

## Lepiotaceous fungi in California, U.S.A. – 4. Type studies of *Lepiota fumosifolia* and *L. petasiformis*

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**Abstract** – The type collections of *Lepiota fumosifolia* and *L. petasiformis* were studied. *Lepiota fumosifolia* has cheilocystidia and abundant pleurocystidia with yellow contents and exudates; spores are smooth, clamp connections present and velar cells globose. This is an older name for *Cystolepiota cystidiosa*, *C. luteicystidiata* and *L. lycoperdoides*. *Lepiota petasiformis* is characterized by rough spores, absence of cystidia and clamp connections, and elongate velar cells. *Cystolepiota pulverulenta* is morphologically identical, and synonymized with it. Three new combinations are made in the genus *Cystolepiota*, viz. *C. fumosifolia*, *C. oregonensis*, and *C. petasiformis*. A key is provided for all *Cystolepiota* species recorded from western North America.

**Key words** – *Agaricaceae*, biodiversity

### Introduction

In an ongoing effort to inventory, describe and catalogue the lepiotaceous fungi (white spored agaricoid members of the family *Agaricaceae*) in California, the type collections of *Lepiota fumosifolia* and *L. petasiformis*, two species with a granular-mealy pileus covering, described from Washington by Murrill (1912), were studied. Both species turn out to belong to *Cystolepiota*, new combinations are made, and their position is discussed. The occurrence of these species in California is confirmed. To facilitate their recognition, a key is provided for the identification of *Cystolepiota* species in western North America.

### Methods

Standard methods for microscopic observations were used; material was revived in Congo red in ammonia; Melzer's reagent and Cresyl blue were used to study reactions of the spore walls. Terminology follows Vellinga (2001). The following notations and abbreviations are used: [15,1,1] indicates that measurements were made on 15 spores in one sample from one collection; avl stands for average length, avw for average width, Q for quotient of length and width and avQ for average quotient.

## Taxonomic descriptions

*Cystolepiota fumosifolia* (Murrill) Vellinga, comb. nov.

Figures 1-2

MYCOBANK MB 510370

Basionym: *Lepiota fumosifolia* Murrill, Mycologia 4: 233. 1912.*Lepiota cystidiosa* A.H. Sm., Papers Mich. Acad. Sci., Arts Letters 27: 58. ('1941')1942;*Cystolepiota cystidiosa* (A.H. Sm.) Bon, Doc. mycol. 11 (43): 26. 1981.*Lepiota luteicystidiata* D.A. Reid, Nova Hedwigia 13, Suppl. (Fung. rar. Ic. col. 2): 9.1967; *Cystolepiota luteicystidiata* (D.A. Reid) Bon, Doc. mycol. 6 (24): 43. 1976.*Lepiota lycoperdoides* Kreisel, Wiss. Z. Ernst Moritz Arndt-Univ. Greifswald 16: 238.1967; *Cystolepiota luteicystidiata* var. *lycoperdoides* (Kreisel) Bon, Doc. mycol. 11 (43): 26. 1981.

Murrill (1912 ): "Pileus convex, not umbonate, gregarious, 3 cm. broad; surface dry, white with isabelline, granular scales, the center isabelline; lamellae free, broad, rather crowded, white, becoming fumous on drying; spores oblong-fusiform, smooth, hyaline, 12 x 7  $\mu$ ; stipe equal or tapering upward, cylindric, smooth, white, furfuraceous, pale-avellaneous below, 6 cm. long, 6 mm. thick; veil soon breaking into fragments which cling to the margin and stipe.

"Type collected on the ground in woods near Seattle, Washington, October 20-November 1, 1911, W.A. Murrill 229."

## Type study

**Basidiospores** [20,1,1] in side view 4.9-5.7 x 2.6-3.1  $\mu$ m, avl x avw = 5.2 x 2.9  $\mu$ m, Q = 1.6-2.0, avQ = 1.8, oblong with flattened adaxial side, in frontal view oblong or obovoid, often in tetrads, non-dextrinoid, non-amyloid, metachromatic in Cresyl blue, smooth. **Basidia** 4-spored. **Lamella edge** sterile, set with cheilocystidia. Individual cheilocystidia hard to recover; cheilocystidia narrowly clavate with separate capitulum, with yellow contents and yellow exudates. **Pleurocystidia** numerous, about 25  $\mu$ m apart from each other, easily recognizable because of the yellow exudate which turns red in Congo red, most numerous close to lamella edge, similar in shape to cheilocystidia, but individual cystidia not recovered. **Pileus covering** made up of loosely arranged globose and ellipsoid cells, 25-60 x 25-40  $\mu$ m, with brown walls. **Clamp connections** present.

COLLECTIONS EXAMINED (the above description is based on the type only) –U.S.A., WASHINGTON, NEAR SEATTLE, X.20-XI.1, 1911, W.A. Murrill 229 (holotype, NY).

CALIFORNIA, Humboldt Co., HUMBOLDT REDWOODS STATE PARK, SOUTH OF WEOTT, 12.XI.2004, E.C. Vellinga 3278 (UC; Genbank nrITS EF121817).

Comments – *Lepiota fumosifolia* is transferred to the genus *Cystolepiota* on account of its pileus covering made up of loosely arranged globose cells, and the small, non-dextrinoid spores.

Most striking in this species is the abundance of cystidia, on the edge and the sides of the lamellae. The pleurocystidia stand out as dark red dots in Congo red. The yellow exudate and contents are visible when viewed in ammonia. As

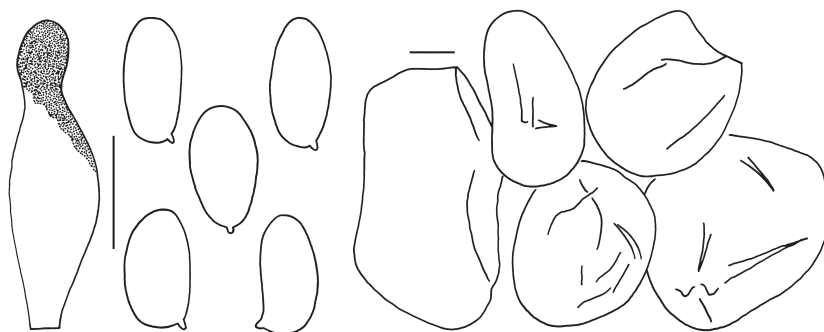


Fig. 1: *Cystolepiota fumosifolia* – spores, cheilocystidium, pileus covering elements. Scale bar is 5  $\mu\text{m}$  (spores) or 10  $\mu\text{m}$  (cystidium, pileus covering elements). All from holotype.

Smith (1966) also pointed out, the spores are not  $12 \times 7 \mu\text{m}$  and fusoid, as stated by Murrill (1912), but much smaller and oblong.

*Cystolepiota cystidiosa*, described from Michigan (Smith 1942) is identical, in macroscopical and microscopical characters and is placed in the synonymy of *L. fumosifolia*.

A discussion and comparison of the type collections of *C. cystidiosa*, *L. lycoperdoides* and *C. luteicystidiata* was given by Vellinga & Huijser (1998).

Murrill (1912) indicated the macroscopical differences between *C. fumosifolia* and *C. petasiformis*. The pileus of *C. fumosifolia* is convex, whereas in *C. petasiformis* it is often conical because of the copious velum cells. The lamellae of *C. fumosifolia* turn a smoky colour on drying, a feature also described by Vellinga & Huijser (1998) for European material of this species (as *C. cystidiosa*), whereas the lamellae of dried specimens of *C. petasiformis* are cream coloured.

Microscopically, the differences are more conspicuous: abundant cheilocystidia and pleurocystidia in *C. fumosifolia*, none in *C. petasiformis*; globose velar cells on the pileus in *C. fumosifolia*, and elongate, irregularly-shaped cells in *C. petasiformis*; and smooth spores in *C. fumosifolia*, versus rough, finely warted spores in *C. petasiformis*.

*Cystolepiota fumosifolia* appears to be rare in the Pacific states of North America. The present author has seen the species once, in the redwood forests of northern California (see collections examined).

*Lepiota oregonensis* can be confused with *C. fumosifolia*. It is a smaller species, with rusty-brown discoloration, without pleurocystidia. The cheilocystidia and spores are of the same size and shape as those in *C. fumosifolia*. *Lepiota oregonensis* comes very close to the European species *C. hetieri* (Boud.) Singer, the only difference being the presence of pleurocystidia (at least close to the

lamella edge) in *C. hetieri*, and the absence of pleurocystidia in *L. oregonensis*. Smith (in Smith & Sundberg 1979) noted that clamp connections are also absent; however, study of the type specimen revealed that they are present, as in all *Cystolepiota* species with globose velar cells (pers. obs.). The new combination *Cystolepiota oregonensis* (H.V. Sm.) Vellinga (MYCOBANK MB 510371; basionym *Lepiota oregonensis* H.V. Sm. in Mycotaxon 8: 449. 1979) is here proposed.

This species has not been found in California yet, but is known from several places in western Oregon and Washington.

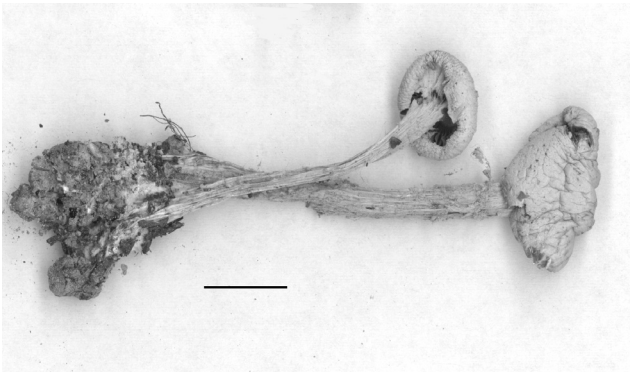


Fig. 2: *Cystolepiota fumosifolia* – dried specimens of collection ecv3278. Compare with the scan of the type collection conserved at NY, at the web site <http://207.156.243.8/emuwebnybg/pages/common/imagedisplay.php?irn=103199> (accessed on 13 November 2006).

***Cystolepiota petasiformis* (Murrill) Vellinga, comb.nov.**

Figure 3

MYCOBANK MB 510372

Basionym: *Lepiota petasiformis* Murrill, Mycologia 4: 232. 1912.

*Lepiota pulverulenta* Huijsman, Persoonia 1: 328. 1960; *Leucoagaricus pulverulentus* (Huijsman) Bon, Doc. mycol. 8 (30-31): 70. 1978; *Leucoagaricus pulverulentus* (Huijsman) M.M. Moser, Röhrlinge-Blätterpilze, 4. Aufl.: 246. 1978; *Cystolepiota pulverulenta* (Huijsman) Vellinga, Persoonia 14: 407. 1992; *Pulverolepiota pulverulenta* (Huijsman) Bon, Doc. mycol. 22 (88): 30. 1993.

*Leucoagaricus pulverulentus* f. *minimus* Bon, Migl. & Brunori, Doc. mycol. 19 (75): 54. 1989; *Pulverolepiota pulverulenta* f. *minima* (Bon, Migl. & Brunori) Bon, Doc. mycol. 22 (88): 30. 1993; *Cystolepiota pulverulenta* f. *minima* (Bon, Migl. & Brunori) La Chiusa, Riv. Micol. 41: 152. 1998.

Murrill (1912): “Pileus thin, hat-shaped, with prominent conic umbo, scattered or gregarious, 1.5-2.5 cm. broad; surface dry, rosy-isabelline, or about the color of the back of the hand, covered with an abundance of fine powder; lamellae free, subdistant, rather broad, white; spores ellipsoid, smooth, hyaline, minute, 3.5 x 2 µ; stipe slender, tapering upward, clothed with powder like the pileus, reaching 5 cm. long and 2-3 mm. thick; veil fugacious, not forming an annulus.

“Type collected in humus in woods near Seattle, Washington, October 20-November 1, 1911, W.A. Murrill 629. Also collected in the same region, Zeller 119. It suggests some forms of *L. cretacea*.”

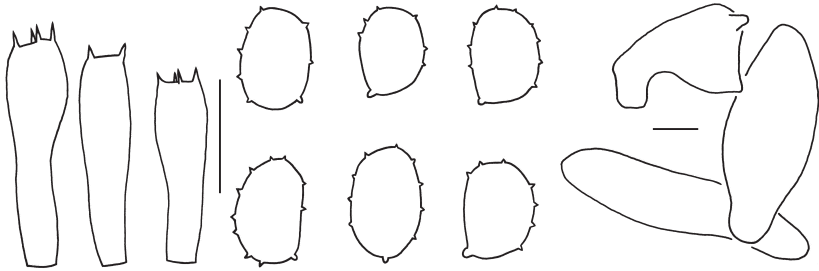


Fig. 3: *Cystolepiota petasiformis* – spores, basidium, pileus covering elements. Scale bar is 5  $\mu\text{m}$  (spores) or 10  $\mu\text{m}$  (basidia, pileus covering elements). All from holotype.

### Type study

**Basidiospores** [20,1,1] in side view 3.9-5.4 x 2.6-3.2  $\mu\text{m}$ , avl x avw = 4.7 x 2.8  $\mu\text{m}$ , Q = 1.6-1.85, avQ = 1.66, oblong with flattened adaxial side, in frontal view oblong, congophilous, not dextrinoid, and metachromatic in Cresyl Blue, with small warts or spines. **Basidia** 14-21 x 5-6  $\mu\text{m}$ , 4-spored, without clamp connection at base. **Lamella edge** fertile; **cheilocystidia** absent. **Pleurocystidia** absent. **Pileus covering** made up of loosely arranged irregular, oblong and some subglobose cells, around 22-70 x 8-22  $\mu\text{m}$ , with pale brown walls, hard to recover. **Clamp connections** absent.

COLLECTIONS EXAMINED (the above description is based on the type only) – U.S.A., WASHINGTON, NEAR SEATTLE, X.20-XI.1, 1911, W.A. Murrill 629 (holotype, NY); Clallam Co., JOYCE, 11.X.1935, A.H. Smith 3104 (MICH); OLYMPIC NATIONAL PARK, WALL CREEK, 29.IX.1941, D.E. Stuntz (coll. A.H. Smith 17388) (MICH).

OREGON, MT. HOOD, 24.IX.1922, C.H. Kauffman (MICH).

CALIFORNIA, San Mateo Co., SAN FRANCISCO WATERSHED, 8.XII.2000, E.C. Vellinga 2572 (UC; genbank nrITS AF391035); *ibidem*, 23.XII.2002, E.C. Vellinga 2968 (UC); *ibidem*, 28.I.2003, E.C. Vellinga 3017 (UC); *ibidem*, 25.II.2003, E.C. Vellinga 3048 (UC); Humboldt Co., HUMBOLDT REDWOODS STATE PARK, SOUTH OF WEOTT, 8.XI.2004 (UC); Marin Co., POINT REYES, BEAR VALLEY TRAIL, 26.XI.2004, E.C. Vellinga 3322 (UC); MT TAMALPAIS, BOLINAS-FAIRFAX ROAD, 15.XI.2005, E.C. Vellinga 3373 (UC).

Comments – *Cystolepiota petasiformis* is easily recognized because of the copious velum on the basidiocarps often forming a conical top on the pileus, the slightly rough spores, and the absence of cystidia and clamp connections. The roughness of the spores in this species has not been noted before, though with a good 100x objective it is easily discernible.

Spores from the Kauffman collection from Mt Hood in Oregon, are a bit longer than those of the type: [11,1,1] 5.1-6.0 x 2.7-3.1  $\mu\text{m}$ ,  $\text{avl} \times \text{avw} = 5.5 \times 3.0$   $\mu\text{m}$ ,  $Q = 1.7-2.0$ ,  $\text{av}Q = 1.87$ , but other characters are in agreement with those for *C. petasiformis*.

*Lepiota petasiformis* is transferred to *Cystolepiota* here. Singer (1975, 1986) listed *L. petasiformis* (as *L. petasitiformis*) as "obviously" belonging to *Cystolepiota*, but he did not propose a new name for them, neither did he cite the basionym. Though there are some morphological differences (e.g. *Cystolepiota* species have clamp connections and smooth spores), in other respects it fits well into the genus. In analyses based on molecular characters (Vellinga 2003, 2004) monophyly of *Cystolepiota* including *C. petasiformis*, is acceptable, but further research on this group and its relationships with *Lepiota* sect. *Echinatae* and the genus *Melanophyllum* are needed.

*Cystolepiota pulverulenta* is tentatively placed in the synonymy of *C. petasiformis*, to which it is morphologically very similar. It should be noted that Huijsman (1960) did not notice the roughness of the spores of *L. pulverulenta*. The present author does not know how to distinguish the two morphologically, but the nrITS sequences of two collections, representative of the taxa in western North America and in Europe, contain eight differences. These collections are sister taxa forming a monophyletic group in the sample studied (Vellinga 2003). It is not known whether the type collection from Washington has the same nrITS sequence as the Californian collection.

Vellinga (1992, 2003) discussed the generic placement of this species or species complex. The species has been accommodated in *Lepiota* (Huijsman 1960), *Leucoagaricus* (Bon 1978), *Cystolepiota* (Vellinga 1992) and its own genus *Pulverolepiota* (Bon 1993).

*Cystolepiota petasiformis* is rare in California, but has been found scattered throughout the western part of the state, in Monterey cypress, and coastal Redwood forests (see under 'Collections examined'). Sieger (2003) included it in his key but noted that he has never seen the species in Washington.

### Key to the *Cystolepiota* species in western North America

1. Stipe and pileus with lilac and violaceous tinges; smell strong, of coal gas (indole), like the smell of *Tricholoma sulphureum* (Bull. : Fr.) P. Kumm. and *T. inamoenum* (Fr. : Fr.) Gillet ..... *C. bucknallii*<sup>1</sup>
1. Stipe and pileus pinkish, white, or whitish and often discolouring with age, without lilac or violaceous tinges, and not smelling of coal gas, but of *Lepiota cristata* (Bolton : Fr.) P. Kumm.

<sup>1</sup> *Cystolepiota bucknallii* (Berk. & Broome) Singer & Cléménçon is rare in the Pacific Northwest (Sieger 2003), and has not yet been found in California.

2. Pileus covering copious, made up of elongate inflated irregular cells; basidiospores rough; clamp connections absent ..... *C. petasiformis*
2. Pileus covering made up of globose cells; basidiospores smooth; clamp connections present
  3. Basidiocarps slender; pileus small (about 1 cm, rarely up to 2 cm) and white; stipe vinaceous, especially at base; cheilocystidia absent ..... *C. seminuda*<sup>2</sup>
  3. Basidiocarps slender to quite robust, with pink pileus, or starting out white and discolouring isabelline to rust-brown; cheilocystidia present
  4. Pileus covered with small pink granulose warts, which do not change colour ..... *C. moelleri*<sup>3</sup>
  4. Pileus covered in white or whitish floccose granular velum, changing colour with age to isabelline or rusty brown
    5. Basidiocarp with age with isabelline colours; pleurocystidia abundant over entire surface of lamellae; pleurocystidia and cheilocystidia with yellow contents and exudates ..... *C. fumosifolia*
    5. Basidiocarp with rusty brown colours with age; pleurocystidia absent; some yellow contents or exudates can be present in cheilocystidia .. *C. oregonensis*

### Acknowledgements

Curators of the herbaria NY and MICH are acknowledged for the loan of type material and other collections. The Mycological Society of America's A.H. and H.V. Smith Award enabled me to visit the herbarium of the University of Michigan at Ann Arbor, and see the specimens in situ. The San Francisco Public Utilities Commission granted permission to inventory the cypress groves of the San Francisco watershed area (west of Crystal Spring Reservoir). Christian Lange and Ana Esperanza Franco Molano gave much appreciated comments on an earlier version. Partial funding by NSF grant DEB 0618293 is gratefully acknowledged.

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<sup>2</sup> *Cystolepiota seminuda* (Lasch) Bon is the most common *Cystolepiota* species in the area, and can be found in various forest types.

<sup>3</sup> *Cystolepiota moelleri* Knudsen is known from the state of Washington (Birkebak, pers. comm.).

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