Rare Plant Status Review: *Marsupella aquatica*
Proposed Rejection from Addition to California Rare Plant Rank 2B.2, G3 / S1
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Background and Taxonomy
Marsupella aquatica (Lindenb.) Schiffn. is an aquatic liverwort (nonvascular plant) in the family Gymnomitriaceae. This taxon was originally described as *Jungermannia emarginata* var. *aquatica* Lindenb. (Lindenberg 1829) and was then transferred to the genus *Marsupella* as *M. emarginata* var. *aquatica* (Lindenb.) Dumort. (Dumortier 1831). This treatment as a variety of *M. emarginata* has been followed by many subsequent authors and appears in some recent publications (e.g., Hong 1982, Christy and Wagner 1996, Wagner et al. 2000, USFS & BLM 2005, Wagner 2008). However, others recognize it as a distinct species *M. aquatica* (Váňa et al. 2010, Söderström et al. 2015, Stotler and Crandall-Stotler 2017, NatureServe 2021), and the species rank is supported by recent molecular analyses (Vilnet et al. 2010, Bakalin et al. 2019).

Marsupella is a genus of leafy liverworts with about 25 species (Váňa et al. 2010, Bakalin et al. 2019) characterized by having (1) bilobed leaves that are transversely inserted in two rows and ± spreading; (2) underleaves absent; (3) archegonia and sporophytes borne at the apex of the main stem or lateral branch; and (4) lacking specialized asexual reproductive structures (Doyle and Stotler 2006). *Marsupella aquatica* has more-or-less unbranched stems (3) 5–8 (12) cm long and 1.6–2.5 mm wide; the leaves are dark green to blackish and obcordate to suborbicular in outline with dimensions 0.8–1.6 mm long × (0.8) 1.0–2.0 (2.5) mm wide (i.e., wider than long) and apices rounded or sometimes subacute to apiculate; it reportedly grows in "extensive, dense patches" or "robust colonies" (USFS & BLM 2005, Wagner 2008, Exeter et al. 2016). It resembles and might be confused with *M. emarginata* which is the most common species of *Marsupella* in western North America (Hong 1982). However, *M. aquatica* differs in being larger (mostly 5–8 cm tall vs. 1–4 cm in *M. emarginata*), dull or dark green to blackish in color (vs. greenish brown to reddish brown), leaves broader, stiffer and more strongly spreading (ca. 90° from the stem), leaf apex with sinus between lobes descending less than 1/5 of leaf length (vs. sinus descending for 1/5-1/4 of leaf length), leaf margins more strongly revolute, and leaves bistratose (composed of two cell layers) near the base (vs. unistratose throughout) (Watson 1981, Hong 1982, Christy and Wagner 1996, USFS & BLM 2005, Wagner 2008, Bakalin et al. 2019). At the molecular level, the *trnL* intron of chloroplast DNA in *M. emarginata* has a deletion of 43 base pairs that is lacking in *M. aquatica* and other *Marsupella* species (Vilnet et al. 2010).

Ecology
Marsupella aquatica is strictly aquatic, i.e. it is reportedly restricted to cold, fast-flowing, montane or subalpine, perennial streams where it grows attached to submerged rocks (Christy and Wagner 1996, USFS & BLM 2005, Wagner 2008, Exeter et al. 2016). One account indicates it is found in both still and running waters (Hong 1982). The species may be intolerant of poor water quality (BLM 1996) and is unlikely to be desiccation-tolerant (Wagner 2008).
The most distinctive difference between *M. aquatica* and the morphologically similar *M. emarginata* is in their respective habitats; *M. emarginata* is not truly aquatic but does occur in mesic to wet places and is sometimes found on streambanks (i.e., it does not grow in habitats that are submerged throughout the year) (Christy and Wagner 1996, USFS and BLM 2005, CNABH

2021; but see Wagner et al. 2000). In southwestern British Columbia, the habitat of *M. emarginata* is on "rocks, boulders, outcrops or cliff faces [in] humid forests, subalpine meadows, or near streams and lakes" (Godfrey 1977). In California, *M. emarginata* potentially occurs "[o]n shaded, damp soil and rock of river banks, ravines and cliffs; occasionally on submerged rocks in creeks" (Doyle and Stotler 2006).

Another similar species is *M. sphacelata* which sometimes occurs in streambeds or lake margins that are submerged at least part of the year. Plants of this species have a blackish color, similar to that of *M. aquatica* but distinct from the red-brown of *M. emarginata*. However, the deeper leaf lobes of *M. sphacelata* (sinus descending to 2/5 of the leaf length) will readily distinguish it from both *M. emarginata* and *M. aquatica* (Wagner 2008, Exeter et al. 2016, Bakalin et al. 2019).

The sexual condition of *M. aquatica* is dioicous (i.e., having archegonia and antheridia on separate plants, ensuring cross-fertilization) (USFS & BLM 2005, Exeter et al. 2016, Bakalin et al. 2019). In the British Isles, the presence of sporophytes in this species was described as "fairly frequent" (Paton 1999, cited by USFS & BLM 2005). Water is required for the sperm to swim to the archegonia and is also the vector for dispersing spores or any non-specialized asexual propagules (i.e., plant fragments) produced by this species (USFS & BLM 2005).

Distribution and Abundance
Marsupella aquatica has a wide distribution in the Northern Hemisphere including Europe, Russia, Greenland, Canada, and the U.S. in Alaska, the Pacific Northwest and New England (Váňa et al. 2010, Stotler and Crandall-Stotler 2017, CNABH 2021). It is evidently rare in the Pacific Northwest with about five locations in the North Cascades of Washington state and one additional location at Waldo Lake in central Oregon (Hong 1982, Christy and Wagner 1996, Wagner et al. 2000, USFS & BLM 2005, Wagner 2008, Exeter et al. 2016, CNABH 2021, CPNWH 2021).

In California there is just one potential locality record for *M. aquatica*, based on an August 1972 collection (*Norris 23,253*, OSC) at ca. 5,500 feet elevation in the Siskiyou Mountains near Preston Peak (CNABH 2021, CPNWH 2021). The collecting locality was described as being near a small lake at the headwaters of Preston Creek; additional field-work is needed since abundance and habitat data are lacking. The Siskiyou County record is the species' southernmost known occurrence in western North America and is separated from the central Oregon locality by about 150 miles.

According to Doyle and Stotler (2005), there are five species of *Marsupella* in California: *M. emarginata*, *M. bolanderi*, *M. sphacelata*, *M. sprucei*, and *M. sparsifolia*. For some unknown reason, these authors did not indicate the presence of *M. aquatica* in California or cite the above-mentioned collection by Norris.

During review of this species on the CNPS Forum in April 2021, David Wagner, a bryologist of the Northwest Botanical Institute in Oregon, commented that the identification of the specimen *Norris 23,253* should be checked. He had not been aware of a California occurrence of this species. In order to confirm the occurrence of this species in California, he and the Curator of the OSU herbarium (OSC) attempted to locate *Norris 23,253* (Mickley pers. comm. 2022, Wagner pers. comm. 2021 and 2022). Wagner reviewed all collections of *M. aquatica* and *M. emarginata* var. *aquatica* in the herbarium and could not find a California specimen under either name. The

first author also contacted Barbara Crandall-Stotler, a specialist in this group of liverworts, and she confirmed that she has never examined *Norris 23,253* (Crandall-Stotler 2021). It is probable that *Norris 23,253* has been reidentified as a different species, and the database that is shared with the CNABH and CPNWH never got updated. Therefore, we cannot confirm that this species occurs in California.

Status and Threats

Marsupella aquatica is assigned a Global rank of G3 (Vulnerable, meaning that the species is considered to be at moderate risk of extinction); the rationale for this ranking is that the species is widespread but rare, with an estimated 100 occurrences and 8,000 individuals throughout its geographic range (NatureServe 2021). In Quebec, *M. aquatica* has a status of S1 (Critically Imperiled due to extreme rarity), and is SNR (not ranked) in British Columbia and Nova Scotia, Canada. In Oregon, it is S1 and is placed on ORBIC List 2 (threatened with extirpation from Oregon) (ORBIC 2019); it is SNR in all other states of occurrence. *Marsupella aquatica* is also listed as a "Survey and Manage" species under the *Northwest Forest Plan* (USFS & BLM 2014), where it is placed in Category B (rare but pre-disturbance surveys not practical; manage all known sites and conduct strategic surveys) (BLM 2021).

Possible threats to *M. aquatica* include deterioration of water quality (e.g., due to increased recreational activity) or changes in stream hydrology (e.g., due to prolonged drought associated with long-term climate change) (BLM 1996, USFS & BLM 2005, Wagner 2008). If verified, ~~T~~the only potential known occurrence in California may be well protected (at least in the short term) by its remote location within the federally designated Siskiyou Wilderness (Klamath National Forest).

Summary

Based on the available information, CNPS and CNDDB recommend adding *Marsupella aquatica* to the Considered But Rejected list ~~2B.2~~ of the CNPS Inventory. ~~The single known locality in California is protected within a federally designated Wilderness Area; we thus would propose a threat rank of 0.2 at this time.~~ If the single potential occurrence ~~knowledge on the distribution, threats, and rarity status~~ of *M. aquatica* in California is verified or if new California occurrences are found~~changes in the future~~, we will re-evaluate its status at that time.

Actions

CNPS: Reject Addition of *Marsupella aquatica* to 2B.2; Add to Considered But Rejected list
CNDDB: Reject Addition of *Marsupella aquatica* to G3 / S1

Draft CNPS Inventory Record

Marsupella aquatica (Lindenb.) Schiffn.
stream ladderwort
Gymnomitriaceae
CRPR 2B.2
Maine, New Hampshire, New York, Oregon, Vermont, Washington
Siskiyou
Preston Peak (4112375)
Subalpine coniferous forest / on submerged rocks in cold, fast-flowing, perennial streams; elevation 1,675 meters.
liverwort (aquatic)

Last seen in 1972; field-work needed. Most similar to *M. emarginata* which is not truly aquatic. Traditionally treated as *M. emarginata* var. *aquatica*; see *Annals of the Missouri Botanical Garden* 102(4): 648 (2017) and *Cryptogamie, Bryologie* 40(7): 59–85 (2019) for discussion of species status.

Final CNPS Inventory Record
Marsupella aquatica (Lindenb.) Schiffn.
Considered But Rejected (CBR)
CBR Reason: Presence in California needs confirmation; identity of single collection from 1972 in the Siskiyou Mtns. near Preston Peak (*Norris 23253*, OSC) is suspect and needs verification, but the voucher is lost. Field surveys needed.

Literature Cited

Bakalin, V.A., V.E. Fedosov, A.V. Fedorova, and V.S. Nguyen. 2019. Integrative taxonomic revision of *Marsupella* (Gymnomitriaceae, Hepaticae) reveals neglected diversity in Pacific Asia. *Cryptogamie, Bryologie* 40(7): 59–85.

[BLM] USDI Bureau of Land Management, Oregon/Washington State Office. 1996. Draft management recommendations for stream ladderwort *Marsupella emarginata* var. *aquatica* (Lindenb.) Dumort. Version 1.1. Portland, OR. Available at: https://www.blm.gov/or/plans/surveyandmanage/MR/Bryophytes/maem.pdf

[BLM] USDI Bureau of Land Management, Oregon/Washington State Office. 2021. Survey and Manage History and Update. Website https://www.blm.gov/or/plans/surveyandmanage/history.php [accessed March 2021].

Christy, J.A. and D.H. Wagner. 1996. Guide for the identification of rare, threatened or sensitive bryophytes in the range of the northern spotted owl, western Washington, western Oregon, and northwestern California. USDI Bureau of Land Management, Oregon/Washington State Office, Portland, OR. Available at: https://doi.org/10.5962/bhl.title.119939

[CNABH] Consortium of North American Bryophyte Herbaria. 2021. Website https://bryophyteportal.org/portal/ [accessed March 2021].

[CPNWH] Consortium of Pacific Northwest Herbaria. 2021. Data provided by the participants of the Consortium of Pacific Northwest Herbaria. University of Washington Herbarium. Website http://www.pnwherbaria.org/data/search.php [accessed March 2021].

Doyle, W.T. and R.E. Stotler. 2006. Contributions toward a bryoflora of California III. Keys and annotated species catalogue for liverworts and hornworts. *Madroño* 53(2): 89–197.

Dumortier, B.C.J. 1831. *Sylloge Jungermannidearum Europae indigenarum*. Tournay (J. Casterman).

Exeter, R.L., J. Harpel, and D. Wagner. 2016. Rare Bryophytes of Oregon. USDI Bureau of Land Management, Salem District, Salem, OR. 378 p. Available at: https://doi.org/10.5962/bhl.title.121822

Godfrey, J.L.D. 1977. The Hepaticae and Anthocerotae of southwestern British Columbia. Ph.D. thesis, University of British Columbia, Vancouver.

Hong, W.S. 1982. The genus *Marsupella* in western North America. *Lindbergia* 8(3): 166–176.

Lindenberg, J.B.W. 1829. *Synopsis hepaticarum europaearum*. Bonnae [Bonn].

NatureServe. 2021. NatureServe Explorer. Website https://explorer.natureserve.org [accessed March 2021].

[ORBIC] Oregon Biodiversity Information Center. 2019. Rare, Threatened and Endangered Non-Vascular Plants, Algae, Lichen, and Fungi Species of Oregon. Institute for Natural Resources, Portland State University, Portland, OR. 30 pp. Available at https://inr.oregonstate.edu/sites/inr.oregonstate.edu/files/2019-rte-nonvascs.pdf [accessed March 2021].

Söderström, L., A. Hagborg, M. von Konrat, et al. 2015. World checklist of hornworts and liverworts. *PhytoKeys* 59: 1–828.

Stotler, R.E. and B. Crandall-Stotler. 2017. A synopsis of the liverwort flora of North America north of Mexico. *Annals of the Missouri Botanical Garden* 102(4): 574–709.

[USFS & BLM] USDA Forest Service, Region 6 and USDI Bureau of Land Management, Oregon/Washington State Office. 2005. Conservation assessments for 11 species of bryophytes. Portland, OR. Available at: https://www.blm.gov/or/plans/surveyandmanage/files/ca-br-11-species-herbertus-aduncus-20110217.pdf

[USFS & BLM] U.S. Department of Agriculture Forest Service and U.S. Department of Interior Bureau of Land Management. 2014. List of Survey and Manage Species in Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures; as amended by Annual Species Reviews 2001-2003. Available at: https://www.blm.gov/or/plans/surveyandmanage/files/sm-fs-enc3-table1-1-dec2003wrtv.pdf [accessed March 2021].

Váňa, J., L. Söderström, A. Hagborg, M. von Konrat, and J.J. Engel. 2010. Early Land Plants Today: Taxonomy, systematics and nomenclature of Gymnomitriaceae. *Phytotaxa* 11: 1–80.

Vilnet, A.A., N.A. Konstantinova, and A.V. Troitsky. 2010. Molecular insight on phylogeny and systematics of the Lophoziaceae, Scapaniaceae, Gymnomitriaceae and Jungermanniaceae. *Arctoa* 19: 31–50.

Wagner, D.H. 2008. Species fact sheet: *Marsupella emarginata* var. *aquatica*. USDA Forest Service, Region 6 (Pacific Northwest), Portland, OR. Available at: https://www.fs.fed.us/r6/sfpnw/issssp/documents/planning-docs/20190329-sfs-br-marsupella-emarginata-var-aquatica-201802.docx

Wagner, D.H., J.A. Christy, and D.W. Larson. 2000. Deep-water bryophytes from Waldo Lake, Oregon. *Lake and Reservoir Management* 16(1–2): 91–99.

Watson, E.V. 1981. *British Mosses and Liverworts* (3rd ed.). Cambridge University Press.

Persons Contacted:

Crandall-Stotler, Barbara. 2021. Faculty, Southern Illinois University, Carbondale. Email about the identification of herbarium specimen *Norris 23,253.* Personal communication 13 April 2021.

Mickley, James. 2022. Curator, Oregon State University Herbarium. Email about the identification of herbarium specimen *Norris 23,253.* Personal communication 6 October 2022.

Wagner, David. 2021-22. Northwest Botanical Institute, Eugene, Oregon. Email about the identification of herbarium specimen *Norris 23,253*. Personal communications April 2021-October 2022.