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*Pseudocrossidium obtusulum* (Pottiaceae, Bryopsida) new to Montana with a key to North American species in the genus

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PSEUDOCROSSIDIUM OBTUSULUM (POTTIACEAE, BRYOPSIDA)
NEW TO MONTANA WITH A KEY TO NORTH AMERICAN
SPECIES IN THE GENUS

P.M. Eckel, I.A. Hoy, and J.C. Elliott

ABSTRACT.—The moss species Pseudocrossidium obtusulum (Lindb.) Crum & Anderson is reported for the state of Montana. Recent systematics of the genus Pseudocrossidium in North America is discussed.

Key words: mosses, bryophytes, Montana, Pseudocrossidium, P. crinitum, P. hornschuchianum, P. obtusulum, P. replicatum, P. revolutum.

Montana has one of the richest recorded moss floras of the western United States, with 410 known species and varieties (Elliott in preparation). Although most collecting has occurred in the western portion of the state, a concentrated examination of particularly dry habitats in Ravalli County has yielded species new to the state (Eckel, Hoy, and Elliott in preparation). These species are members of a cryptoflora of minute bryophytes occurring on various soil substrates, of which one is the following species:

Pseudocrossidium obtusulum (Lindb.) Crum & Anderson

USA, Montana, Ravalli Co., east side of Bitterroot Valley, North Birch Creek watershed; 7 miles SSE of Stevensville, NW NE Sec. 12, T7N, R19W, 3600’ elev., from vertical S-facing cliff face, N side of irrigation ditch just above old water level; Hoy 306, April 6, 1996 (BUF).

There are 5 species of Pseudocrossidium Williams presently listed in the moss flora of North America north of Mexico (Anderson et al. 1990). Spence (1987) has given a good review of the literature and American distribution of 4 of these, the 5th being P. obtusulum (Lindb.) Crum & Anderson, a species considered by some to be a variety of P. revolutum (Brid. in Schrad.) Zand. (Tan et al. 1981), and by others to be indistinguishable from the latter in local populations in the field (McIntosh 1986). The variety was elevated to species status by Crum and Anderson (1989) for the North American checklist (Anderson et al. 1990), but without discussion. Zander (manuscript in preparation) has determined that P. revolutum does not occur in the Arctic or Greenland, or elsewhere in North America. Because one of the obstacles to the convenient study of arid bryophyte cryptoflora is the scattered taxonomic treatments, an attempt has been made here to summarize the genus to date in North America with a key and illustrations to the 5 species.

Historically, species in the genus Pseudocrossidium have been placed in the genera Barbula Hedw., Desmatodon Brid., and Tortula Hedw. However, most are distinguishable from these genera by the strongly and strikingly revolute leaf margins, most evident on transverse sections of the leaf, resembling 2 cylinders separated by a groove (Zander personal communication) as opposed to the usual plain or narrowly recurved leaves of other species of other genera. The character of differentiated perichaetial leaves may differentiate the genus in the broadest sense, especially species in South America where the bulk of the species occur; but for the 4 taxa occurring in North America (here excluding P. revolutum), only P. hornschuchianum has such—a species found to date in North America in only 2 botanical gardens, 1 in British Columbia (Tan et al. 1981), the other in Massachusetts (Mishler and Miller 1983).

The genus is separated from Barbula and other genera of the Barbuloideae, such as Didymodon, by the absence of a ventral stereid

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band in the costa. Neither Desmatodon nor Tortula has this feature either; or it is occasionally weakly present. McIntosh (1986) has also pointed out the useful character of the sharp and deep costal groove or keeled leaf in Pseudocrossidium, whereas in Tortula and Desmatodon the leaf is broadly channeled and the costa in section is nearly circular with an elevation, sometimes distinctive, on the ventral surface composed of differentiated cells. Zander (1993) has indicated that the crescent-shaped dorsal stereid band, as opposed to the semicircular band of Desmatodon and Tortula, is distinctive in Pseudocrossidium.

McIntosh (1986) has also distinguished P. obtusulum (as P. revolutum) from Didymodon brachyphyllus (Sull. in Whipp.) Zand., a species sometimes associated with P. obtusulum, by the dense papillae, as well as the lack of ventral stereid band. Tortula muralis Hedw. and its closely related if not synonymous species, Tortula brevipes (Lesq.) Broth. and Desmatodon phlithobius Sull. & Lesq., also have broadly spirally once-revolute margins and densely papillose leaves, but usually have a rather long, smooth awn. Tiny specimens may, however, be only mucronate and are distinguished from P. obtusulum by the latter’s flattened, crescent-shaped dorsal stereid band.

Key to Pseudocrossidium Species in North America and Greenland (Figs. 1-5)

1. Leaves short- to long-awned:
   2. Leaves rounded-obtuse at base of short awn; ventral costal surface concave; guide cells 4; Mexico, Arizona, New Mexico, Texas, Utah...
   3. Pseudocrossidium crinitum (= P. aureum)
   2. Leaves acute at base of short-awn; ventral costal surface convex; guide cells 2; botanic gardens in British Columbia and Massachusetts...
   1. Pseudocrossidium hornschuchianum

1. Leaves merely apiculate to short-mucronate:
   3. Leaves relatively long, 1.0-1.5 mm, ligulate to oblanceolate, apex obtuse; ventral costal surface concave; guide cells (4-6); margins strongly spirally revolute, inrolled margins of bright green thin-walled cells with hollow papillae, without propagula; Mexico, SW USA...
   3. Pseudocrossidium replicatum
   2. Leaves relatively short, 0.7-1.2 mm, ovate to ovate-deltoid, apex broadly acute; ventral costal surface convex; guide cells 2-3; margins revolute 1 time, of undifferentiated cells, sometimes with rhizoidal and costal propagula; southern California, American NW, Arctic, and Greenland...
   1. Pseudocrossidium obtusulum

Pseudocrossidium revolutum is a European species with oblanceolate to ligulate upper leaves, more strongly and more narrowly revolute margins extending nearly to the leaf base, margins as seen in section 1 1/2 times revolute with leaves strongly twisted and inrolled when dry. The leaf mucro is not stout and is shorter than in P. obtusulum, whose leaves are imbricated or only somewhat twisted when dry. The perichaetial leaves are strongly differentiated in P. revolutum and there is no record of propagula in this species, whereas the perichaetial leaves of the occasionally gemmiferous P. obtusulum are weakly differentiated or undifferentiated.

Pseudocrossidium obtusulum is rare in the Arctic (Zander in preparation) but distributed from Greenland, the Northwest Territories, and Alaska south to the Yukon, British Columbia, Oregon, and southern California just north of the Mexican border (map in Tan et al. 1981). In an extensive dry-steppe vegetational study by McIntosh (1986), the species was reported as locally common in the interior of British Columbia. The Montana station is an inland extension of its previously recorded range. McIntosh’s description of the area as the Cordilleran steppe or shrub-steppe is extended eastward to southern Wyoming and Colorado, based on Daubenmire (1978). The area of the collections presently reported also represents the steppe conditions as characterized in McIntosh’s south central British Columbia study. It is probably also controlled by the rain-shadow effect of the western mountains. No rhizoidal tubers as described and illustrated by Tan et al. (1981) were observed in the Montana collections.

As to Pseudocrossidium obtusulum belonging to floristic elements with distinctive distribution patterns, the reports of P. revolutum by McIntosh as a western North American—Eurasian species must be revised as P. revolutum has been excluded from the North American flora. That species would now be characterized as a Eurasian species. Pseudocrossidium obtusulum would then belong to McIntosh’s western North American—western Eurasian element, since this species occurs from the Arctic to southern California and 2 stations in what one might expect to be temperate steppe conditions in central Germany and southern Sweden (Tan et al. 1981). Schofield (1980) discusses the disjunct flora of western North
Figs. 1-5. 1, Pseudocrossidium hornschuchianum; 2, P. crinitum; 3, P. replicatum; 4, P. obtusulum; 5, P. revolutum (from European material), showing the relative size of the perichaetial leaf to vegetative leaves. Scale bars: leaves, $a = 0.5$ mm; cross sections, $b = 100 \mu$m.
America and Europe, describing species that are widespread in America, such as *P. obtusulum* discussed here, but which are "restricted to few sites . . . throughout Europe." It is apparent that this species is an element of this disjunct distribution. "The absence of these and other species from most of Asia . . . strongly implies that these disjuncts have been isolated for many thousands of years, at least" (Schofield 1980).

The specimens were collected on very fine sandy loam composed of 53% sand, 40% silt, and 7% clay with a bulk density of 1.35 g/cm³. Although volcanic ash deposits occur in the region nearby, that substrate was absent from the soil where specimens were collected. The site is in dryland sagebrush–bunchgrass habitat with precipitation varying from 8 to 20 inches/yr. Plants were growing on a vertical face just above the waterline of a large irrigation canal, and consequently the soil is continuously moist for nearly 5 months, from May to September, and extremely dry during the other 7 months. *Didymodon vinealis* (Brid.) Zand. var. *vinealis* was associated with the specimens.

Although *Pseudocrossidium obtusulum* has gemmae in North America, it fruits, and richly so, only in Greenland.

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