-amyloid, cyanophilous, cheilocystidia and pleurocystidia present, hymenophoral tramas inverse, vascular hyphae often present, pileipellis a cuts or ixocutis sometimes with transitions to a trichoderm, clamp connections absent.

**Type species:** *Volvariella argentina* Speg.

**Habitat and Distribution:** Saprophytic, terrestrial, on wood, or on decaying agarics (genus *Clitocybe*), probably one species also parasitic. Cosmopolitan, but not in arctic and high alpine region.

#### Key to Species of *Volvariella* in Korea

1. Spores more than 11  $\mu\text{m}$  long, cap viscid, white to pale brownish grey ..... (1) *V. gloiocephala*
1. Spores less than 11  $\mu\text{m}$  long, cap mostly dry ..... 2
2. Growing on wood or woody grass, cap 50~200  $\mu\text{m}$ , white or pale yellow ..... (2) *V. bombycina*
2. Not growing on wood, but terrestrial or on decaying agarics ..... 3
3. On the ground in coniferous or deciduous woods ..... 4
4. Cap 50-200 mm, stipe smooth ..... 5

5. Cap 50-100 mm, volva white or pale brown sepia at least in part

..... (3) *V. volvacea* var. *volvacea*

5. Cap 80-200 mm, volva externally dark brown or blackish brown

..... (4) *V. volvacea* var. *nigricans*

4. Cap less than 60 mm, stipe finely silky-fibrillose 6

6. Cap and volva coloured ..... 7

7. Volva without hairs or base with whitish scattered hairs ..... 8

8. Spores 4.1-6  $\mu\text{m}$  ..... (5) *V. taylori*

8. Spores 6-7.5  $\mu\text{m}$  ..... (6) *V. subtaylori*

7. Volva densely with white mycenoid hairs

..... (7) *V. villosavolva*

6. Cap and volva white or whitish, becoming pale yellowish grey with age ..... 9

9. Cap 5-30 mm, stipe slightly pruinose at apex when young, soon entirely-glabrous ..... (8) *V. pusilla*

9. Cap 30-50 mm, entirely pubescent in lower half with age

..... (9) *V. hypopithys*

3. Growing on other Agarics (*Clitocybe hydrogramma* var. *alba*) ..... (10) *V. surrecta*

(1) 예쁜비단털버섯 *Volvariella gloiocephala* (DC. : Fr.) Boekhout & Enderle in Beitr. Kenntn. Pilze Mitteleur. 2: 78. 1986.

*Agaricus gloiocephalus* DC. in DC. & Lam., Fl. franc. 6: 52. 1815; *Agaricus gloiocephalus* DC. : Fr., Syst. Mycol. 1: 278. 1821; *Volvaria gloiocephala* (DC. : Fr.) Gillet, Hyménomycètes : 388. 1876; *Volvaria speciosa* var. *gloiocephala* (DC. : Fr.) R. Heim in Rey. Mycol. 1, Suppl.: 89. 1936; *Volvariella speciosa* var. *gloiocephala* (DC. : Fr.) Sing. in Lilloa 22 : 401. ('1949') 1951; *Volvariella speciosa* f. *gloiocephala* (DC. : Fr.) Konr. & M., Ic. sel. Fung. 6: 52. 1924; *Volvariella speciosa* f. *gloiocephala* (DC. : Fr.) Court. in Bull. Soc. mycol. Nord. 34: 16. 1984; *Amanita speciosa* Fr., Observ. mycol. 2: 1. 1818; *Agaricus speciosus* (Fr.) Fr.: Fr., Syst. mycol. 1: 278. 1821; *Volvaria speciosa* (Fr. : Fr.) Kumm., Führ. Pilzk.: 99. 1871; *Volvariella speciosa* (Fr. : Fr.) Sing. in Lilloa 22: 401. ('1949') 1951; *Agaricus emendatior* Berk. & M. A. Curtis, in Ann Mag. nat. Hist., ser. III, 4: 288. 1859.

Pileus 45~122  $\mu\text{m}$  wide, ovoid when young, becoming somewhat campanulate to convex, finally plane usually with broad umbo, somewhat viscid when moist, glabrous when dry, at times with patches of universal veil, with striates toward margin, pearl grey or brownish grey. Context flesh, thin, white, odor & taste mild. Lamellae free, subcrowded to crowded, at first white then sordid, edge fimbriate. Stipe 120~180  $\times$  5~16 mm, cylindrical to subcylindrical, thickened downward, glabrous, but somewhat pilose at the base, white. Volva lobed, lacerate, white,

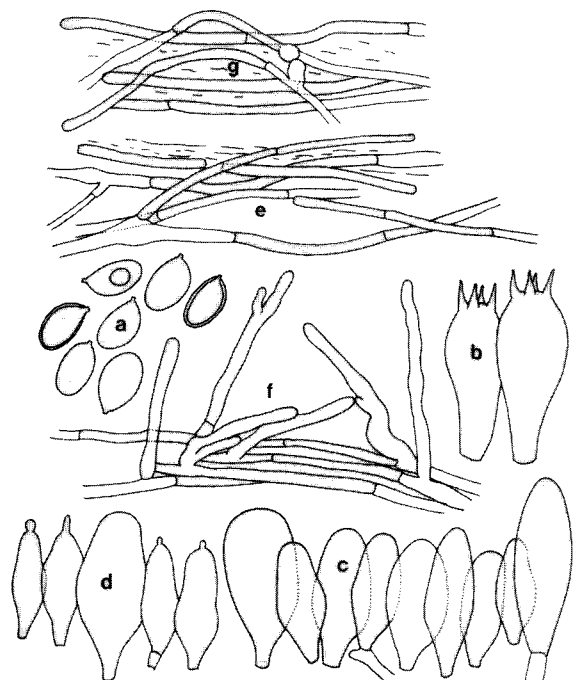
margin even. Spores  $11.0\text{--}13 \times 6.0\text{--}8.0 \mu\text{m}$  ( $11\text{--}16.5 \times 6.5\text{--}10 \mu\text{m}$ ), ovoid, smooth, inamyloid; Basidia  $35.0\text{--}36.5 \times 11.0\text{--}15.0 \mu\text{m}$  ( $35\text{--}45 \times 11\text{--}14 \mu\text{m}$ ), 4-spored. Pleurocystidia  $55\text{--}88 \times 18.0\text{--}40.0 \mu\text{m}$  ( $45\text{--}85 \times 14\text{--}26 \mu\text{m}$ ) subcylindric to fusoid at times with knob at the apex, at times fusoid-ventricose or lanceoloid at times with long neck at the apex, common. Cheilocystidia  $53\text{--}143 \times 20\text{--}55 \mu\text{m}$  ( $40\text{--}65 \times 15\text{--}25 \mu\text{m}$ ), fusoid with or without projection, up to  $45 \mu\text{m}$ , rarely branched, or the neck enlarged or slender, clavate at times with long neck or a slender projection, abundant. Pileipellis consist of gelatinous hyphae, up to  $200 \mu\text{m}$  thick, hyphae without clamp connection (Figs. 1, 2, 11A and 11B).

**Edibility:** edible

**Habit & Habitat:** solitary to gregarious on the rich humus soil at the area of shiitake cultivation in woods.

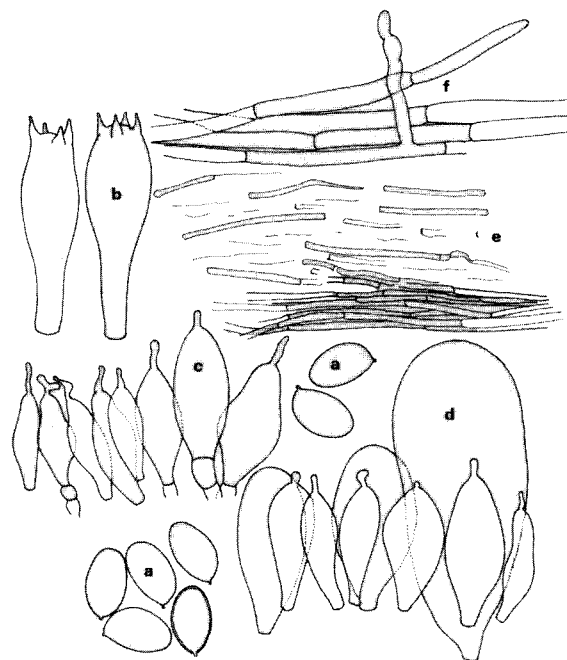
**Materials examined:** Yongsil, Jungmoon-dong, Seogupo-shi, Jeju Island, 10 Jun. 1996 (ASIS 5785, GBDS 3501); Segok-dong, Kangnam-gu, Seoul, 26 May 1993 (GBDS 13)

**Observation:** This taxon was divided into two varieties; *V. speciosa* var. *speciosa*, which usually appeared in summer and with a white pileus and var. *gloiocephala* which usually appeared in autumn and with a grey to fuliginous pileus by Dahncke (1993). However Boekhout & Enderle (1986) rearranged them as a basionym of *V. gloiocephala* based on the forming two color of pileus,



**Fig. 1.** Microscopic structures of *Volvariella gloiocephala* (grayish fuliginous type).

a) basidiospores ( $\times 100$ ) b) basidia ( $\times 100$ ) c) pleurocystidia ( $\times 100$ ) d) cheilocystidia ( $\times 100$ ) e) pileipellis ( $\times 40$ ) f) stipitipellis ( $\times 40$ ) g) surface of the volva ( $\times 40$ )



**Fig. 2.** Microscopic structures of *Volvariella gloiocephala* (white type).

a) basidiospores ( $\times 100$ ) b) basidia ( $\times 100$ ) c) cheilocystidia ( $\times 100$ ) d) pleurocystidia ( $\times 100$ ) e) pileipellis ( $\times 40$ ) f) stipitipellis ( $\times 40$ )

greyish and white, from one strain of this taxa. Authors rearranged that the taxa which recorded as *V. speciosa* var. *gloiocephala* in the report of NIAST in 1996, is of a synonym of *V. gloiocephala* according to the opinion of Boekhout & Enderle. Because any differences were not found in size and shape of spores and cystidia and etc. between the greyish fuliginous type (Fig. 1) and white type (Fig. 2). Specimen of *V. speciosa* var. *speciosa*, which was reported by Park & Cho (1992) was not found and authors could not re-study about it.

(2) 흰비단털버섯 *Volvariella bombycina* (Schaeff. : Fr.) Sing. in Lilloa 22 (1949): 401, 1951.

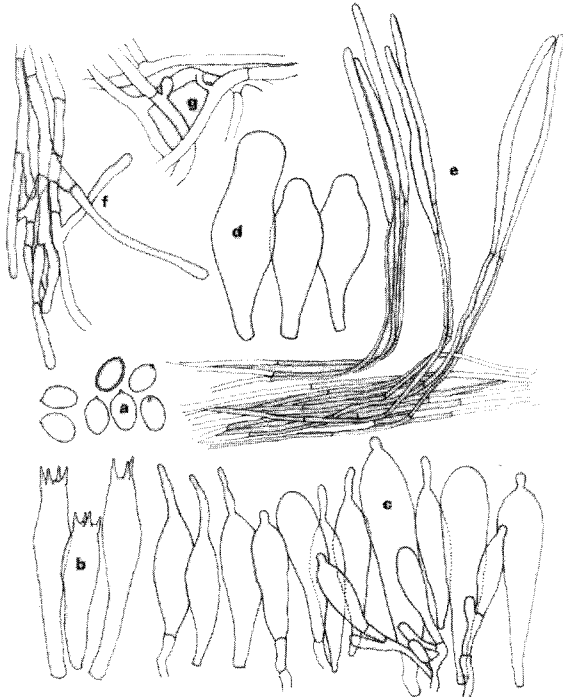
*Agaricus bombycina* Schaeff., Fung. Bavariae 4: 42. 1774; *Agaricus bombycinus* Schaeff.: Fr., Syst. mycol. 1: 277. 1821; *Volvaria bombycina* (Schaeff.: Fr.) Kumm., Fuhr. Pilzk.: 99. 1871; *Volvariopsis bombycina* (Schaeff.: Fr.) Murrill, Mycologia 3: 281. 1911.

**Edibility:** edible

**Habit & Habitat:** solitary or in small group on the compost pile, stump of withered willow tree,

**Material Examined:** 9 Sep. 1983 (ASIK 306); Pyongchang, Kangwon, 27 Aug. 1985 (ASIK 1255); Kimchon, Kyongbuk, 30 Jun. 1994 (GBDS 1275); Sunchang, Chonnam, 4 Jul. 1998 (ASIS 7054)

**Observation:** This species is characterized in having the pileal surface covered with white silky hairs, margin exceeding the lamellae, the robust habit, the habitat on



**Fig. 3.** Microscopic structures of *Volvariella bombycina*.  
a) basidiospores ( $\times 100$ ) b) basidia ( $\times 100$ ) c) cheilocystidia ( $\times 100$ ) d) pleurocystidia ( $\times 100$ ) e) pileipellis ( $\times 40$ ) f) stipitipellis ( $\times 40$ ) g) surface of volva ( $\times 40$ )

wood and the medium sized spores. Somewhat common from summer to autumn in Korea. Sometimes it is severely caused to decrease the products of oyster mushrooms by widely spreading on the beds for the cultivation house (Figs. 3, 12A and 12B).

**(3) 풀버섯 *Volvariella volvacea* (Bull: Fr.) Sing. in Lilloa 22: 401, ('1949') 1951. var. *volvacea***

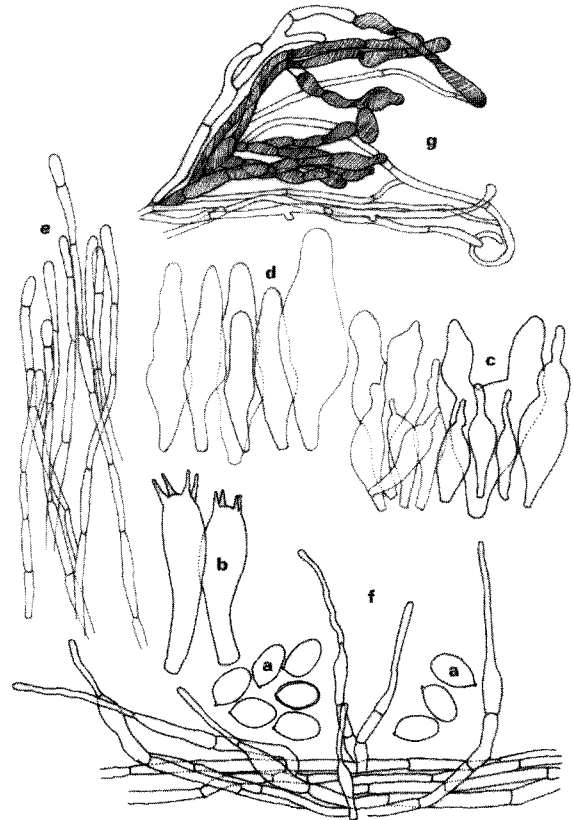
*Agaricus volvaceus* Bull., Herb. France: pl. 262. 1786; *Agaricus volvaceus* Bull: Fr., Syst. mycol. 1: 278. 1821; *Volvaria volvaceus* (Bull.: Fr.) Kumm., Fuhr. Pilzk.: 99. 1871; *Volvariopsis volvacea* (Bull. : Fr.) Murrill in N. Amer. Fl. 10: 144. 1917; *Agaricus virgatus* Tent. Disp. meth. Fung.; 66. 1797; *Volvaria virgata* (Pers.) Quél. in Mém. Soc. Émul. Montbéliard, sér. II, 5: 344. 1873 (Champ. Jura Vosges 2).

**Edibility:** edible.

**Habit & Habitat:** Hot and humid time in summer, gregarious on the rich humus sawdust and a compost pile shiitake cultivation in woods.

**Materials Examined:** Suwon, Kyonggi-do 19 Jul. 1988 (ASIK 2350); 9 May 1972 (OKM 6353)

**Observation:** This taxon is easily recognized by the innately fibrillose pileus, the distinct bulbous surrounded by the dark brown membranous volva, medium sized spores and habitat on wood. It is similar to *V. caesi-*



**Fig. 4.** Microscopic structures of *Volvariella volvacea* var. *nigricans*.

a) basidiospores ( $\times 100$ ) b) basidia ( $\times 100$ ) c) cheilocystidia ( $\times 100$ ) d) pleurocystidia ( $\times 100$ ) e) pileipellis ( $\times 40$ ) f) stipitipellis ( $\times 40$ ) g) surface of the volva ( $\times 40$ )

*otincta*, but the latter differs by having the smaller spores and bluish around center of the pileus when fresh. In European literature *V. volvacea*, for which the Friesian diagnosis indicated a strongly fibrillose-irrigate pileus and growing in the greenhouse, may be misapplied to this species growing on wood.

**(4) 검은비단털버섯 *Volvariella volvacea* var. *nigricans* (Kawam. ex) Hongo**

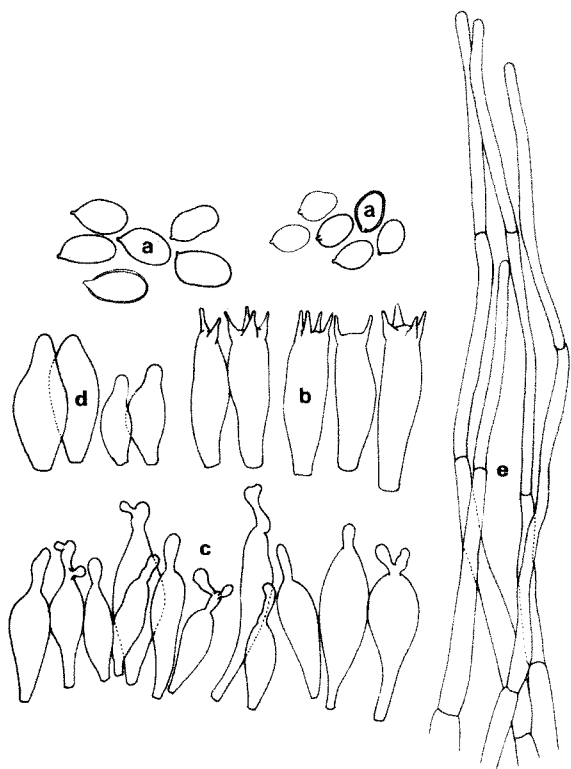
**Edibility:** edible.

**Habit & Habitat:** Hot and humid time in summer, gregarious on the rich humus sawdust and compost pile.

**Materials Examined:** Suwon, Kyonggi-do, 12 Sep. 1989 (ASIK 3171); 13 Sep. 1989 (ASIK 12-1); 23 Aug. 1995 (ASIS 5152).

**Observation:** This taxon differs from typical species by the larger size of the pileus and stipe and the darker volva than those of type species (Figs. 4, 13A and 13B).

**(5) 회색비단털버섯 *Volvariella taylori* (Berk.) Sing. in Lilloa 22 (1949): 401, 1951.**



**Fig. 5.** Microscopic structures of *Volvariella taylora*.  
a) basidiospores ( $\times 100$ ) b) basidia ( $\times 100$ ) c) cheilocystidia ( $\times 100$ ) d) pleurocystidia ( $\times 100$ ) e) pileipellis ( $\times 40$ )

*Agaricus taylora* Berk., Outl. Berk. Fungol.: 140, 1860;  
*Volvaria taylora* (Berk.) Gillet, Hyménomycètes: 386, 1876.

**Edibility:** edible.

**Habit & Habitat:** solitary or gregarious on the rich humus soil at the area of shiitake cultivation in woods.

**Material Examined:** Pyongchang, Kangwon, 27 Aug. 1985 (ASIK 1256); 7 Sep. 1986 (ASIK 1993); Tongdosa, Yangsan, Kyongnam, 2 Jul. 1997 (ASIS 6283).

**Observation:** This species is characterized in having the short ovoid or broadly ellipsoid spores, the radially fibrillose pileus, the coloured externally and the habitat on soil or in grass. *V. caesiointincta* is very similar to this taxa in having the volva coloured externally, but it differs in habitat on wood, pileus with bluish tints and narrower ellipsoid spores (Figs. 5, 14A and 14B).

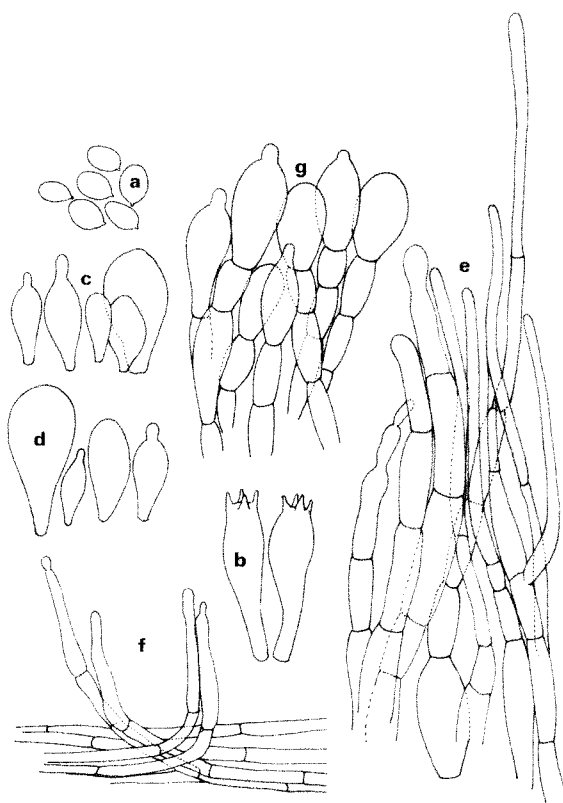
**(6) 각시비단털버섯 *Volvariella subtaylori* Hongo**

**Edibility:** unknown.

**Habit & Habitat:** Scattered to gregarious on the sandy soil at oak trees.

**Material Examined:** Suwon, Kyonggi, 26 Jul. 1991 (ASIK 3863); 26 Jul. 1991 (ASIS 5152); 7 Jul. 1998 (ASIS 7056, ASIS 7147); Chongyang, Chungnam, 27 Jul. 1991 (ASIK 4073).

**Observation:** This species is close to *V. taylora* in shape and in microscopic structures, but can be easily dis-



**Fig. 6.** Microscopic structures of *Volvariella subtaylori*.  
a) basidiospores ( $\times 100$ ) b) basidia ( $\times 100$ ) c) cheilocystidia ( $\times 100$ ) d) pleurocystidia ( $\times 100$ ) e) pileipellis ( $\times 40$ ) f) stipitipellis ( $\times 40$ ) g) maginal cell of cap ( $\times 40$ )

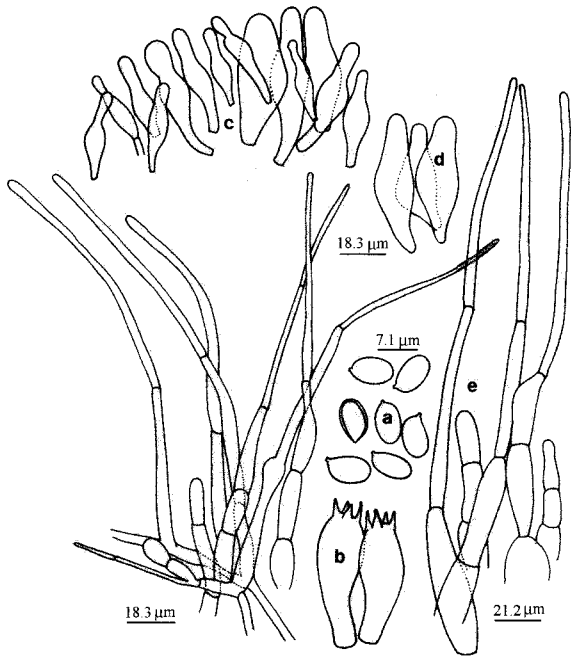
tinguished from it in having dark coloured pileus, the vilose volva, and the pubescent stipe. And also somewhat resembles *V. volvacea* (Fr.) Sing. in the pileus colour, however the latter differs in its larger size of the carpophores and the somewhat larger spores, very uncommon in Korea (Figs. 6, 15A and 15B).

**(7) 새털비단털버섯 (신칭) *Volvariella villosavolva* (Lloyd) Sing. Lilloa 22: 401, 1951.**

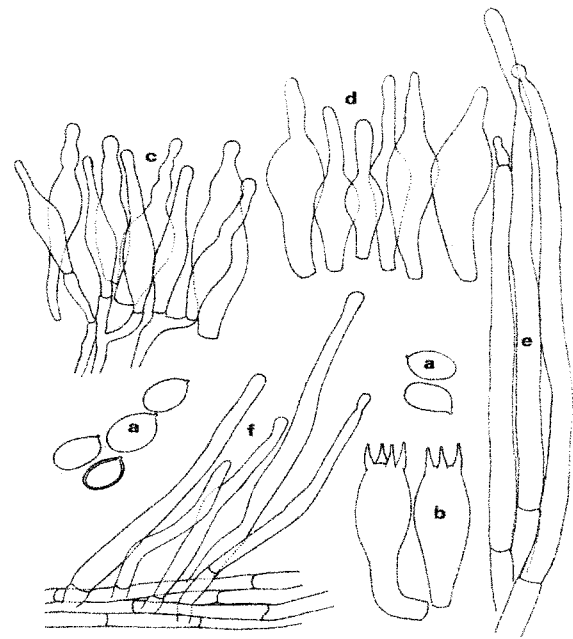
*Volvaria villosavolva* Llyod, Myc. Notes 1: 31, 1899;  
*Volvariopsis villosavolva* (Llyod) Murr., N. Amer. Flora 10: 142, 1912.

Pileus 20~35 mm broad, at first ovoid to hemispherical, then campanulate, finally expanding to almost plane with umbo at center, dry, uneven, innately fibrillose, somewhat rimose, margin short striate when mature, pale brownish grey (6D2-3) towards margin, (7F2) to (8F2) around center. Context thin, white. Odor indistinct. Taste mild. Lamellae free, close, ventricose, edge entire, pinkish cinnamon when mature.

Stipe 45~60  $\times$  15~55 mm, subcylindric, tapered upward, subpruinose at the apex, white terete, solid then becoming hollow. Volva 6.5~10 mm high, thick, with 2~3 lobes, brownish grey (7-8F2), densely covered with white myceloid hairs.

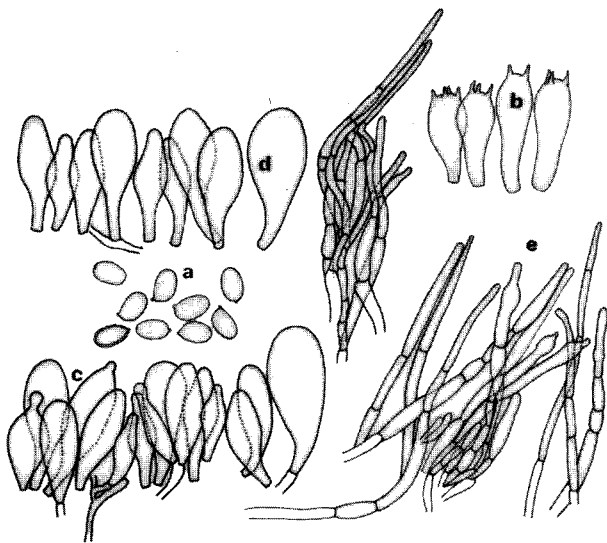


**Fig. 7.** Microscopic structures of *Volvariella villosavolva*.  
 a) basidiospores (×100) b) basidia (×100) c) cheilocystidia (×100) d) pleurocystidia (×100) e) pileipellis (×40) f) stipitipellis (×40)

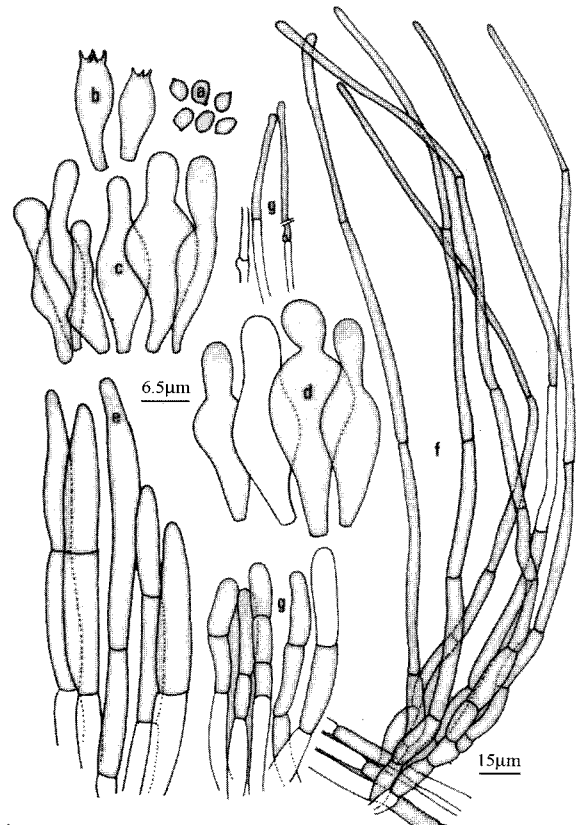


**Fig. 9.** Microscopic structures of *Volvariella hypopithys*.  
 a) basidiospores (×100) b) basidia (×100) c) cheilocystidia (×100) d) pleurocystidia (×100) e) pileipellis (×40) f) stipitipellis (×40)

Spore print sordid. Spores 7~8.0 × 4.5~5.0 μm, ovoid, to broadly ellipsoid, somewhat thick walled. Basidia 24~26 × 9.0~10.0 μm, normal, 4-spored, rarely 2-spored, without basal clamp. Pleurocystidia 66~77 × 18.0~20 μm, fusoid-ventricose, sublageniform, ventricose, thin-walled, rare. Cheilocystidia 35.5~73.0 × 7.0~26.0 μm, larger uniform, fusoid-ventricose, clavate with obtuse or narrow



**Fig. 8.** Microscopic structures of *Volvariella pusilla*.  
 a) basidiospores (×100) b) basidia (×100) c) cheilocystidia (×100) d) pleurocystidia (×100) e) pileipellis (×40) f) stipitipellis (×40)



**Fig. 10.** Microscopic structures of *Volvariella surrecta*.  
 a) basidiospores (×100) b) basidia (×100) c) cheilocystidia (×100) d) pleurocystidia (×100) e) pileipellis (×40) f) hairs at the base of stipe (×40) g) marginal cell of volva (×40)

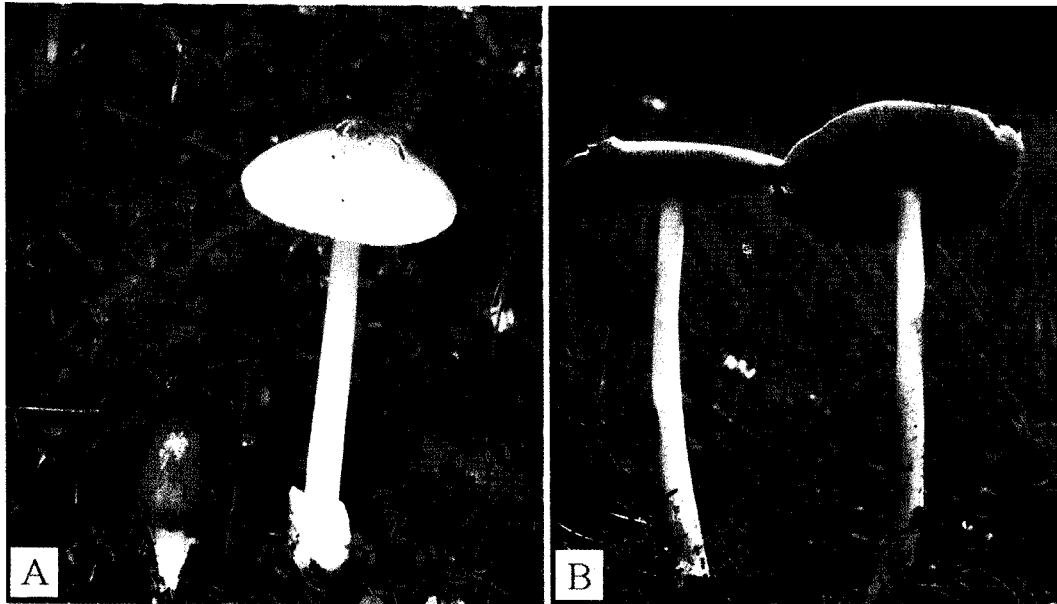


Fig. 11. *Volvariella gloiocephala*. A) grayish fulvous type ASIS 5785 and B) white type GBDS 13.

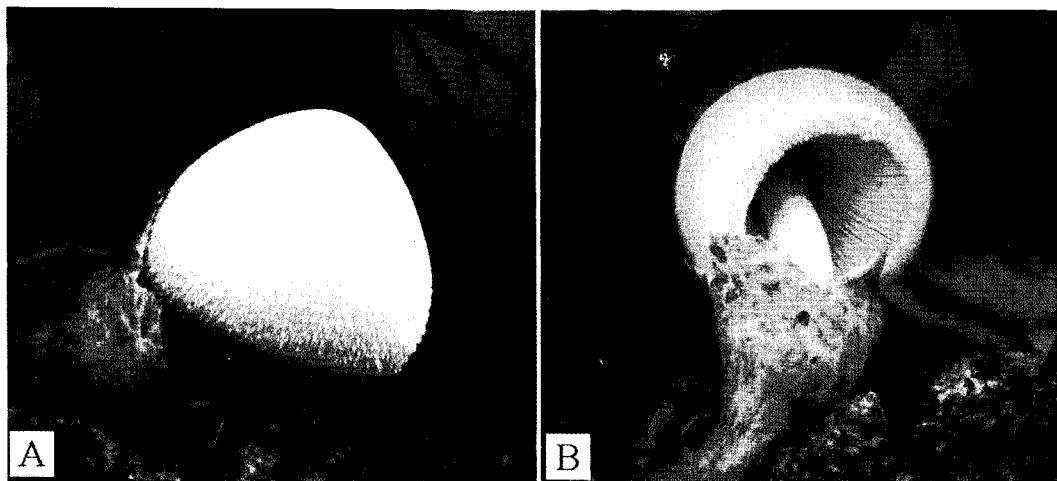


Fig. 12. *Volvariella bombycina*. A), B) ASIS 7054.

neck, thin-walled, abundant. Pileipellis  $35\sim360 \times 11\sim14.0 \mu\text{m}$ , radially arranged with cylindric hyphae, thin-walled, pale brown pigment. Stiptipellis  $100\sim110 \times 4.0\sim10.0 \mu\text{m}$ , composed of cylindric hyphae, hair of volva cylindric hyphae, hyphae without clamp connection.

**Edibility:** unknown

**Habit & Habitat:** Solitary on the humus soils in greenhouse.

**Material Examined:** Suwon, 21 Aug, 1995 (GBDS : 2857).

**Observation:** This species is easily distinguished from the other members of *Volvariella* by having the volva with long white filamentous hairs. This is the first record of thin species from Korea (Figs. 7, 16A and 16B).

(8) 요정비단털버섯 *Volvariella pusilla* (Pers. ex Fr.) Sing.

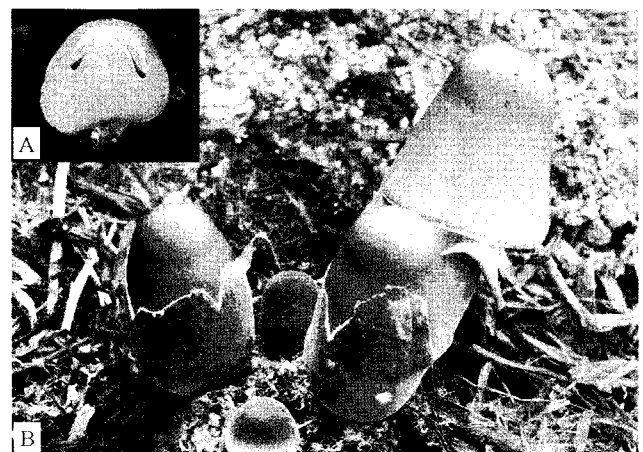


Fig. 13. *Volvariella volvacea* var. *nigricans*. A) longitudinal section in egg stage. B) ASIS 7054.

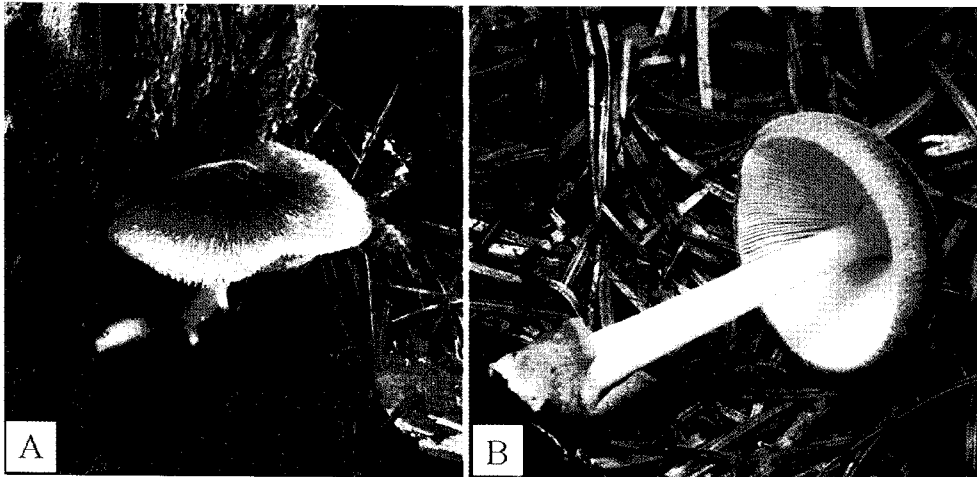


Fig. 14. *Volvariella taylori*. A) ASIS 6283. B) ASIK 1993.

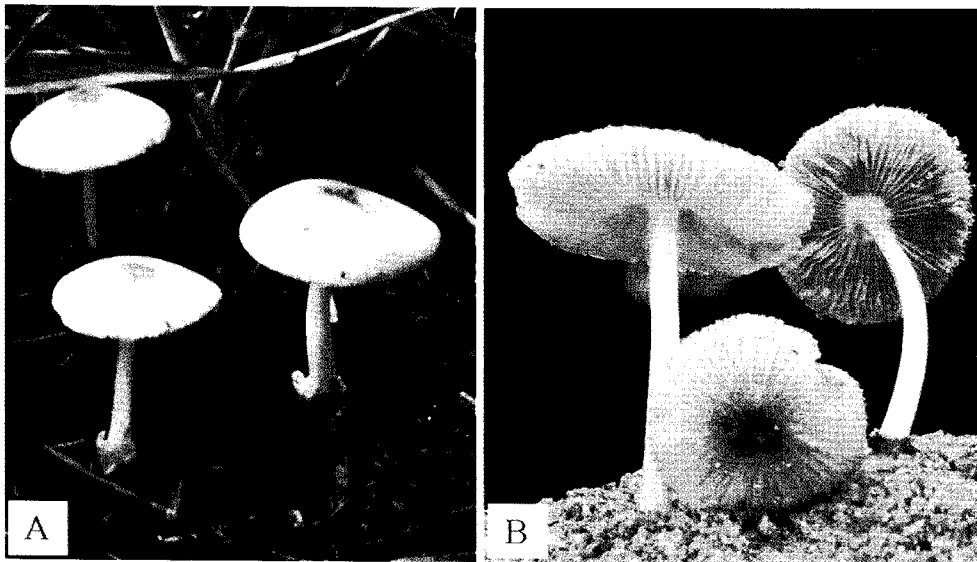


Fig. 15. *Volvariella subtaylori*. A) ASIS 7056. B) ASIK 4073.

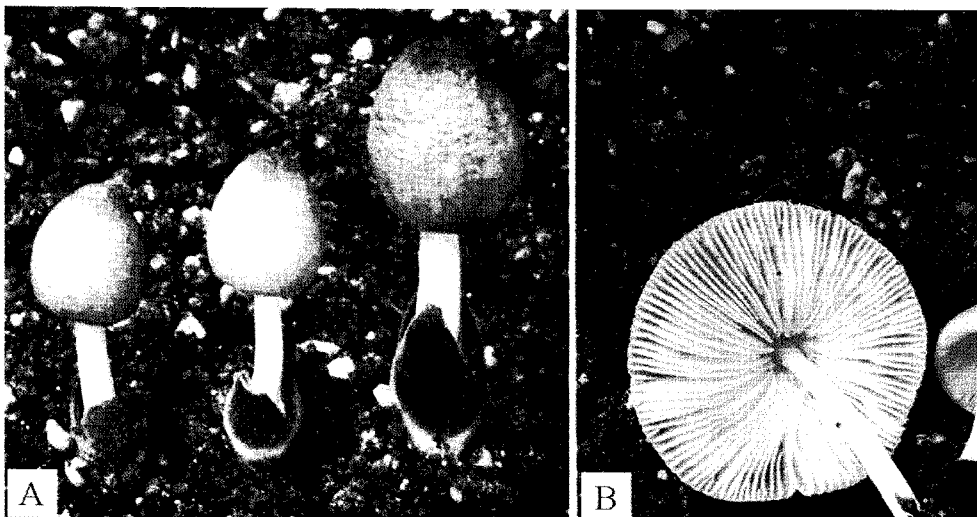


Fig. 16. *Volvariella villosavolva*. A) and B) GBDS 2857.



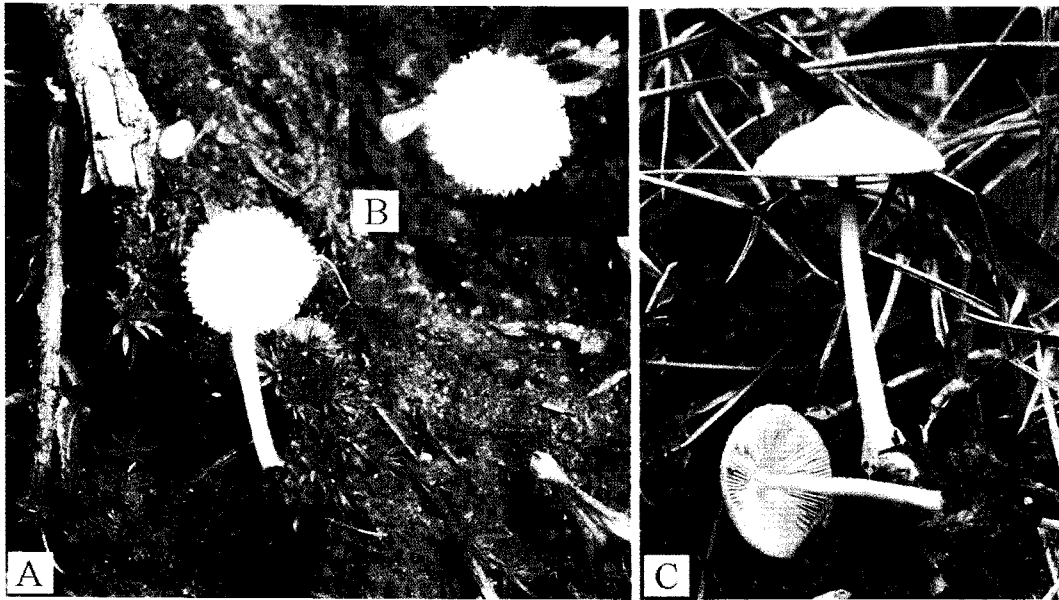


Fig. 17. *Volvariella pusilla*. A) and B) GBDS 611; *Volvariella hypopithys*. C) OKM 212637.

in Lilloa 22: 401. ('1949') 1951.

**Edibility:** unknown

**Habit & Habitat:** Solitary, terrestrial in deciduous forests on clay soil, but also in greenhouse.

**Material Examined:** Kwangnung, 27 Jul. 1977 (OKM 16014); Suwon, 24 Aug. 1985 (ASIK 1244); Kanggyosan, Suwon, 20 Aug. 1993 (GBDS 661); Pyongchang, 14 Jul. 1998 (ASIS 7117).

**Observation:** This species is similar to *V. hypopithys* in gross shape, but distinguished from it by having the smooth surface on stipe and the hyphae of the pileipellis longer than those in *V. hypopithys* (Figs. 8, 17A and 17B).

(9) 백마비단털버섯 *Volvariella hypopithys* (Fr.) Shaffer in Mycologia 49: 572. 1957.

*Agaricus hypopithys* Fr., Hymenomyc. cur.: 183. 1874; *Volvaria hypopithys* (Fr.) P. Karst., Ryssl., Finl. Skand. Halföns Hattsvamp.: 251. 1879; *Vovariella hypopithys* (Fr.) Mos., Blätter-Bauchpilze, 1. Aufl.: 110. 1953 (invalid, basionym not mentioned).-*Volvaria plumulosa* Lasch ex Quél. in Bull. Soc. bot. Fr., 24: 320. ('1877') 1878; *Volvariella plumulosa* (Lasch ex Quél.) Sing. in Lilloa 22: 401, ('1949') 1951.-*Agaricus pubesentipes* Peck in Rep. N. Y. St. Mus., nat. Hist. 29: 39. 1878; *Volvaria pubesentipes* (Peck) Sacc., Syll. Fung. 5: 658. 1887 (as *V. pubipes*); *Volvariopsis pubesentipes* (Peck) Muirill in N. Amer. Fl. 10: 141. 1917; *Volvariella pubesentipes* (Peck) Sing. in Lilloa 22: 401. ('1949') 1951.-*Volvaria parvula* var. *biloba* Mass. J. Brit. Fung. Fl.: 296. 1893; *Volvaria pusilla* var. *biloba* (Mass.) J. Lange, Fl. agar. dan. 2: 80. 1937.

**Edibility:** unknown

**Habit & Habitat:** Solitary, terrestrial on forest litter in deciduous forests on rich to rather rich soils.

**Material Examined:** Kwangnung, 22 Sep. 1984 (ASIK 25; OKM 21637).

**Observation:** As a member belonging to the group of small white volvariellas, this species is closely related to *V. pusilla*, but the latter differs by having the smooth stipe and habitat commonly in conifers. *V. murinella* also are both small to medium sized species, but they have pale grey to pale grey-brownish pileus (Figs. 9 and 17C).

(10) 갈매기비단털버섯 *Volvariella surrecta* (Knapp) Sing. in Lilloa 22 401. ('1949') 1951.

*Agaricus surrectus* Knapp. J. Naturalist Ed. 1: 363. 1829; *Volvaria surrecta* (Knapp) Ramsbottom in Trans. Br. mycol. Soc. 25: 326. 1942; *Agaricus loveianus* Berk. in Sm., Engl. Fl. 1. 5(2): 104. 1836; *Volvaria loveianus* (Berk.) Gillet, Hymenomycetes: 386. 1876; *Volvaria hypop-*



Fig. 18. *Volvariella surrecta*. GBDS 1618.

*ithys* subsp. *loveiana* (Berk.) Konr. & M., Ic. sel. Fung. 1: pl. 17 fig. 2. 1928.

**Edibility:** unknown

**Habit & Habitat:** Solitary, on or near the old fruit-bodies of *Clitocybe*

**Materials Examined:** Chongyang, 7 Oct. 1991 (GBDS 1615); Seoul, 31 Aug. 2000 (ASIS 8533); Seoul, 31 Aug. 2000 (ASIS 8549).

**Observation:** This species is easily recognized by its habitat on rotting carpophores of *Clitocybe hydrogramma* var. *alba*, white pileus and silky tomentose stipe base (Figs. 10 and 18).

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