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## Additional notes on the Lycoperdaceae of the Beartooth Plateau

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**Abstract:** Notes are provided for two taxa of the Lycoperdaceae collected in the alpine zone of the Rocky Mountains, Beartooth Plateau: *Bovista pila* is reported for the first time from this area. The studied material of *Lycoperdon utriforme* fits the concept of *Calvatia hungarica* Hollós. The new combination *Lycoperdon utriforme* var. *hungaricum* is formally introduced.

**Key words:** Alpine fungi, Beartooth Plateau, Lycoperdaceae, *Bovista pila*, *Lycoperdon utriforme* var. *hungaricum*, *Calvatia hungarica*

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**Introduction:** In the summer of 2008 the author participated in the International Symposium on Arctic and Alpine Mycology (ISAM) and collected fungi in the alpine zone of the Beartooth Plateau in the Rocky Mountains,

U.S.A. Most of the collection sites were situated well above the timber line at elevations ranging from 2950 to 3200 m. The vegetation in these sites varies from arctic alpine dwarf shrubs such as *Dryas octopetala* L., *Salix arctica* Pall. and *S.*

*reticulata* L. to shrubs of 1 m high of *Salix glauca* L. and *S. planifolia* Pursh in more sheltered sites. Extensive marshes, some small *Sphagnum* bogs and extensive moss carpets are also present in the area. One site had low shrubs of *Betula nana* L. (= *B. glandulosa* Michx.). The soil is mostly granitic. For more details on the geology and vegetation of the research area see Cripps and Horak (2008). The agarics have been summarized by Cripps and Horak (2008). Until recently no data were available on the Lycoperdaceae occurring in this area. Kasuya (2010, this volume) lists 10 species of the Lycoperdaceae, based on his collections made during ISAM in 2008. Notes are given here on two additional taxa. *Bovista pila* Berk. & Curt., found twice during ISAM 2008, brings the total of known taxa of the Lycoperdaceae from the Beartooth Plateau to 11. Two other collections fit the description of *Calvatia hungarica* Hollós very well. This taxon is treated by most authors at the variety level: *Handkea utrififormis* var. *hungarica* (Hollós) Kreisel. Recent molecular studies (Larsson and Jeppson 2008, Bates et al. 2009) show that *Handkea utrififormis* clusters in the *Lycoperdon* clade making the appropriate name for the species *Lycoperdon utrififorme* Bull.:Pers. *Lycoperdon uriforme* is included in the paper of Kasuya (2010, this volume), but without details on varietal level. The new combination *Lycoperdon utrififorme* var. *hungaricum* is formally introduced.

**Material and Methods:** All macroscopical characters are described from fresh material. Colour codes conform to Kornerup and Wanscher (1978, "Methuen") and Munsell (1988). The microscopic characters were studied in cotton blue lactic acid after gently heating in water with a very small amount of detergent, using a light microscope. Spore measurements were taken at 1000x magnification in cotton blue lactic acid using an ocular micrometer with a 1 µm grid; the subdivision in 10th of µm was estimated. Spore measurements were taken of at least 20 spores

which were randomly selected. Spores that were evidently unripe (with aberrant colour and/or ornamentation) were omitted. The ratio between spore length and width is represented as  $q$ ; the mean of  $q$  as  $Q$ . All collections will be deposited in L.

**Results:** Although only a portion of the Beartooth gasteromycete collections has been studied so far the following species have been identified from the alpine zone: *Bovista pila*, *Bovista plumbea* Pers.:Pers., *Lycoperdon frigidum* Demoulin, *Lycoperdon turneri* Ellis & Everh. and *Lycoperdon utrififorme*. *Calvatia booniana* A.H. Smith was present in the subalpine zone as well. Apart from *B. pila* all these species have been recently reported by Kasuya (2010, this volume). In August 2008 *Lycoperdon frigidum* was the most common gasteromycete found in the area. The descriptions of *Bovista pila* and *Lycoperdon utrififorme* given below are based on the material collected on the Beartooth Plateau.

***Bovista pila*** Berk. & Curt. in Grevillea 2: 49 (1873). (Fig. 1)

Selected synonym: *Bovista montana* Morgan in Journ. Cincinnati Soc. Nat. Hist. 14: 145 (1892).

Gasterocarp globose to subglobose, 28-34 mm high, 30-48 mm wide, slightly constricted and wrinkled at the base, detached from the substrate; opening by a large apical pore (30-35 mm wide) with a frayed edge. Exoperidium completely weathered off. Endoperidium very thin, less than 0.2 mm thick, paper-like, smooth and slightly shiny, light brown (Methuen 5D3-4) to light reddish brown (Methuen 6D3-4) in some specimens with darker stains. Gleba cottony, loosely adhering to the endoperidium, dark reddish brown (Methuen 8F8, Munsell 2,5YR3/2). Subgleba absent.

Spores globose, brown, smooth to faintly punctate (almost smooth), 4.6-5.6  $\mu\text{m}$  including ornamentation (idem. excl.), with a short sterigmatal remnant (0.8-1.5(-1.8)  $\mu\text{m}$  long) with a truncate end; spore ornamentation if present very low, hardly visible at 1000x; no loose sterigmata in gleba. Eucapillitium bovista-type, subelastical (less elastical than usual in bovista-type capillitium), densely and dichotomously branched, up to 19  $\mu\text{m}$  in main branches, 3-5  $\mu\text{m}$  in end branches, dark chestnut brown, not to very weakly cyanophilous, without septa, thick-walled; walls in main branches 2-4  $\mu\text{m}$  thick, in end branches 0.8-1.2(-1.5)  $\mu\text{m}$  thick, lumen 40-60%, with incrustations, without pores; end branches tapering into an acute tip. Paracapillitium absent.



Fig 1. *Bovista pila* A. Gasterocarp (Jalink 7718). B. Capillitium with spores (Jalink 7731).

Material studied: USA. Wyoming, Park County, Wyoming Creek, 45°00.170N 109°40.000 W:

altitude 3080 m, Jalink 7718, leg. L.M. Jalink & exc., ISAM, Aug. 8, 2008 (ecology unknown); altitude 3150 m, Jalink 7731, leg M.M. Nauta & L.M. Jalink, Aug. 8, 2008, in vegetation of short acrocarp mosses.

Remarks: The combination of a bovista-type capillitium, apedicellate spores and the lack of a subgleba are characteristic for *B. pila*. The closely related *B. plumbea* and *B. nigrescens* Pers. differ in having spores with a long pedicel. Both collections from the Beartooth Plateau fit the description of *B. pila* given by Kreisel (1967) very well. The carpophores are relatively small, but still within the ranges given by Smith (1951, 30-90 mm), Bowerman and Groves (1962, 35-65 mm) and Kreisel (1967, 28-60 mm). Kambly & Lee (1936) and Coker and Couch (1928) give larger sizes: 60-90 mm. According to Kreisel (1967) *Bovista pila* is a typical North American species with boreal and montane distribution. There are no published and well documented occurrences outside North America, except for probably Jakutischen ASSR, Asia (Kreisel, 1967). A recent publication of its occurrence in Turkey (Stojchev et al. 1998) gives no macroscopical or microscopical information from which the identification can be verified. Records from Europe are considered doubtful (Kreisel, 2001). The occurrence of *Bovista pila* in Brazil (Baseia, 2005, Trierveiler-Pereira and Baseia, 2009) needs further confirmation. The material from Brazil differs from typical *B. pila* in having a greyish yellow gleba (Methuen 4C3). Yellowish and greenish tinges in the gleba of *Bovista* are an indication of an unripe or not fully matured gleba ("notreif" in the terminology of Kreisel, 1967). The identification of unripe or "notreif" material is unreliable because the characters of capillitium and spores can differ significantly from those found in fully ripe gleba. Kreisel reports specimens of *Bovista nigrescens* with apedicellate spores in "notreif" specimens. There are no known records of *Bovista pila* from (sub-) arctic areas such as Greenland, Iceland or

Svalbard (Lange 1948, 1987, 1998). At least in part of its distribution *Bovista pila* is a common and widely distributed species (Kambly and Lee 1936; Smith, 1951; Ramsey, 2003). The ecology given in literature comprises pastures, pastured woods (Smith 1951) and open woods (Kambly and Lee 1936). It can be concluded that *B. pila* is not a typical arctic alpine species, but instead has a more temperate distribution: boreal to montane. The distribution given by Kreisel (1967) is still accurate, although the southern limit of the distribution is probably in lower longitudes and elevations than reported by him. Its distribution is confined to North America. An excellent illustration is given by Hollós (1904, tab. XXIII fig. 1-2 (gasterocarp, capillitium and spores) as *B. montana*). Other illustrations are given by: Coker and Couch (1928, plate 60 (gasterocarps) and plate 114 fig 9 (basidium) and fig 10-11 (spores)), Smith (1951, plate XXIV fig 1 (gasterocarps)), Kreisel (1967, fig. 25 c-d (capillitium), fig 27 u (spore), fig 37 (distribution map)) and Bessette et al. (1997, page 458 (gasterocarps)).

***Lycoperdon utriforme* var. *hungaricum***  
(Hollós) Jalink comb. nov. (Fig. 2, 3)

Mycobank Number 518729

Basionym: *Calvatia hungarica* Hollós in Matematikai és természettudományi értesítő 19, p. 510 (1901).

Synonyms: *Handkea utriformis* var. *hungarica* (Hollós) Kreisel in Nova Hedwigia 48(3-4): 289 (1989); *Calvatia caelata* var. *hungarica* (Hollós) F. Smarda in Pilat (red.) Flora CSR Gasteromycetes, page 285 (1958).

Gasterocarp turbinate, 45 mm high, 52-70 mm wide, constricted and furrowed near base, attached to the soil; surface smooth in lower half, areolate on top, pale brown, opening by disintegration of the peridial wall around the

gleba; peridium moderately tough. Exoperidium 1 mm thick, pale brown, rhomboid areolate. Endoperidium very thin, dull brown with a silverish hue, papery. Gleba powdery, adhering to endoperidium and subgleba, dark brown (Methuen 5F6, Munsell 10YR 3/4); pseudocolumella absent. Subgleba present, 18 mm high, 42-65 mm wide, vinaceous brown, in Jalink 7654 yellowish in lower part, lacunar (1.5-2 cells/mm); pseudodiaphragma present.

Spores subglobose to ellipsoid or ovoid, rarely globose,  $q = 1.00-1.15$  ( $Q=1.05$ ), yellowish brown *sub micr.* in water, smooth to faintly punctate, 4.7-5.6 x 4.5-5.5  $\mu\text{m}$  incl. ornamentation (mean: 5.1-5.2x4.9-5.0), idem excl. ornamentation; sterigmal remnant short (0.5-1 $\mu\text{m}$ ); spore ornamentation absent to almost absent; no sterigmal debris in gleba. Eucapillitium handkea-type, very fragile, breaking into short fragments (80-150  $\mu\text{m}$  long), 3.5-7  $\mu\text{m}$  in diameter, brown *sub micr.* in water, cyanophilous, thin to slightly thick walled (0.3-0.6  $\mu\text{m}$ ), lumen 70-80%, without incrustations or with some incrusting debris, with numerous variable pores and slits, without septa, branching rare; slits occasionally furcate in top view. Paracapillitium absent.

Ecology: between mosses, a.o. *Polytrichum*.

Material studied: USA. Colorado, Carbon County: Quad Creek, 45°01.444'N 109°24.468'W, altitude 3010 m, Jalink 7654, leg. L.M. Jalink, Aug. 4, 2008; Highline Trailhead, 45°00'N 109°24'W, altitude 3080 m, Jalink 7665, leg L.M. Jalink, Aug. 5, 2008.

Remarks: The handkea-type capillitium and the almost smooth spores are characteristic for *Lycoperdon utriforme*. The term handkea-type capillitium has been introduced by Kreisel (1998) for fragile lycoperdon-type capillitium with long slit like pores and rare septa. Both collections from the Beartooth Plateau fit the concept of

*Calvatia hungarica* well. Hollós (1901, 1904a, 1904b) described *Calvatia hungarica* as a species very close to *Calvatia caelata* (= *Lycoperdon utriforme*). *Calvatia hungarica* is characterized by depressed fruiting bodies with smaller subgleba and more slender capillitium than in *Lycoperdon utriforme*. Hollós (1904b) concludes with the remark that based on research of his material he thinks *Calvatia hungarica* is not a true species but a variety of *C. caelata*. Smarda (in Pilat 1958) is the first to treat *C. hungarica* formally at varietal level when he recombines it into *Calvatia caelata*. The combination *Calvatia bovista* var. *hungarica* (Hollós) Smarda ex Zeller & Smith (1964) is invalid since no full and direct reference is given to the basionym (ICBN 2006 art, 32.5 and 33.4). The same applies to the combination *Calvatia utriformis* var. *hungaricum* (Hollós) F. Smarda ex Calonge



Fig 2. *Lycoperdon utriforme* var. *hungaricum*. A. Mature gasterocarp (Jalink 7654). B. Old gasterocarp (Jalink 7665).

(1998). In 1989 Kreisel recombined the taxon into his newly defined genus *Handkea*: *Handkea*



Fig 3. *Lycoperdon utriforme* var. *hungaricum*. Capillitium and spores (Jalink 7665).

*utriformis* var. *hungarica* (Hollós) Kreisel. The results of molecular analysis (Bates 2004, Larsson and Jeppson 2008, Bates et al. 2009) show that the genus concepts in the Lycoperdaceae need revision and that *Handkea utriformis* clusters well in the *Lycoperdon* clade. The appropriate name for *Handkea utriformis* is *Lycoperdon utriforme* Bull.: Pers. Since *Calvatia hungarica* has not yet been recombined into *Lycoperdon utriforme*, the new combination *Lycoperdon utriforme* var. *hungaricum* is formally introduced.

*Lycoperdon utriforme* is widespread in North America. *Lycoperdon utriforme* var. *hungaricum* has been reported from Wyoming and Colorado as *Calvatia bovista* var. *hungarica* and from Utah as *Calvatia tatrensis* var. *tatrensis* (Zeller & Smith, 1964). According to Kreisel (1989) *Lycoperdon utriforme* var. *hungaricum* is found in open grasslands, mainly in the mountains. It probably has a preference for regions with a continental climate. *Lycoperdon utriforme* has not been reported from true arctic areas, but it is known from lowland locations in Iceland (Lange, 1948, 1990).

Illustrations of *Lycoperdon utriforme* var. *hungaricum* are almost nonexistent. Hollós

(1904b) gives a gasterocarp (plate XIV fig 11), a transverse section of a gasterocarp showing gleba and subgleba (plate XIV fig 12) and capillitium and spores (plate XIV fig 13) of *Calvatia hungarica*.

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