

***Botrychium alaskense*, a New Moonwort from the Interior of Alaska**

WARREN HERB WAGNER, JR.†

Department of Biology, University of Michigan, Ann Arbor, MI 48109-1048

JASON R. GRANT

Laboratoire de botanique évolutive, Institut de botanique, Faculté de Sciences, Université de
Neuchâtel, Case Postale 2, CH-2007 Neuchâtel, Switzerland

ABSTRACT.—*Botrychium alaskense* W. H. Wagner & J. R. Grant is described as a new species from the interior of Alaska. It is an allotetraploid of *B. lunaria* (L.) Sw. × *B. lanceolatum* (S.G. Gmel.) Ångstr., the same species parentage that gave rise to the morphologically and isozymically distinct *B. pinnatum* H. St. John.

Outside of North America, only seven species of *Botrychium* are currently recognized: *Botrychium boreale* Milde, *B. lanceolatum* (S.G. Gmel.) Ångstr., *B. lunaria* (L.) Sw., *B. matricariifolium* (Döll) A. Braun, *B. multifidum* (S.G. Gmel.) Rupr., *B. simplex* E. Hitchc., and *B. virginianum* (L.) Sw. Each of these species is also recorded in North America, although the identity of *B. boreale*-like plants in North America is in question, and likely represent either *B. pinnatum* H. St. John or *B. alaskense* W.H. Wagner & J.R. Grant. In addition, North America has more than 25 endemic species, nearly all of which have been recognized in the past three decades, and some of which are still undescribed. A surprisingly large number of these occur in the cordilleran region of western North America.

The majority of the North American endemics have been overlooked apparently because of their inconspicuous appearance, their common occurrence in unexpected, disturbed habitats, or their general rarity. We here describe another new species, this one from the interior of Alaska.

***Botrychium alaskense* W. H. Wagner & J. R. Grant, sp. nov., Figs. 1–2.**

A *B. pinnato* H. St. John tropophoro oblongo-deltato, saturate viridibus, pinnis usque 4–6-jugis irregulariter decompositis, inter se approximatis vel distantibus, lobulis plerumque oblongis angulatis, basi anguste (per 40–90°) cuneatis diversa.

→

FIG. 1. Three species of *Botrychium* from northwestern North America. Bottom row left (3 specimens), *Botrychium pinnatum* (W. H. Wagner 99128 et al., MICH). Bottom row right (3 specimens), *B. lanceolatum* (W. H. Wagner 99120 et al., MICH). Remaining (18 specimens), *B. alaskense* (W. H. Wagner 99005 et al., MICH).



TYPE: U.S.A. ALASKA. BIG DELTA QUAD: Vicinity of Fairbanks: Salcha River, 12 km. up the river from its crossing of the Richardson Hwy, at mile 323.1, 64°29'195"N, 146°39'629"W, 23 June 1999, *W. H. Wagner 99005* with *J. R. Grant, F. S. Wagner, A. Gilman, P. Zika, H. W. Grant* and *W. L. Grant* (holotype MICH; isotypes ALA, B, BM, F, G, GH, ISC, MO, NY, P, S, U, UC, US, WTU).

Trophophore stalk 3–10 mm long, up to 2 times the length of the trophophore rachis; lamina bright green, leathery, oblong-deltate, 1-pinnate, up to 6 cm long and wide; pinnae up to 6 pairs, horizontal to slightly ascending, approximate to distant, the basal and supra-basal pair not or slightly more distant than the supra-basal and 3rd pairs, the basal pinnae equal to or slightly longer than the supra-basal pair, broadly lanceolate to broadly trullate, unlobed (small plants) to deeply lobed (large plants), with up to 5, narrowly oblong pairs of lobes, these up to 10 mm long, 3 mm wide, asymmetrically truncate, broadly (2–3 mm) attached and confluent to the rachis, shallowly concave at the basiscopic base; lobe tips irregularly crenate-dentate. Sporophore 2-pinnate, with 3 major branches. Chromosomes evidently tetraploid.

PARATYPES: U.S.A. ALASKA. **ANCHORAGE QUAD:** Black Spruce Campground, Fort Richardson Military Reservation northeast of Anchorage, disturbed floodplain with graminoids and forbs among young cottonwood and alder, 1 August 2001, *D. Farrar 01-07-01-4*. **BIG DELTA QUAD:** Salcha River, 12 km up the river from its crossing of the Richardson Highway at mile 323.1, 64°29'N, 146°45'W, July 1996, *J. R. Grant 96-02625b* (ALA); Salcha River, 12 km up the river from its crossing of the Richardson Highway at mile 323.1, 64°29'N, 146°45'W, 23 June 1999, *J. R. Grant 99-03572* with *W. H. Wagner, F. Wagner, P. Zika, A. Gilman, H. W. Grant, & W. L. Grant* (ALA); Between Harding Lake and the Salcha River on the Richardson Hwy (Alaska Hwy. 2), opposite Harding Rd. [the entrance to the Harding Lake Recreation Area], 64°26'N, 146°54'W, 255 m, 26 June 1999, *W. H. Wagner 99119* with *J. R. Grant, F. S. Wagner & P. Zika* (MICH); Between Harding Lake and the Salcha River on the Richardson Hwy (Alaska Hwy. 2), opposite Harding Rd., 64°26'N, 146°54'W, 255 m, 26 June 1999 *J. R. Grant 99-03584* (ALA); Salcha River, 12 km up the river from its crossing of the Richardson Highway at mile 323.1, 64°29'N, 146°45'W, July 2000, *J. R. Grant 00-3828* (ALA); Between Harding Lake and the Salcha River on the Richardson Hwy., opposite Harding Rd., 64°25'N, 146°53'W, 12 July 2000, *J. R. Grant 00-3833* (ALA); Between Harding Lake and the Salcha River on the Richardson Hwy., opposite Harding Rd. 64°26'N, 146°54'W, 12 July 2000, *J. R. Grant 00-3837* (ALA); Mile 323.1 Richardson Hwy where it crosses the Salcha River, dry disturbed area in pioneer vegetation along roadside, 64°28'N, 146°55'W, 24 June 2001, *J. R. Grant 01-4093* (ALA); Between Harding Lake and the Salcha

→

FIG. 2. *Botrychium alaskense* W. H. Wagner & J. R. Grant (drawn from *Grant 00-3833* and *Grant 00-3837*).



*Botrychium
alaskense*

TABLE 1. Comparison of full-sized trophophores (and sporophores) of *Botrychium pinnatum* and *B. alaskense*

Character	<i>B. pinnatum</i>	<i>B. alaskense</i>
Trophophore outline	Narrowly ovate	Broadly ovate-deltate
Apex	Abruptly narrowed	Gradually narrowed
Pinna overlap when present	Mainly near pinnae bases	Mainly submedial on pinnae, commonly absent
Lowest pinna length	Mostly 2.0 cm or less	Mostly 2.5 cm or less
Lowest pinna width	Mostly 1.0 cm or less	Mostly 1.5 cm or less
Lobe apices	Strongly rounded	Angular
Pinna base angle	120°–140°	40°–90°
Contracted pinna base	Less than 0.5 mm, broadly adnate	At least 1 mm, narrowly adnate
Veinlet interval	Nearly 1 mm	Mostly 0.5 mm or less
Sporophore length	0.5–1.5× trophophore length	0.4–1.0× trophophore length
Low, widely separated sporophore branches	Occasional	Prevalent

River on the Richardson Hwy., opposite Harding Rd., 64°26'N, 146°54'W, 26 June 2001, *J. R. Grant 01-4096* (ALA). **LAKE CLARK QUAD:** North Rim of the Western Amphitheater of the Northern TELAQUANA Badlands, Lake Clark National Park, in a basin excavated by wind, south facing slope at 5 degrees, vegetation 50% vascular, 50% lichen, 15 August 2001, *P. Caswell s.n.* **LIVEN-GOOD QUAD:** White Mts., limestone ridge in a grassy slope, 800 m, 15 July 1953, *O. Gjaerevoll 593* (ALA). **MT. MCKINLEY QUAD:** Kantishna Mining District, 63°31'N, 150°56'W, 900 m, Wickersham Dome, moist herbaceous, NE-facing alpine slopes, 26 June 1990, *C. J. Parker 2294* (ALA). **NENANA QUAD:** Tamarack Inn, mi. 298, Parks Hwy. [Alaska Hwy. 2], 7 miles S of Nenana, 64°28'N, 149°03'W, 25 June 1999, open field with *B. lanceolatum* (rare), *B. lunaria*, and *B. minganense*, *W. H. Wagner 99113* with *J. R. Grant, F. S. Wagner, & P. Zika* (MICH); *J. R. Grant 99-03578* (ALA). **TALKEETNA QUAD:** Chedotlotina Glacier, Denali National Park, with netleaf willow, mountain avens, polar willow, dwarf scrub meadow, 20 August 2001, *M. Duffy MD-01-258A*. **TANANA QUAD:** Manley Hot Springs area, 21 km E of Manley, 65°05'N, 150°19'W, roadside ditch near Extensive Survey Stand No. 138, 16 June 1973, *J. Foote 3049* (ALA).

Herbarium records from western Alaska and Siberia may also represent *Botrychium alaskense*, but require further study to confirm their identity. The new species may be distinguished from its closest relatives by the following key:

1. Trophophore deltate; sporophore stalk 1/3–1/4 as long as the sporophore; pinna pairs 3 or 4; basal pinna pair 2× as wide as the adjacent pinna pair; basiscopic pinna margin straight to slightly concave and upswept *B. lanceolatum*
1. Trophophore ovate to deltate; sporophore stalk 1/2–1/3 as long as the sporophore; pinna pairs 5–7; basal pinna pair equal to or slightly larger than the suprabasal pair; basiscopic pinna margin concave to deeply concave and spreading 2.

- 2(1). Trophophores mostly ovate-deltate; pinnae somewhat irregularly incised, bright green, ovate, distant to approximate, their lobes mostly narrowly oblong, angular; pinna bases forming an angle of ca. 40°–90° *B. alaskense*
2. Trophophores mostly ovate; pinnae very regularly incised, dark (olive) green, broadly oblong, mostly approximate, their lobes mostly broadly ovate, rounded; pinna bases truncate to cordate, forming an angle of ca. 120°–140° *B. pinnatum*

From plants analyzed using enzyme electrophoresis, it was determined that *B. alaskense* is an allotetraploid of *B. lunaria* × *B. lanceolatum* (D. Farrar, pers. comm.). That would not be a particular surprise, except that *B. pinnatum* has the same parentage. Farrar's preliminary results indicate that *B. alaskense* may have arisen through hybridization between *B. lanceolatum* × *Eurasian B. lunaria*, whereas *B. pinnatum* originated as *B. lanceolatum* × *American B. lunaria*.

Most of the localities where moonworts have been found in interior Alaska include *Botrychium alaskense*; the others observed to date have only *B. lunaria* and/or *B. minganense*. All sites with *B. alaskense* studied by one or both of us are in open, non-forested areas. They include revegetating sandbars along the Salcha River, a mowed field or lawn ca. 30 years old along the Parks Highway, and roadsides along the Richardson Highway.

The immediate vicinity of Fairbanks has produced seven species: *B. alaskense*, *B. lanceolatum*, *B. lunaria*, *B. minganense* Victorin, *B. multifidum*, *B. pinnatum*, and a new species, *B. yaaxudakeit* Stensvold & Farrar. A possible eighth species with affinities to *B. alaskense* may be another undescribed species that is currently being investigated by the junior author. As presently known, the Fairbanks area has the largest number of species of *Botrychium* in Alaska. The most common are *B. lunaria* and *B. minganense*, and the least common is *B. multifidum*. *Botrychium lunaria* was the only species in several localities, while *B. minganense* appeared as the only species in one locality. *B. lunaria* and *B. minganense* grew together in all localities except the foregoing. *B. alaskense*, *B. lunaria*, *B. minganense*, and *B. lanceolatum* were found growing together in three localities, and all seven species were found growing together in one locality.

In three of the sites, the individuals of *B. alaskense* are estimated at well over 200. The plants are obvious because of their unusually large size, characteristic trophophore shape, and shining, bright green color. Growing with *B. alaskense* are young woody plants or herbs. Associated woody plants include *Arctostaphylos uva-ursi*, *Betula neoalaskana*, *Picea glauca*, *Populus balsamifera*, *P. tremuloides*, *Rosa acicularis*, *Rubus idaeus*, *Salix alaxensis*, *S. bebbiana*, *Shepherdia canadensis*, and *Vaccinium uliginosum*. The most prominent associated herbs that can be used as indicators of moonwort sites, even when *B. alaskense* is absent include *Taraxacum officinale*, *Fragaria virginiana*, *Potentilla norvegica*, *Cornus canadensis*, and *Galium boreale*. Particularly, the presence of strawberries nearly always indicates the presence of moonworts.

Botrychium alaskense always grows in somewhat recently disturbed areas. In naturally disturbed sites, it is found on re-vegetating sandbars and along

new oxbow lakes. In man-induced disturbances, populations are found in abundance growing in weedy, infrequently-mowed fields or lawns, or in the ditches and associated edges of the major highways of the interior of Alaska.

The phenology of *B. alaskense* is intermediate between *B. lunaria* and *B. lanceolatum*. *Botrychium lunaria* sporulates first and is completely finished before the sporangia of *B. lanceolatum* have begun to ripen. *Botrychium alaskense* sheds its spores after *B. lunaria* has finished and before those of *B. lanceolatum*.

ACKNOWLEDGMENTS

The staff of the University of Alaska Museum—Herbarium (ALA), Alan Batten and Carolyn Parker, are thanked for lending specimens and photocopies and for their gracious hospitality during a visit in the summer of 1999 by both authors. Florence Wagner is thanked for her field assistance and for help with the preparation of specimens and the manuscript. Don Farrar is thanked for the isozyme evidence, and for careful review of the manuscript. The following persons helped in various ways, especially while carrying out the field studies: Arthur Gilman, Henry W. and Wyan L. Grant, and Peter Zika. Rupert Barneby is thanked for preparing the Latin diagnosis and for reviewing the manuscript. Bobbi Angel skillfully prepared the line-drawings.