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Морфологическое исследование рода *Agaricus* Монголии

Morphological study of genus *Agaricus* of Mongolia

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Реферат. В статье представлена информация о макро- и микроморфологических особенностях 7 видов рода *Agaricus* (*A. arvensis*, *A. campestris*, *A. bernardii*, *A. silvaticus*, *A. silvicola*, *A. tabularis*, *A. xanthodermus*), а также данные об их распространении в Монголии.

Summary. The present contribution provides information about macro– and micromorphological features of six species of the genus *Agaricus* (*A. arvensis*, *A. campestris*, *A. bernardii*, *A. silvaticus*, *A. silvicola*, *A. tabularis*, *A. xanthodermus*) from Mongolia, as well as data for their distribution in the country.

Introduction

Agaricus is a genus of mostly medium to large gilled mushrooms (Geml, Royse, 2002). Fruitbodies of fungi belonging to the genus *Agaricus* are characterized by a white or yellow pileus and free gills with a regular trama when young, later becoming irregular (Janusz et al., 2008). The cap surfaces have appressed hyphae, radially arranged, and under varying conditions may appear glabrous, fibrillose, squamous, or areolate. They have chocolate–brown to purple brown spores, gills that are free from the stem, close, pallid to pinkish when young, then colored by the spores to chocolate–brown to blackish brown at maturity (Ahmad et al., 2009). In species identification the spore size is significant also.

The stem is central, separates easily from the cap, and is fleshy, except in the fragile. Flesh color is pure white or whitish unless otherwise noted (Maria, Georgi, 2004). The stem may be solid, stuffed or hollow. An *Agaricus* will always have a ring on the stem. If evanescent, there will still be evidence that a ring had been there, such as a zone on the stipe or fragments clinging to the pileus edge. If the ring is thin, silky or cottony, it may be termed «single», meaning there would be no veil patches on the underside. When the ring is composed of two clearly visible layers of tissue, it is called «double». In some cases the under layer will have separated into colored patches on the underside of the upper layer (Wasser, 1980).

Staining reactions should especially be noted in fresh specimens by cutting or rubbing the flesh of the cap and stalk, and in the extreme base of the stem. Some species are unchanging with rubbing or cutting. Many species grow in grassy areas, others will fruit near trees or in woodlands. Many species look very similar to others, and many are variable in size, shape and color (Wasser, 1980; Ali, Kenan, 2010).

The present contribution provides information about the macro– and micromorphological features of six species of the genus *Agaricus* (*A. arvensis, A. campestris, A. silvaticus, A. silvicola, A. tabularis A. xanthodermus*) from Mongolia, as well as data for their distribution in the country.

This is aimed to study a possibility to use those macro and micromorphological features for recognizing and determining species that were determined on morphological inter–comparison study six species of *Agaricus* genus.

Materials and Methods

This survey covered totally 30 samples storing in the herbarium of the Institute of Botany, Mongolian Academy of Sciences. Ten of them have been collected and identified by Dr. G. Uranchimeg in 1982–1987, and

20 of them were collected in 1995–2012 by us. Each sample was studied in the field by taking measurements on the morphological structures of the cap, stem and recording gills color, shape and dimensions. Also smell and taste for each fruiting structure were taken in consideration. Samples were photographed and then specimens kept in small polyesterene boxes inside ice box.

Scanning electron microscopy – Lamellar fragments (approx. 1–2 mm) were removed from dried basidiomes, attached to aluminum mounts using double-stick tape and gold-palladium sputter coated at a nominal coating thickness of 15 nm using a Hummer VII sputtering system (Anatech Ltd., Alexandria, Virginia). Basidiospores were examined at 15 kV using a Carl Zeiss DSM–940 scanning electron microscope.

Macromorphological descriptions were made from fresh basidiomes. Color designations correspond to Kornerup and Wanscher (1967), and are noted as combinations of plate, column and row numbers. Preparation of hand sections for observation of micromorphological characters and use of descriptive terms follow (Largent et al., 1977). Sections were mounted in 4 % KOH for measurement of basidiospores and other micromorphological features and in Melzer's reagent to test for amyloidity.

Basidiospore measurements were made with the hilar appendix and ornamentation excluded (Matheny, Bougher, 2005). Length-width ratios (Q) were calculated for each basidiospore, and a mean calculated for each collection (Q^m) (Keirle et all, 2004; Todd et al., 2005). Spore print for each sample was taken and the ornamentation of the gill type was also defined. Spores were microscopically tested by recording the shape, color and size of more than 20 arbitrary chosen spores.

Drawings of micromorphological features were prepared using a drawing tube attached to a Leica DMLS compound microscope.

The fungi were identified with the aid of works by Wasser (1980) and Cappelli (1984).

Results

Agaricus arvensis Schaeff., 1774

Macroscopic features. Pileus 10–18 cm across, hemispherical when young, later conic-convex to plane, sometimes with on obtuse umbo, surface white when young, finally radially fibrillose – suede-like to almost smooth, later splitting up into fine, appressed squamules and strongly turning yellow to yellowish ocher, margin incurved for a long time, acute. Flesh white, yellow under the cuticle, thick in the center of the pileus, thin toward the margin, odor strongly anise to almond–like taste mild, nutty. Lamellae whitish to gray-pink when young, soon purple-to black-brown, narrow, free, edges smooth. Stipe 4–10 x 1–2 cm, cylindrical, somewhat enlarged toward the base, pithy–solid when young, hollow with old, fragile, surface white and smooth above the annulus, white and smooth to squamulose below, yellowing when touched, annulus white, membranous, pendent, sometimes two-layered, upper surface smooth, lower surface coarsely floccose. Entire fruit body yellowing when old or touched. Microscopic features: Spores elliptical, smooth, honey-brown, thick-walled, 6–10 x 4–5 μm, *Q*: 1.5–2; dark purple-brown. Basidia clavate, 15–20 x 6.5–7.5 μm, with 4 sterigmata, without basal clamp. Marginal cells somewhat clavate, 10–20 x 6–10 μm.

Habitat. Generally regarious to grouped, more rarely solitary, in meadows, pastures, parks, or at the edges of forests. sumiin khoolo

Distribution. Tuvaimag, Altanbulag sum, Hustain nuruu, in meadows, 07.08.2001, Herbarium, UBA/241.

Agaricus campestris Fr. 1821

Macroscopic feature. Pileus 5–12 cm across, spherical when young, soon convex to plane, surface smooth when young, then with increasingly concentric, poorly developed, appressed fibrillose scales, also with brownish tones when old, margin incurved for a long time, hung with white veil remnants when young. Flesh white, scarcely to faintly reddening when cut, thick in the center of the pileus, thin toward the margin, odor pleasantly fungoid, taste mild, nutty. Lamellae pale flesh–reddish even when young, purple–black in age, narrow, free, edges smooth. Stipe 4–10 x 1–2 cm, cylindrical, usually somewhat tapered or pointed toward the base, solid, rigid, fragile, surface finely longitudinally white–fibrillose to slightly floccos-fibrillose when young, browning in age, annulus pendent, membranous to fibrillose–floccose. Spores elliptical, smooth, pale gray-brown, thick-walled, with a very faint germ pore, 8–9 x 6–7 μm, Q: 1,3–1,2; dark brown.

Habitat. It grows in the soil in meadows, grasslands and fields, in steppe.

Distribution. Zavhan aimag, Ider sum, Tegshiin gol, in meadows, 02.08.2012, Herbarium, UBA/12/123.

Agaricus sylvaticus Schaeff. 1774

Macroscopic features. Pileus 7–10 cm across, hemispherical when young, later convex to plane, surface when young white, tomentose dull, later progressively splitting into concentric, appressed squamules which stain light brownish in age, margin abtuse. Flesh white, thick in the center of the pileus, thin toward the margin, after a rather long time turning faintly reddish when cut and then turning brown, especially in the center of the pileus and the base of the stipe, odor pleasantly spicy, sourish, taste mild, rather unpleasant. Lamellae whitish when young, soon pale pink, finally pink–brown, broad, free, some forked, edges smooth. Stipe 4–6 x 1–2 cm, cylindrical, base marginate–bulbous, solid when young, stuffed to hollow when old, fragile, surface white and smooth above the annulus, white and banded on a white background below it throughout life, annulus simple, thin, membranous, white, pendent. Spores elliptical, smooth, honey–brown, thick–walled, 4.5–6 x 2.9–3.8 μm, *Q*: 1.3–1.9.

Habitat. It grows on needle litter in spruce and mixed forests.

Distribution. Zavhan aimag, Tosontsengel sum, Nariinii am, N 48°29’51,4». E 97°54’38,4’’, h= 2024 м, in spruce forests, 27.07.2012, Herbarium, UBA/T–3–4.

Agaricus silvisolae Bohus et Locsmandi 1994

Macroscopic features. Pileus 5–10 cm across, obtusely conical with a plane disc when young, then hemispherical to convex, finally expanded and plane, usually with a plane umbo, surface dull to satiny, finely innately radially fibrillose, milk–white to cream–colored when fresh, later with a yellowish tone, also with a lilac tinge, especially in the center, ocher in age, turning sulfur–yellow when touched, incurved for a long time, joined to the stipe by a membranous veil when young, later projecting beyond the lamellae. Flesh white, slightly gray-lilac in places, thick in the center of the pileus, thin toward the margin, odor like anise, taste mild, pleasantly nutty. Lamellae gray-white when young, remaining pale for a long time, then gray-pink, finally gray-violet to violet-black, narrow, free, edges finely jagged. Stipe 6–12 x 0,7–1 cm, cylindrical, base often bent and clavate to bulbous, also with a marginate bulb, solid to hollow, fragile, surface above the annulus smooth, whitish to faintly pink-violet to gray-violet, surface below whitish and slightly longitudinally fibrillose, strongly yellowing when touched, annulus membranous, pendent, white, upper surface smooth, lower surface coarsely floccose. Spores elliptical, smooth, thick-walled, honey-brown, 5.2–6.7 x 3.8–4.6 μm; Q: 1.3–1.6; purple-brown.

Habitat. In hardwood and coniferous forests, on soil, leaves, or needles.

Distribution. Darhan–Uul aimag, Shariingol sum, Monostoin am, in coniferous forests, 18.08. 2008, Herbarium, UBA/0836.

Agaricus tabularis Pers. 1828

Macroscopic features. Pileus 5–10 cm across, very thick, fat, solid, hemispherical when young, almost outspreaded when old. Pileus edges splited across deeply with very large squama. Flesh whitish, turning yellow when touched. Lamellae narrow, free, white when young, brown when getting old. Stipe thick, 1–3 cm wide, 3–4 cm tall, solid, thick rings. Spores wide elliptical, 7–9 x 6–7.5 μm.

Habitat. Grow in soils of semidesert, desert and steppe

Distribution. Included in Red data book of Mongolia. Hovd aimag, Hovd sum, N 48°50’61,0», E 92°03’17,5’’, in the steppe, 29.07.2011, Herbarium, UBA/1102.

Agaricus xanthodermus Genevier Bull., 1876

Macroscopic features. Pilues 5–8 cm across, hemispherical to trapezoidal when young, surface radially fibrillose when young, later splitting to form radial squamules, gray-brown to gray-ocher margin enrolled for a long time acute. Flesh white barely yellowing when cut tnick odor faintly phenolic sometimes absent taste mild unpleasant. Lamellae gray-pink when young later increasingly puple-brown to purple-black, narrow L=118–

145, I=5–7, free edges smooth. Stipe 5–10 x 1–1.5 cm, cylindrical, base bulbous, at times also somewhat marginate, surface above the annulus white to pale pink and smooth, surface below white and smooth annulus white, membranous, pendent, upper surface smooth, lower surface finely floccose, flesh and surface of the base of the stipestrongly yellowing when rubbed or cut. Spores broadly elliptical, smooth, honey-brown, thick-walled, 4,9–6,5 x 3–4 cm Q:1,5–1,6. Dark purple-browns.

Habitat. Growing scattered or in large groups, sometimes clustered together; in grass and in cultivated areas; occasionally in woods.

Distribution. Dornod aimag, Khalkh gol sum, Ar sumiin hooloi, N 47°16’51,1», E 118°57’20,2’’, h= 900 м, 14.07.2009, Herbarium, UBA/0904.

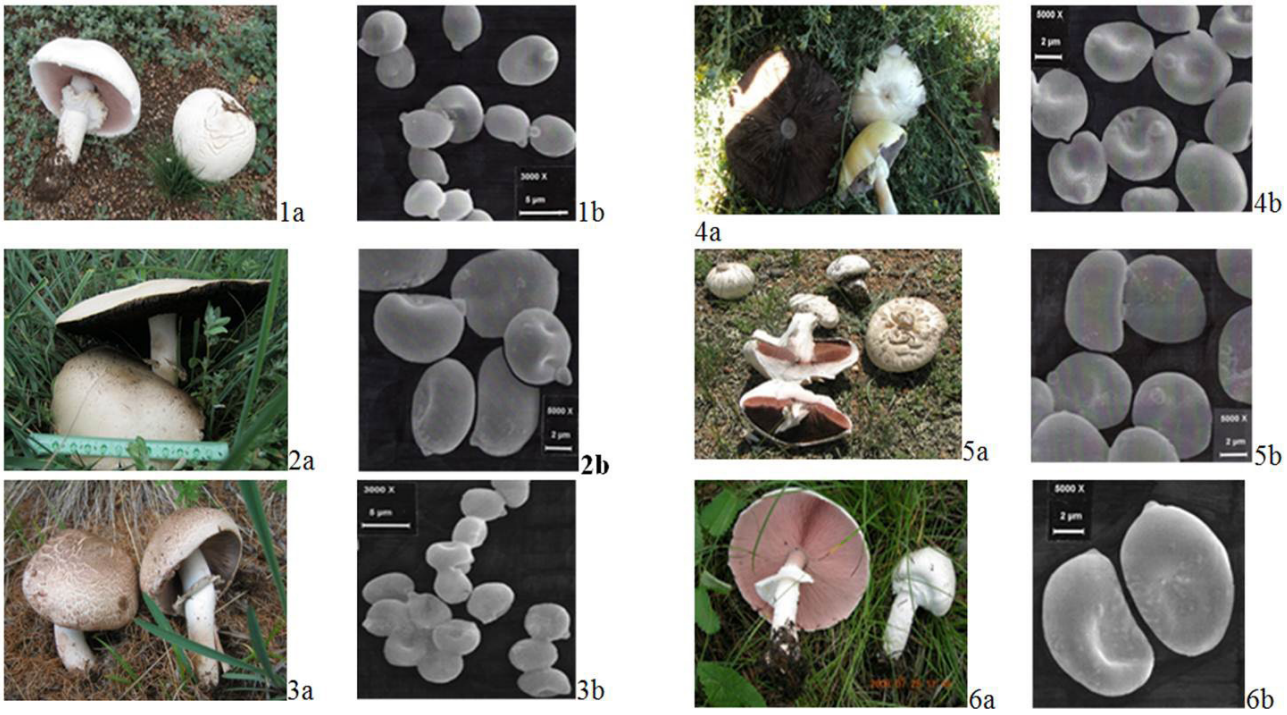

Fig. 1. Basidiomata and scanning electron micrographs of basidiospores. of genus *Agaricus.* 1. *Agaricus arvensis* (1a. basidiomata, 1b. basidiospores, x3000, Bar=2µm) 2. *A. campestris* (2a. basidiomata, 2b. basidiospores, x5000, Bar=2µm) 3. *A. silvaticus* (3a. basidiomata, 3b. basidiospores, x3000, Bar=2µm) 4. *A. silvicola* (4a. basidiomata, 4b. basidiospores, x5000, Bar=2µm) 5. *A. tabularis* (5a. basidiomata, 5b. basidiospores, x5000, Bar=2µm) 6. *A. xanthodermus* (6a. basidiomata, 6b. basidiospores, x5000, Bar=2µm).

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