New records of genus *Volvariella* (Pluteaceae) from Cuc Phuong National Park

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Abstract:

Cuc Phuong National Park is a natural reserve located in Ninh Binh, Hoa Binh and Thanh Hoa provinces. Cuc Phuong is Vietnam's oldest National Park and also is one of the most important sites for biodiversity in Vietnam. Little is known about the diversity of macrofungi in this special area. This paper presents the collecting process of fungal samples and the identification and description of some fungal species belonging to the genus *Volvariella* (Pluteaceae) based on the morphological characteristics in Cuc Phuong National Park, Ninh Binh province. This study identified 5 species including *Volvariella murinella, Volvariella gloiocephala, Volvariella volvaceae, Volvariella taylorii,* and *Volvariella pusilla*. Interestingly, of them, 4 macrofungus species were first recorded at this National Park.

Keywords: **Cuc Phuong National Park, mushroom, new records, Pluteaceae, *Volvariella.***

Classification number: **6.1**

Introduction

Volvariella is a large genus belonging to the family Pluteaceae, order Agaricales, Hymenomycetidae, Eubasidiomycetes, Basidiomycotina and Eumycota [1]. Most of the *Volvariella* species possess some morphological characteristics such as a volva at the bottom of the stipe, none annulus, none pink gills, none free lamellae, not attached to the stipe, spore print pinkish or brownish, pink spores thin-walled to somewhat thick-walled and growing on porous soils or on wood. However, some *Amanita* species are also superficially similar to *Volvariella*, and therefore, they are easily recognised as *Amanita.*

Volvariella species are best known as valuable foods. Many of them are natural nutrient sources rich in proteins, amino acids, minerals and vitamins A, B, C, D, E, etc. In addition, some species have medicinal value. At present, some species are being studied for the processing or extraction of bioactive ingredients for the production of drugs that support the treatment of many diseases.

Materials and method

Morphological description

This study is based on samples collected during the period 2016-2017. The materials are deposited at the Faculty of Environment, Hanoi University of Natural Resources and Environment (Vietnam).

Macromorphological features are all based on fresh materials and all aspects of size, shape, colour and colour changes, texture, odour and taste are documented [2]. Features of both young and old fruit bodies were recorded. The colour was described in daylight using terms and notations in a colour guide by Kornerup and Wanscher (1978) [3].

Micromorphological characteristics were documented from the analyses of dried materials. Spores were observed for measurements and drawings; all other structures were observed in 2-5% KOH or Congo-red.

Microscopy technique:

Add 3 small drops of distilled water to the microscope slide, and then cut 3 small pieces of mushroom in the pileus, lamella and stipe. Then, put them on each drop of water. Use a razor blade to chop the samples. Cover them with the lamen and then press lightly.

Observe specimen at the lens of x 4, x 10 and x 40. Then, add a drop of immersion oil on the specimen on the glass at a lens of x 100.

(Note: when glassing at the lens of x 100, only return to observe at the lens of x 4 and x 100).

Microscopic data need to be determined:

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Spore (at lamella): size, shape, colour and structure (thick or thin, having internal substance or not, internal substance is coloured or colourless, there is a pillar layer between 2 layers or not); **Basidia** (at lamella): size, shape, number of horns, colour and structure (thick or thin, internal substance is coloured or colourless); **Cystidia** (at lamella): size, shape, density, colour and structure (thick or thin, internal substance is colour or colourless); **Pileipellis** (at pileus) and **Stipitipellis** (at stipe): size, shape, having branches or not, having partitions or not, structure of pileipellis (thick or thin, internal substance is coloured or colourless); Clamp connection, if present.

The approach of fungal identification

All the species were identified from *Volvariella* according to taxonomy by Ahlawat, et al. (2010) [4], Dutta, et al. (2011) [5], A. Justo and M.L. Castro (2010) [6] and Seok Soon-Ja, et al. (2002) [2].

The taxonomy of the species was described, and the illustrations were then compared with the species checklist in Vietnam by Tam Kiet Trinh (2011, 2014) [7, 8] and Van Mao Tran (2005) [9].

Results and discussion

Key to species of Volvariella from Cuc Phuong National Park

1. The largest spores being more than 11 µm long; the cap spread out, thick, white or brownish grey, rugged and brownish grey top of cap ……...*V. gloiocephala.*

2. Growing on humus soil ……..…..3

2'. Growing on soil in the coniferous forest ……4

3. The diameter of the cap being about 5-10 cm, blackish brown, grey, volva externally date white or brownish grey ……... *V. volvacea.*

3'. Unclear volva, just roughly, white …… *V. murinella.*

4. Cone-shaped or umbonatae cap. White, dry, smooth surface. Small cap less than 5 cm, volva grey to pale brownish grey ……..……. *V. pusilla.*

4'. Cap with whitish, greyish to pale brownish grey hairs, cap dry and wrinkled…… *V. taylorii.*

1. *Volvariella murinella* (Quél.) M.M. Moser, in Gams, Kl. Krypt.-Fl. Mitteleuropa - Die Blätter- und Baupilze (Agaricales und Gastromycetes) (Stuttgart) 2: 110 (1953).

Syn: *Volvaria murinella* Quél., Compt. Rend. Assoc. Franç. Avancem. Sci. 11: 391 (1883) - *Volvariella murinella* (Quél.) M.M. Moser ex Dennis, P.D. Orton & Hora, Trans. Br. mycol. Soc. 43(2): 167 (1960) (see in Figs. 1-3).

Fig. 1. *Volvariella murinella.*

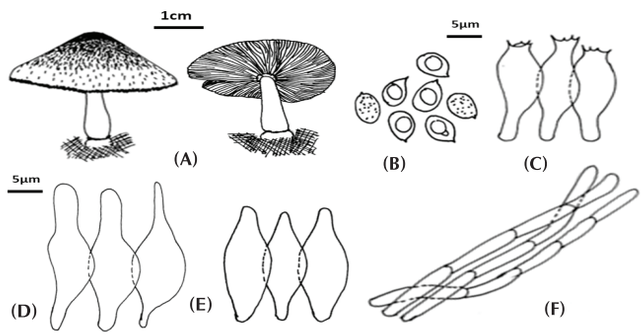

Fig. 2. Microscopic characteristics of *Volvariella murinella.* (A) Pileus, **(B)** Spore, **(C)** Basidia, **(D)** Cheilocystidia, **(E)** Pleurocystidia, **(F)** Pileipellis.

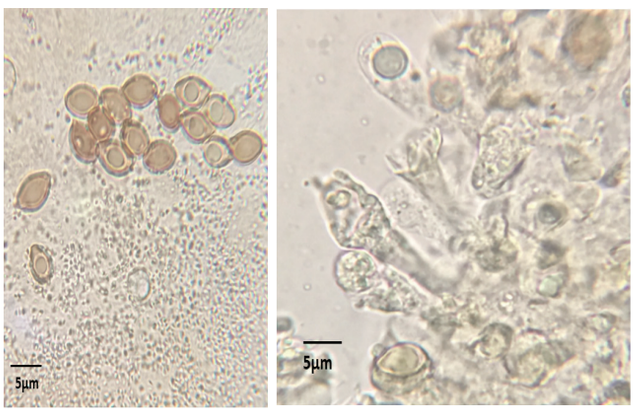

Fig. 3. Microscopic images of *Volvariella murinella.*

Pileus 3-6 cm wide, cone when young and umbonatae when mature, surface with greyish to pale brownish, smooth, clear hairs, edge white, unclear, easy to separate when expanded. Context thick, spongy, soft, white to pinkish. Lamellae free, subcrowded to crowded, at first white then becoming pinkish, spacing about 0.7-1 mm,

breadth 0.2-0.4 mm and the number of series is 3. Pink spore prints. Stipe 3-10 cm long, 0.5-1.5 wide, cylindric to subcylindric, expanded at the bottom, white or brown, roughly and unclear volva at the base. Spores 4.8-5.6 x 4.9-6.6 µm, ellipsoid. Basidia 19-25 x 6-7 µm, clavate shaped and 4-spored. Cheilocystidia with size from 45-65 x 8-15 µm, clavate, subfusiform or ventricose lageniform. Size of pleurocystidia from 20-30 x 10-15 µm, clavate. Pileipellis is a cutis made up of shortcelled hyphae.

Sign: CN27.17-20/7/2017 - Hoa Mac lake - 20°14'52"N - 105°29'38"E; M131.17 - 8/6/2017 - Hoa Mac lake - 20°21'42"N - 105°39'50"E, Cuc Phuong National Park, Ninh Binh.

Edibility: unknown.

Habitat: terrestrial, on porous soils, high humidity.

Comments: when comparing our specimens collected from Cuc Phuong National Park to *Volvariella murinella* of T. Boekhout (1986) [10], it was noted that they have some similar features of morphology and microscopy as follows: pileus in float shape - convex, brown-grey, fade to the outside, visible fuzz on the surface; pink-white stipe; spore in ellipse shape; cheilocystidia in the rhombus shape- fusoid; Pleurocystidia in the bottle shape. Compared to T. Boekhout (1986), the morphological characters of our specimens are clearer and consistent with the documentation of, for instance, basidia, pileipellis. According to T. Boekhout (1986), *Volvariella murinella* grow on moist soil or sandy soil, under trees with a large canopy and appears in the local area.

Comparing our specimens with *Volvariella murinella* of Dong Anh Tran (2013) [11], it was noted that there are some similar features such as: shape of pileus, size of pileus, and gills; the most similar feature according to Dong Anh Tran (2013) is unclear volva only slightly rising. This paper has described the morphology as well as the microscopy more clearly and fully of cheilocystidia, pleurocystidia, pileipellis and some external morphological features of species.

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

Syn: *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) (see in Figs. 4-6).

Fig. 4. *Volvariella volvacea.*

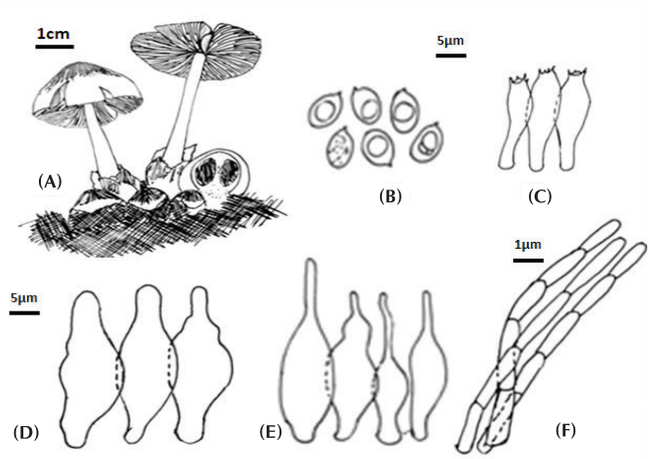

Fig. 5. Microscopic characteristics of *Volvariella volvacea.* (A) Pileus, **(B)** Spores, **(C)** Basidia, **(D)** Cheilocystidia, **(E)** Pleurocystidia, **(F)** Pileipellis.

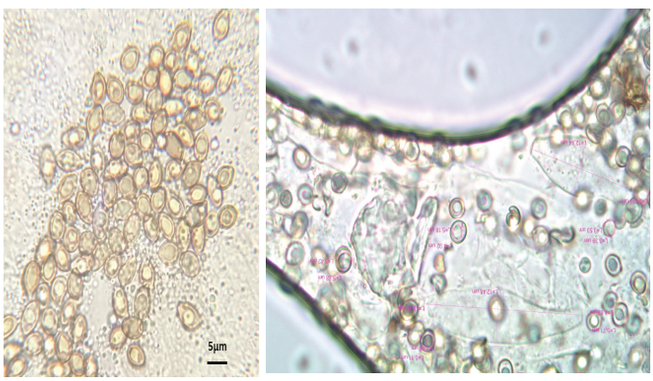

Fig. 6. Microscopic images of *Volvariella volvacea.*

Pileus 2.5-5 cm, ellipse-shaped with young specimens, expanded development to convex or broadly conic, flat, dry, hairs spread out uniformly, greyish, blackish brown or nearly black when young. Context soft, solid, spongy,

white to pale brownish. Lamellae free from the stem, white when young and becoming pink when they mature, close or nearly crowded, spacing about 0.5-1 mm, breadth 0.2-0.4 mm. Pink spore prints. Stipe 3-7 cm long, 0.5-1 cm wide, cylindrical shape, expanded at the bottom, a volva at the base; dry; whitish or brownish; silky, volva is brownish grey to nearly black above and whitish below. Odour likes moist straw. Taste sweetish. Spores 4.6-5.8 x 7-8.5 µm; ellipsoid to elongate or somewhat ovoid. Pleurocystidia 25-30 x 10-15 µm and cheilocystidia 40-58 x 10-12 µm, variously shaped but mostly fusoid-ventricose or clavate. Pileipellis a cutis made up of shortcelled hyphae.

Edibility: edible, high nutritional value.

Habitat: terrestrial or gregarious on porous soils, high humidity, hot and humid time in summer.

Sign: CN33.17 - 20/7/2017 - Hoa Mac lake - 20°15'24"N - 105°32'54"E; CN34.17 - 20/7/2017 - Hoa Mac lake - 20°16'43"N - 105°33'30"E, Cuc Phuong National Park, Ninh Binh.

Comments: comparing this to the research of Dong Anh Tran (2013) [11], it was noted that there are some similar features in morphology, such as: at first, toadstool in the egg shape, as mature pileus in cone shape, convex at the top and flat expanding on both sides; smooth surface, smooth white grey yarns, black mushroom top; odour are soft, sweet and slightly sour, stipe is smooth and white, volva is calyx, dark grey or ash grey; basidia is the mace shape with 4 horns. Compared to *Volvariella volvacea* of Dong Anh Tran (2013), I have described the morphology as well as the microscopy of the CN33.17 sample more clearly and fully. According to Dong Anh Tran (2013), *Volvariella volvacea* appears in the North provinces mainly from April to November and Southern delta all year. Compared to the research by Seok Soon-Ja, et al. (2002), the CN33.17 sample collected from Cuc Phuong National Park has many similar features in microscopy, such as spores, basidia, cheilocystidia, pleurocystidia and pileipeillis. However, our specimens have not yet described the fibre system such as stipitipellis and the structure of the fibre system of volva.

Compared to M. Kuo (2008) [12], our specimens also has some similarities with the *Volvariella volvacea* species, such as toadstool has the egg shape at early ages, pileus has the cone shape with slightly convex top as mature, or the pileus enlarges almost flat, dry surface, grey colour and white or brown stalk. Compared to the microscopy with *Volvariella volvacea* of M. Kuo (2008), our specimen also has some similar characteristics such as the shape of spores, cheilocystidia, pleurocystidia and pileipellis. However, M. Kuo (2008) did not characterise the morphology of basidia. According to M. Kuo (2008), *Volvariella volvacea* grows in clusters, in woody forests, greenhouses, flower gardens, composting piles and similar locations all year depending on the climate, but they often grow in the summer and are widely distributed in North America, more commonly in the Eastern Great Plains. Thus, our specimens were collected in Cuc Phuong National Park and have many same morphological and morphological characteristics with *Volvariella volvacea* of Seok Soon-Ja, et al. (2002), Dong Anh Tran (2013) and M. Kuo (2008). As a result, we recognise that our samples belong to the species *Volvariella volvacea*.

3. *Volvariella gloiocephala* (DC.) Boekhout & Enderle, Beiträge zur Kenntnis der Pilze Mitteleuropas 2: 78 (1986) (see Figs. 7-9).

Syn: *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.

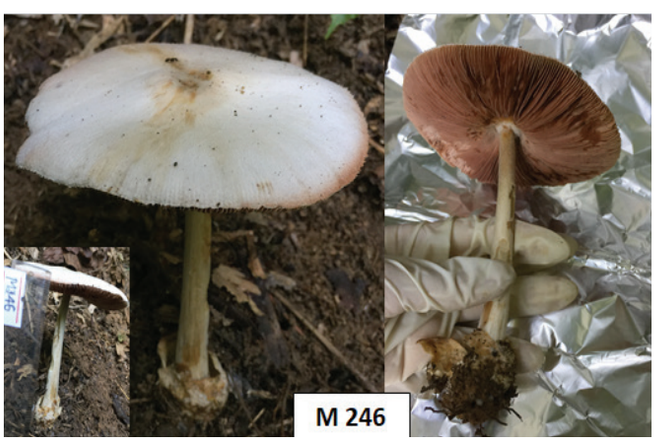

Fig. 7. *Volvariella gloiocephala.*

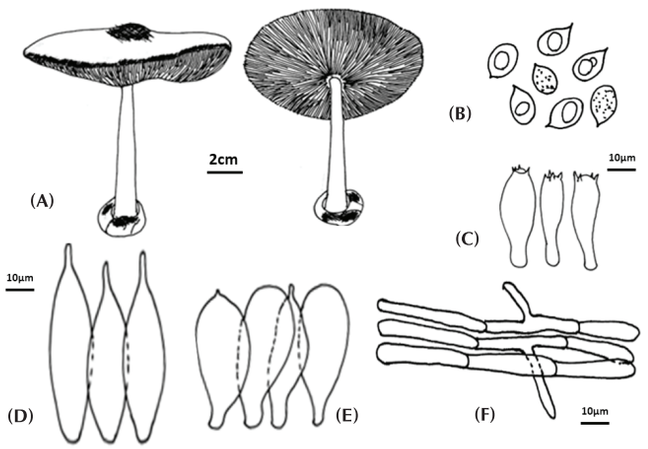

Fig. 8. Microscopic characteristics of *Volvariella gloiocephala.* **(A)** Pileus, **(B)** Spores, **(C)** Basidia, **(D)** Cheilocystidia, **(E)** Pleurocystidia, **(F)** Pileipellis.

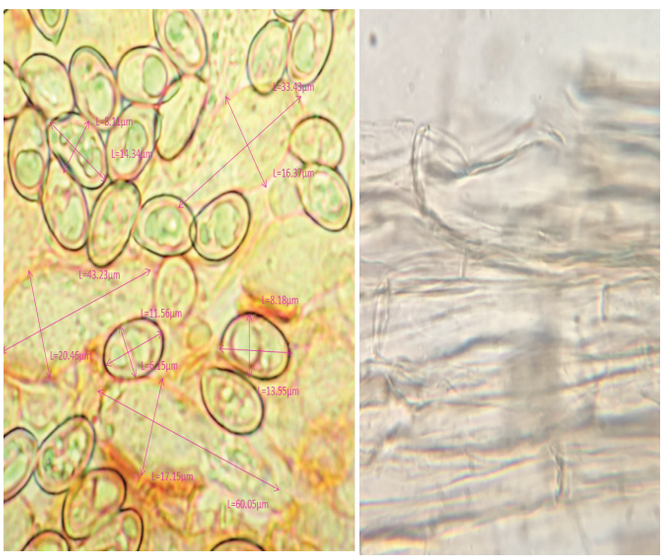

Fig. 9. Microscopic images of *Volvariella gloiocephala.*

Pileus 5-13 cm, void when young, becoming somewhat campanulate to convex or umbonatae, dry, surface with white and smooth hairs, greyish or brownish top of pileus. Context flesh, soft, spongy, thin, white. Lamellae free, subcrowded to crowded, edge fimbriate, white when young and then becoming brownish-pink, spacing 0.5-1 mm, breadth about 0.2-0.3 mm. Pink spore prints. Stipe 8-12 long, 1-1.5 thick, white to pale brownish, cylindric to subcylindric, expanded at the bottom and glabrous. Sack-like volva which may be prominent, white. Spores 11-14 x 6-8 µm, ovoid or elipsoid. Basidia 30-35 x 10-14 µm, 4-spored. Pleurocystidia 30-50 x 15-25 µm subcylindric to fusoid at times with knob at the apex or not. Cheilocystidia 50-75 x 15-25 µm, fusoid with, the neck enlarged or slender, clavate at times with long neck. Pileipellis consist of gelatinous hyphae, branched.

Edibility: edible.

Habitat: terrestrial on porous soils, high humidity.

Sign: M246.17 - 8/8/2017 - Antediluvian cave - 20°20’22”N - 105°37’46”E; M247.17 - 8/7/2017 - Antediluvian cave - 20°20’23”N - 105°37’48”E, Cuc Phuong National Park, Ninh Binh.

Comments: compared to the research of Seok Soon-Ja, et al. (2002) [2], the M246 sample collected from Cuc Phuong National Park has many similar features such as the Pileus is large, oval-shaped, slightly convex at the top, as they mature, it becomes almost flat (umbonate), it is covered with fine white fuzz, has light brown, darker mushrooms edges, slightly dry surface, the pileus meat is thin, white and soft; lamella are freely lined up closely and is pink brown as they mature; the stalk is cylinderical, white and expanded to the bottom; the spores are egg-shaped and the basidia is mace-shaped with four horns; the pleurocystidia is fusoid-shaped with a knob at the apex; the cheilocystidia is oval. Mostly, the M246 sample has the similar morphological and morphological characteristics compared to the *Volvariella gloicephala* species from Vietnam. According to Seok Soon-Ja, et al. (2002), the *Volvariella gloiocephala* species is edible, distributed shingly on humus areas, especially in shiitake plantations.

Compared to M. Kuo (2008) [12], the M246 sample also has similarities with the *Volvariella gloicephala* species such as: size of pileus, shape of pileus, colour, lamella, stipe, spore, cheilocystidia and pleurocystidia. However, M. Kuo (2008) did not clearly describe the surface of pileus, the substance in context, the substance in stipe, lamella, basidia and pileipellis. According to M. Kuo (2008), the *Volvariella gloiocephala* species is edible and distributed individually in gardens, lawns and firewood, mainly in the forest and grows primarily in the North in spring and in southern California in the winter, and is widely distributed in North America.

Based on the morphological and microscopic characteristics of the *Volvariella gloiocephala* species observed by Seok Soon-Ja, et al. (2002), M. Kuo (2008), it is noted that our specimen (M246.17) has many similarities with them. Therefore, I identify that the specimen M246.17 belongs to the *Vovariella gloiocephala* species.

4. *Volvariella taylorii* (Berk. & Broome) Singer [as ‘taylori’], Lilloa 22: 401 (1951).

Syn: *Agaricus taylorii* Berk. & Broome [as ‘taylori’], Ann. Mag. nat. Hist., Ser.2 13: 398 (1854) - *Volvaria taylorii* (Berk. & Broome) Gillet [as ‘taylori’], Hyménomycètes (Alençon): 386 (1876) (see Figs. 10-12).

Fig. 10. ***Volvariella taylorii.***

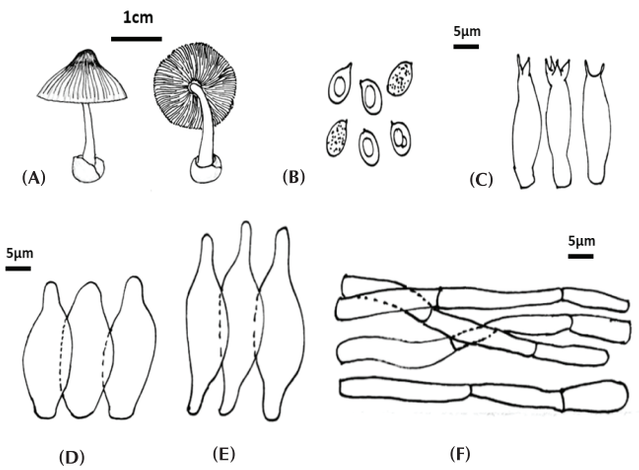

Fig. 11. Microscopic characteristics of ***Volvariella taylorii.*** **(A)** Pileus, **(B)** Spores, **(C)** Basidia, **(D)** Pleurocystidia, **(E)** Cheilocystidia, **(F)** Pileipellis.

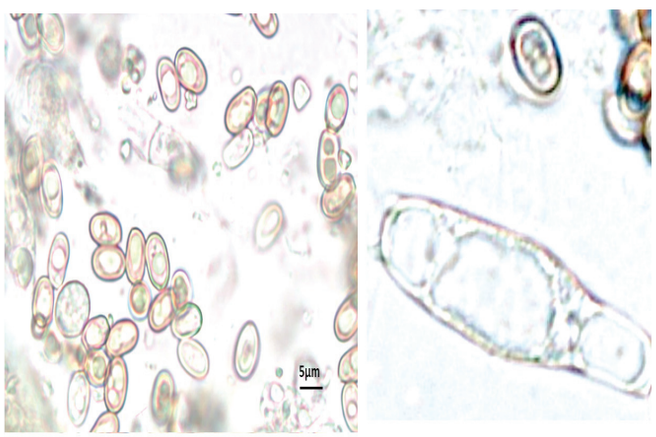

Fig. 12. Microscopic images of ***Volvariella taylorii.***

Pileus 1-2 cm when young and 2-5 when mature, convex after expanding to nearly flat, dry, finely hairy; greyish to brownish grey, the margin not lined, white. Context white, soft, spongy; the thickness in pileus about 1 mm when young and 2-3 mm when mature. Free lamellae and not attached to stipe; whitish becoming pink, close or almost distant, spacing 0.5-1 mm, breadth 0.2-0.3 mm, the number of series is 3 lamellulae. Pink spore prints. Stipe 2.5-6 cm long; 2-5 mm thick, white, thickened downward, glabrous, but somewhat pilose at the base; smooth, finely hairy, grey or brownish volva. Spores 4.8-6 x 4.5-5.2 µm, ellipsoid, thick-walled. Basidia 20-25 x 7-10 µm, normal, 2-4-spored, rarely 2-spored. Pleurocystidia 25-30 x 10-15 µm, fusoid-ventricose, sublageniform, ventricose, thin-walled. Cheilocystidia 35-50 x 10-20 µm, fusoid-ventricose, clavate with obtuse or narrow neck, thin-walled, abundant. The Pileipellis has a size of about 35~360 x 11~14.0 µm, has cylindric hyphae and is thin-walled. The Pileipellis is composed of cylindric hyphae with clamp connection.

Edibility: edible.

Habitat: terrestrial on porous soils, high humidity, in dense forest.

Sign: M106.17 - 8/7/2017 - Center of Cuc Phuong National Park - 20°22’35”N - 105°40’41”E; M108.17 - 8/7/2017 - Center of Cuc Phuong National Park - 20°22’30”N - 105°40’39”E.

Comments: comparing the M106.17 collected from Cuc Phuong National Park, Ninh Binh to *Vovariella taylorii* of Dong Anh Tran (2013) [11], there are some similarities: pileus is convex-shaped or wide hemisphere, fine fuzz, the color of grey to slightly grey, the edge of mushroom is incomplete, the diameter is 2-5 cm; the stalk is 3-6 cm, a bulge in the root, the color is white, smooth, calyx-shaped; the spore is egg-shaped or ellipse-shaped; the basidia is rhombus-shaped; it grows on land. Compared to Dong Anh Tran (2013), our specimen described the morphology as well as the microscopy more clearly and fully described the microscopic characters such as cheilocystidia, pleurocystidia, pileipellis and other morphological features.

Comparing our species to the *Vovariella taylorri* species by Seok Soon-Ja, et al. (2002) [2], there are many similarities in the toadstool morphology, colour and microscopy with *Vovariella taylorri* species such as spores, basidia, cheilocystidia, pleurocystidia and pileipellis. Additionally, Seok Soon-Ja, et al. (2002) clearly described the living environment of species growing singly on humus soil, mainly in the Shiitake forest.

Thus, compared to *Volvariella taylorii* of Dong Anh Tran (2013) and Seok Soon-Ja, et al. (2002), it is noted that there are many similar morphological and morphological characteristics. As a result, we identified that the M106.17 sample collected is a *Vovariella taylorii* species.

5. *Volvariella pusilla* (Pers.) Singer, Lilloa 22: 401 (1951).

Syn: *Amanita pusilla* Pers., Observ. mycol. (Lipsiae) 2: 36 (1800) - *Agaricus parvulus* Weinm., Hym. à Gast. Imp. Ross. Obs. (Petropoli): 238 (1836) - *Volvaria parvula* (Weinm.) P. Kumm., Führ. Pilzk. (Zwickau): 99 (1871) - *Volvaria pusilla* (Pers.) Lloyd, Mycol. Writ. 1(4): 31 (1899) (see Figs. 13-15).

Fig. 13. *Volvariella pusilla.*

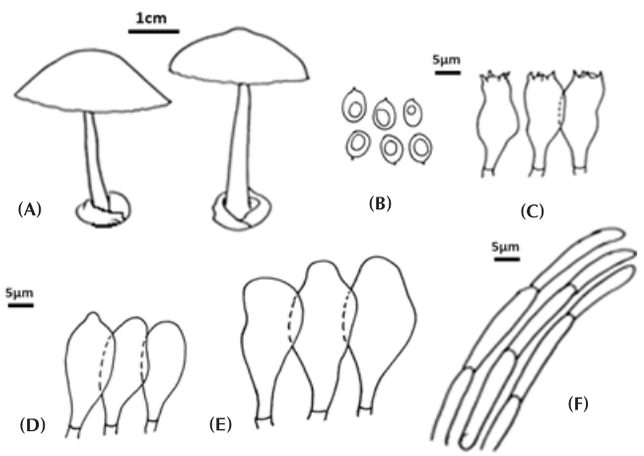

Fig. 14. Microscopic characteristics of *Volvariella pusilla.* **(A)** Pileus, **(B)** Spores, **(C)** Basidia, **(D)** Pleurocystidia, **(E)** Cheilocystidia, **(F)** Pileipellis.

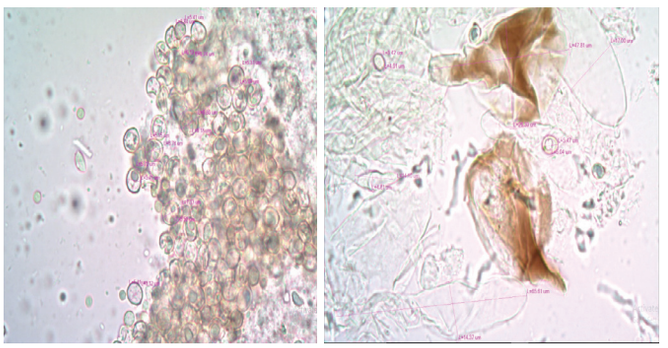

Fig. 15. Microscopic images of *Volvariella pusilla.*

Pileus 1-4 cm, convex to broadly convex to nearly flat, white, the margin lined, slightly sticky when fresh but soon dry, slightly wrinkled when old. Lamellae free from the stem; sub-crowded to crowded, at first, white and then becomes pinkish, spacing about 0.7-0.9 mm. Pink spore prints. Stipe 6-8 cm long, 0.3-0.6 cm thick, cylinder, dry, white, smooth, the base encased in a thick, white to greyish, volva white or brownish, may be buried. Spores 5-7 x 4.5-5.5 µm, ellipsoid. Pleurocystidia 20-30 x 10-15 µm and cheilocystidia 3-50 x 15-25 µm, mostly clavate. Pileipellis composed of cylindric hyphae with clamp connection.

Edibility: unknown.

Habitat: terrestrial on porous soils, high humidity, mostly on grass.

Sign: M185.17 - 15/5/2017 - Hoa Mac lake - 20°15'40"N - 105°33'39"E; M186.17 - 15/5/2017 - Hoa Mac lake - 20°15'42"N - 105°33'22"E; M187.17 - 15/5/2017 - Hoa Mac lake - 20°15'32"N - 105°33'18"E; M188.17 - 15/5/2017 - Hoa Mac lake - 20°16'41"N - 105°32'44"E; M189.17 - 15/5/2017 - Hoa Mac lake - 20°16'42"N - 105°32'43"E, Cuc Phuong National Park, Vietnam.

Comments: comparing specimens (M185.17-M189.17) collected from Cuc Phuong National Park - Ninh Binh to *Volvariella pusilla* of Dong Anh Tran (2013) [11], there are some similarities observed between them: the shape of toadstool, white or slightly brown colour at the top and edge; lamella; stipe is smooth, dried and white; the spores shape. In this paper, we clearly examine some morphology characters as well as the microscopy and fully provide the data of basidia, pleurocystidia, cheilocystidia and pileipellis. According to Dong Anh Tran (2015), *Volvariella pusilla* grows on humus land.

Compared to the *Volvariella pusilla* species in the research by Seok Soon-Ja, et al. (2002) [2], there are many similarities such as size of pileus and stipes, surface of pileus, colour, shape of spores, shape of basidia, pleurocystidia and cheilocystidia và pileipellis. Thus, based on the notes

on *Volvariella pusilla* by Dong Anh Tran (2013) and Seok Soon-Ja, et al. (2002), there are many similar morphological and morphological characteristics of the species *Volvariella pusilla* (Figs. 14, 15).

Conclusions

During the research, based on the morphology described species, we found 5 species described for Cuc Phuong National Park, Ninh Binh province, including *Volvariella murinella, Volvariella gloiocephala, Volvariella volvaceae, Volvariella taylorii* and *Volvariella pusilla.* Additionally, the number of species grows in the lower area. Although, sometimes, there is a strong morphological resemblance of the Vietnam species to the European species and Korean species, there is no co-specificity. Moreover, Cuc Phuong National Park is a place with high biodiversity in general and large mushrooms in particular. It requires further research as well as an establishment of the official list.

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