Mycoscience (2012) 53:139–143
DOI 10.1007/s10267-011-0142-3

SHORT COMMUNICATION

Baeospora occidentalis, a new snowbank agaric from western North America

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Received: 18 July 2010 / Accepted: 14 July 2011 / Published online: 3 August 2011

Abstract *Baeospora occidentalis* is described as a new species associated with melting snow in montane coniferous forests of the western USA. The species is spring-fruiting and is characterized by a long tapering pseudorhiza covered with white basal rhizomorphs which extends deeply into the needle litter or woody debris. It possesses a multiallelic, tetrapolar mating system. Monokaryotic mycelia produce arthroconidia.

Keywords *Baeospora myosura* · Ecology · Litter decomposition · Systematics

During field work in montane regions in the western USA, an agaric was commonly encountered on needle litter and woody debris of conifers beside melting snow. Further examination of the specimens revealed that they fit the description of *Baeospora* Singer (1938), a small genus of the Tricholomataceae.

Species within this genus are characterized by their collybioid basidiomata, small hyaline, smooth, amyloid basidiospores, the frequent presence of pseudorhizae, clamp connections on the hyphae, and their saprotrophic nature on woody debris. As conceived originally by Singer (1938), the genus contained four species [*B. familia* (Peck) Singer, *B. myosura* (Fr.) Singer, *B. myriadophylla* (Peck) Singer, and *B. oligophylla* Singer], but Singer (1943, 1961) later felt that the genus concept was too broad and excluded species with amyloid tissue [*Pseudobaeospora oligophylla* (Singer) Singer] and those that possessed pileocystidia [*Clitocybula familia* (Peck) Singer].

Singer (1986) recognized six species, two of which were temperate (*B. myosura*, *B. myriadophylla*) and four of which were tropical [*B. brunneipes* (Singer) Singer, *B. pallida* Singer, *B. pleurotoides* (Dennis) Singer, *B. pruinatipes* (Singer) Singer]. Singer (1989) subsequently described an additional species from Brazil, *B. mundula* Singer, while Corner (1994) described four new species from Malesia, namely, *B. cristobalensis* Corner, *B. curtipes* Corner, *B. rubrinigrescens* Corner, and *B. violaceifolia* Corner. Maas Geesteranus and Horak (1995) recently described *B. stenophylla* Maas Geest. & E. Horak from Papua New Guinea.

To date, of the 12 species of *Baeospora* known, ten are tropical. The two temperate species, *B. myosura* and *B. myriadophylla*, are widely distributed and well known to field mycologists (e.g., Lincoff 1981; Moser 1983; Breitenbach and Kränzlin 1991; Bessette et al. 1997). As our collections differ morphologically and ecologically from these two taxa, we therefore propose a new species of *Baeospora* occurring in western North America.

Color terminology for freshly collected basidiomata was derived from Kornerup and Wanscher (1978). Material from the collections was studied using light microscopy, with observations being made on tissue of the basidiomata mounted in either Melzer's reagent (Malloch 1981) or 1% (w/v) phloxine. Measurements were taken from tissue mounted in Melzer's reagent.

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Monokaryotic cultures were derived from two separate collections of *Baeospora occidentalis* (Pomerelle Ski Area, Sawtooth National Forest, Cassia Co., ID; Wasatch-Cache National Forest, Rich Co., UT) using basidiospore suspensions diluted in sterile distilled H_2O and spread onto 2% (w/v) malt extract agar for germination. Monokaryotic cultures lacking clamp connections were selected from among the colonies initiated by spore germination and maintained on 2% (w/v) malt extract agar. The mating-types of the monokaryons from each *B. occidentalis* collection were determined by pairing ten randomly selected monokaryons in all possible combinations and looking for clamp formation when sexually compatible strains contacted one another. Based upon the compatible pairings, four monokaryotic tester strains (one from each mating-type) were chosen from each collection of *B. occidentalis* for use in compatibility tests with one another. To determine whether the mating system of *B. occidentalis* is multiallelic, the four tester strains from each collection were paired with one another in all combinations.

Baeospora occidentalis L.J. Hutchison & Kropp, sp. nov. Figs. 1–17

Pileus (7–)12–24(–49) mm latus, planus vel convexus, leviter vel manifeste umbonatus, siccus et glaber, brunneus vel badius, hygrophanus, demum bubalinus. Lamellae confertae, albidae, adnatae, adnexae vel sinuatae, acie integrae. Stipes 10–20(–30) mm longus, 1.5–4 mm crassus, aequalis, ad apicem pruinosus et albidus, basim versus leviter tomentosus et bubalinus. Pseudorhiza 20–40(–70) mm longa, 1.5–3 mm crassa, profunde radicata, gradatim decrescens, rhizomorphis filiformibus albidis numerosis. Basidia 14–20 × 3.5–4(–5) μm, breviter cylindrica vel clavata. Sporae 4–5(–6) × (2–)2.5–3 μm, hyalinae, ellipsoideae vel ovatae, laeves, amyloideae. Cheilocystidia 20–40(–50) × 5–9(–12) μm, numerosa, variabilia, clavata, navicularia, lageniformia vel aliquanto capitata. Pleurocystidia rara.

Holotype: USA., Idaho, Cassia County, Sawtooth National Forest, Pomerelle Ski Area. Gregarious on well-rotted conifer wood and needle litter near melting snow in *Abies lasiocarpa* (Hook.) Nutt.–*Picea engelmannii* Parry ex Engelm. forest, 31 May 2002, B. R. Kropp and L. J. Hutchison (DAOM 234428).

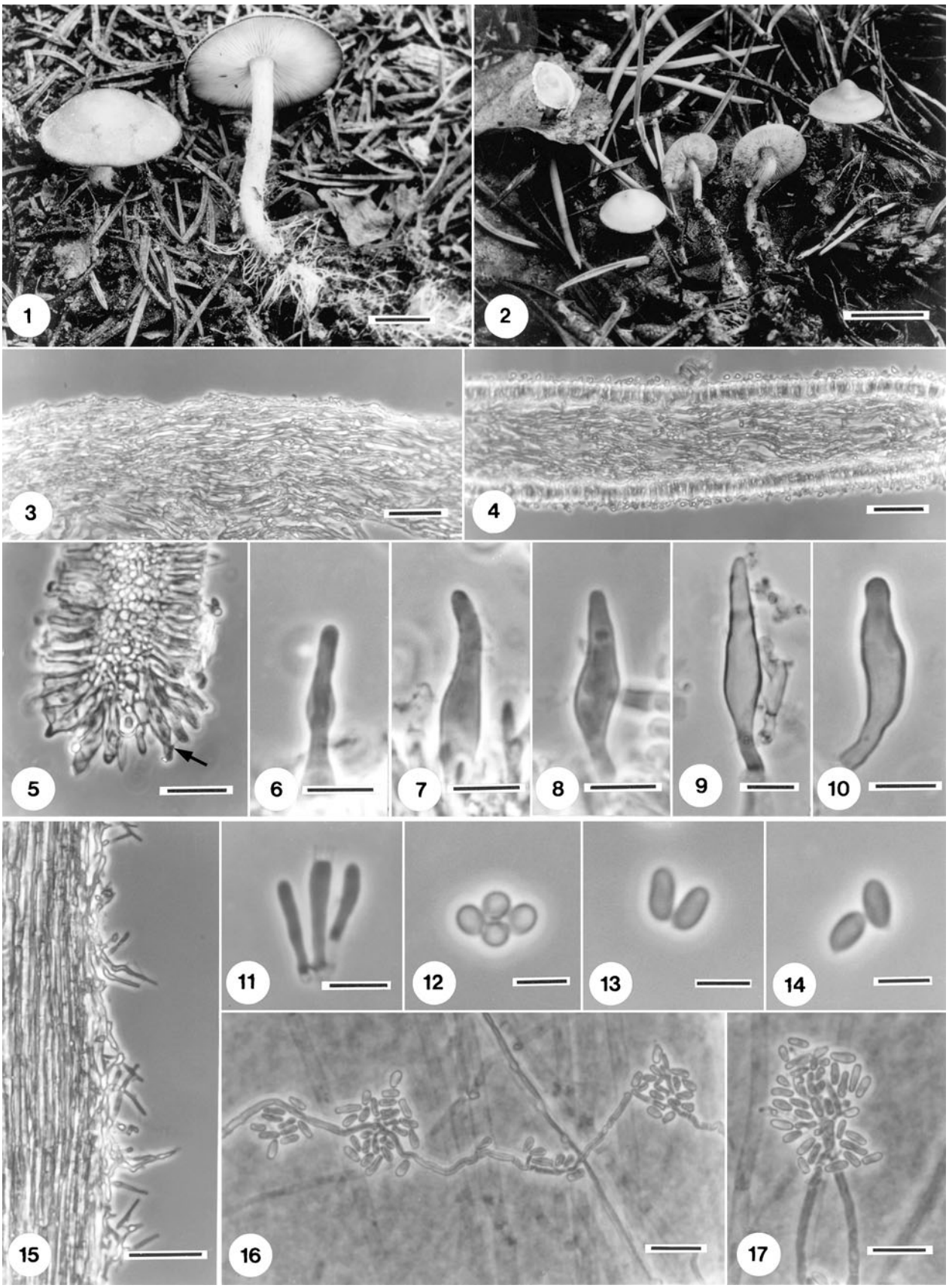
Etymology: *occidentalis*, pertaining to the western range of the taxon in North America.

Basidiomata collybioid. Pileus (7–)12–24(–49) mm in diameter; plane to convex with a slight to prominent umbo; dry, glabrous; dark brown to dark-reddish brown (7F5–8F8) at first, hygrophanous and becoming buff to grayish-orange (6B4); margin sometimes faintly striate

Figs. 1–17 *Baeospora occidentalis*. **Figs. 1**, **2** Basidiomata: **1** UTC 239648, **2** UTC 239649. **Fig. 3** Cross-section of pileipellis showing repent hyphae (DAOM 234425). **Fig. 4** Longitudinal section of a lamella showing arrangement of tramal tissue (DAOM 234425). **Fig. 5** Cross-section of lamellar edge showing cheilocystidia (DAOM 234426). **Figs. 6–10** Cheilocystidia: **6** DAOM 234428, **7–10** DAOM 234426. **Fig. 11** Basidium (DAOM 234428). **Figs. 12–14** Basidiospores: **12** four immature basidiospores (DAOM 234425), **13**, **14** DAOM 234425. **Fig. 15** Caulocystidia (DAOM 234428). **Figs. 16**, **17** Arthroconidia. *Bars* (**1**, **2**) 1 cm; (**3**, **4**, **15**) 50 μm; (**5**) 20 μm; (**6–11**, **16**, **17**) 10 μm; (**12–14**) 5 μm

when moist. Lamellae 1–3 mm wide, narrow (30–80 μm), crowded; white; adnate, adnexed, or sinuate; margins entire. Stipe 10–20(–30) × 1.5–4 mm; central; equal; solid, hollow or stuffed; apex pruinose and whitish becoming lightly tomentose and buff near base. Pseudorhiza 20–40(–70) × 1.5–3 mm, deeply radicating, tapered, covered with dense whitish rhizomorphs and adhering particles of soil and woody debris, usually attached to buried woody material. Odor fungoid or lacking. Taste mild. Basidiospores 4–5(–6) × (2–)2.5–3 μm; hyaline, smooth, weakly amyloid, ellipsoid but sometimes oval; spore print white. Basidia 14–20 × 3.5–4(–5) μm, short-cylindrical to clavate with clamp connection, with four sterigmata 2–3 μm long. Cheilocystidia 20–40(–50) × 5–9(–12) μm; abundant; thin-walled; variable in shape (clavate, fusoid, lanceolate, utriform, lageniform, bottle-shaped, slightly capitate, rarely bifurcate), with clamp connection. Pleurocystidia rare. Caulocystidia 30–75 × 4–6 μm; covering surface of stipe, single or scattered in clusters; variable in shape (cylindrical, clavate, fusoid, or tapering). Pileipellis of compact, clamped, repent, parallel hyphae with an occasional upright hypha on surface; subpellis composed of looser and wider hyphae which are parallel to interwoven. Lamellar trama parallel to interwoven; subhymenium thin, tightly compacted. Arthroconidia 4–8 × 2–3 μm; produced on short pegs in clusters along length of monokaryotic hyphae; variable in shape (pyriform, cylindrical, oval, ellipsoid, clavate, reniform, allantoid).

Additional specimens examined: USA. Nevada, Elko County, Humboldt National Forest, Ruby Mountain Scenic Area, gregarious to scattered in deep needle litter and debris under *Pinus flexilis* James near melting snow, 6 June 2004, B. R. Kropp and L. J. Hutchison (DAOM 234426); USA, Utah, Cache County, Wasatch-Cache National Forest, Beaver Mountain Ski Area, in litter under *Populus tremuloides* Michx., *Pinus contorta* Douglas ex Louden and *A. lasiocarpa*, 26 May 1996, B. R. Kropp and L. J. Hutchison (UTC 239649); USA, Utah, Rich County, Wasatch-Cache National Forest, in litter near melting snow in *A. lasiocarpa–P. engelmannii* forest, 3 June 2000, B. R. Kropp (UTC 239647); USA, Utah, Cache County, Wasatch-Cache National Forest, Beaver Mountain Ski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Area, in litter near melting snow in *A. lasiocarpa–P. engelmannii* forest, 25 May 2001, B. R. Kropp (UTC 239646); USA, Utah, Cache County, Wasatch-Cache National Forest, Beaver Mountain Ski Area, in litter near melting snow with *Populus tremuloides, A. lasiocarpa*, and *P. engelmannii*, 1 June 2001, B. R. Kropp (UTC 239644); USA, Utah, Cache County, Wasatch-Cache National Forest, Beaver Mountain Ski Area, in litter near melting snow in *A. lasiocarpa–P. engelmanii* forest, 1 June 2001, B. R. Kropp (UTC 239645); USA, Utah, Cache County, Wasatch-Cache National Forest, Beaver Mountain Ski Area, in litter near melting snow in *A. lasiocarpa–P. engelmannii* forest, 11 June 2003, B. R. Kropp (UTC 239648); USA, Utah, Weber County, north of Eden, Wasatch National Forest. Powder Mountain Ski Area, scattered on buried conifer wood near melting snow, 31 May 2003, L. J. Hutchison (DAOM 234427); USA, Wyoming, Lincoln County, south of Smoot, Bridger National Forest, Lander trail, gregarious to scattered in deep woody debris under *Pseudotsuga menziesii* (Mirb.) Franco and *A. lasiocarpa*, 4 June 2004, B. R. Kropp and L. J. Hutchison (DAOM 234425).

Other specimens examined: *Baeospora myosura*: Canada, British Columbia, Vancouver Island, French Beach, on *Picea sitchensis* (Bong.) Carrière cone, 12 October 1990, S.A. Redhead (DAOM 216996); Canada, British Columbia, Vancouver Island, Pacific Rim National Park, Pachena Bay, on fallen spruce cones, 6 October 1979, S.A. Redhead (DAOM 175388); Canada, British Columbia, Queen Charlotte Islands, Graham Island, Yakoun River, 6 km S. of Port Clements, on spruce cone, 15 September 1982, S.A. Redhead (DAOM 187549); Canada, New Brunswick, Kent County, Kouchibouguac National Park, west of Information Center, on *Pinus strobus* L. cones in pine forest, 22 September 1977, S.A. Redhead (DAOM 166765); Canada, New Brunswick, Kent County, Kouchibouguac National Park, on fallen white pine cone, 5 October 1978, S.A. Redhead (DAOM 169976); Canada, Nova Scotia, Queen's County, South Brookfield, on white pine cone, 19 September 1987, S.A. Redhead (DAOM 198239); Canada, Ontario, Carleton County, Bell's Corners, on pine cones and needles, 24 September 1952, J.W. Groves and S.C. Hoare (DAOM 34569); Canada, Ontario, Carleton County, Fallowfield, on pine cone scales, 4 October 1956, J.W. Groves and M.E. Elliott (DAOM 54060); Canada, Ontario, Carleton County, Ottawa, Rockcliffe Park, on white pine cones, 14 September 1898 (DAOM F7920); Canada, Ontario, Leeds County, near Gananoque, on white pine cone in mixed woods, 13 September 1982, R.G. Thorn (DAOM 190189); Canada, Ontario, Leeds County, St. Lawrence Islands National Park, Mallorytown Landing, on pine cone, 5 September 1975, M. McCauley (DAOM 153506); Canada, Ontario, Leeds County, St. Lawrence Islands National Park, Thwartway Island, on *Pinus* sp., 18 September 1975, J. Ginns (DAOM 153504); Canada, Ontario, Nipissing District, Algonquin Provincial Park, Frontier Lake, near McManus Lake, on old white pine cone, 30 September 1982, R.G. Thorn (DAOM 190122); Canada, Ontario, Nipissing District, Algonquin Park, Blue Beech Creek, on old cones of white pine, 8 September 1982, R.G. Thorn (DAOM 190184); Canada, Ontario, Nipissing District, Lake Timagami, Timagami Island, on cones of *Pinus*, 11 September 1935, R.F. Cain (DAOM 80336); Canada, Ontario, Renfrew County, Shaw Forest, near Eganville, on white pine cones on ground, 10 September 1987, S.A. Redhead (DAOM 197385); Canada, Ontario, Renfrew County, Petawawa Forest Experimental Station, Cory Lake, on pine cones, 5 September 1941, J.W. Groves and I. L. Conners (DAOM 10581); Canada, Ontario, Simcoe County, south of Alliston, on cones of *P. strobus*, 23 September 1962, R.F. Cain (DAOM 165005); Canada, Ontario, Simcoe County, Wyebridge, on *P. strobus* cones in plantation, 19 September 1975, S.A. Redhead (DAOM 211741); Canada, Ontario, York County, Nashville, on cones of *P. strobus*, 19 September 1953, R.F. Cain (DAOM 50892); Canada, Ontario, York County, west of Maple, on cones of *P. strobus*, 27 September 1937, H.S. Jackson (DAOM 48488); Canada, Quebec, Les Collines-de-l'Outaouais, Chelsea, Kingsmere Road, on pine cones, 17 September 1953, C.A. Loveland (DAOM 40213); Canada, Quebec, Les Collines-de-l'Outaouais, Chelsea, Kingsmere, on pine cone scales, 25 September 1956, M.E. Elliott (DAOM 51996); Sweden, Uppland, Uppsala, Botanical Garden, on a decaying spruce cone in a conifer plantation, 26 September 1946, A. Melderis (DAOM 65290); UK, Berkshire, South Ascot, under *Pinus sylvestris* L., 8 November 1959, D.A. Reid (DAOM 74782); USA, Massachusetts, Franklin County, Conway, on pine cone, 16 September 1960, J.W. Groves (DAOM 71683); USA, New York, St. Lawrence County, Adirondak Mountains, Wakena campus, Star Lake, on fallen cone of *P. strobus*, 6 September 1981, J. Ginns (DAOM 180879); USA, Tennessee, Great Smoky Mountains, T. Anke (DAOM 188986).

The key distinguishing morphological feature separating *B. occidentalis* from *B. myosura* and *B. myriadophylla* is the color of the pileus. *Baeospora occidentalis* possesses a dark-brown to reddish-brown pileus that is hygrophanous to buff, compared to the paler colored pilei of *B. myosura* and the lilac to brownish-colored pilei of *B. myriadophylla*. Distinguishing ecological features include habitat and phenology. *B. occidentalis* colonizes litter and buried (often deeply buried) woody debris of montane conifers in western North America and fruits beside melting snow in the spring. *B. myosura* fruits on conifer cones while *B. myriadophylla*

fruits on woody debris of hardwoods as well as that of conifers. Both of the latter species fruit in summer and autumn.

Results of the compatibility tests showed that *B. occidentalis* has a tetrapolar mating system similar to that reported for *B. myosura* and *B. myriadophylla* (Johnson and Petersen 1997) and that its mating system is multiallelic. The finding of an arthroconidial anamorph among monokaryotic isolates of *B. occidentalis* is comparable to what Petersen (1995) reported for *B. myosura* and *B. myriadophylla*, although for the latter two species it is presumed that the arthroconidial anamorphs were associated with dikaryotic mycelia.

Some of the more interesting assemblages of macrofungi in forested ecosytems are those associated with melting snow in montane environments (Cooke 1955; Miller 1965). Fifty species commonly associated with snowbanks in the western mountains of North America were listed by Arora (1986). Our investigations commonly found *Clitocybe albirhiza* H.E. Bigelow & A.H. Smith, *C. glacialis* Redhead, Ammirati, Norvell & M.T. Seidl, *Neohygrophorus angelesianus* (A.H. Smith & Hesler) Singer, and *Melanoleuca angelesiana* A.H. Smith co-fruiting in the same habitat and at the same time as *B. occidentalis*. Of particular interest, we have also found *Strobilurus albipilatus* (Peck) V.L. Wells & Kempton fruiting at the same time in the same habitat. Because the basidiomata of *B. occidentalis* are similar in morphology, size, and coloration to those of *S. albipilatus* [=*Collybia albipilata* Peck (see Fig. 133 in Miller 1980)], we have often mistaken it for the latter species. Only upon examination under the microscope did we realize our mistake. The macroscopic similarity of the two species may partially explain why *B. occidentalis* has previously been overlooked despite its widespread abundance.

Another explanation for the lack of previous recognition of *B. occidentalis* may have to do with its geographic distribution. It currently is known only from the mountains of southern Idaho, northern Utah, southwestern Wyoming, and northeastern Nevada. Extensive searches in similar habitats over the past decade have failed to find this species in British Columbia and Alberta in Canada, and in Washington, northeastern Oregon and northern Idaho of the USA, suggesting that it has a distribution restricted to the area known as the Great Basin (Cronquist et al. 1972) and thus has escaped detection from field mycologists so far.

A key to temperate species of *Baeospora* is provided below.

A key to temperate species of *Baeospora*

1. Lamellae lilac, pileus grayish-lilac to brown ……..……..….....***B. myriadophylla***
1. Lamellae whitish to buff, pileus buff or dark brown to reddish brown..... 2
2. Pileus buff to pale brown, fruiting on conifer cones, widespread.....***B. myosura***
2. Pileus initially dark-brown to reddish-brown becoming buff, fruiting on buried woody debris near melting snow, restricted to western North America..... .....***B. occidentalis***

Acknowledgments Dr. Scott Redhead (DAOM) kindly provided specimens on loan. Financial support was provided by a Natural Sciences and Engineering Research Council of Canada Discovery grant to L.H.

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