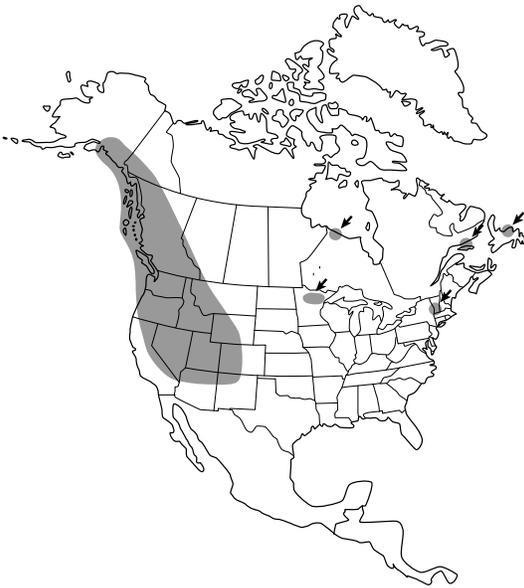


## *Botrychium ascendens*

**Family:** Ophioglossaceae  
**Genus:** *Botrychium*  
**Species:** *Botrychium ascendens* W. H. Wagner  
**Common Names:** Upswept Moonwort; Upward Lobed Moonwort  
**Ploidy:** Tetraploid



**Published description:** Plants exclusive of roots reaching to 20 cm tall, averaging 10-12 cm tall, the common stalk 5 cm [2-12] tall, sporophore one-third to one-half again as long as the trophophore; trophophore bright yellow-green and shiny in life, the veins conspicuous and the lamina surface somewhat crinkled; trophophore stalk 1-30 percent of total trophophore length; blade outline narrowly oblong-triangular, up to 6 cm long and 2 cm wide; segments up to six pairs, strongly ascending, the upper ones extremely ascending; lower pinnae with somewhat curved posterior margins and straight anterior margins, commonly with marginal sporangia; largest pinnae 12 mm long, 10 mm wide; veins dichotomous, 2 or 3 major veins entering the pinna base, 14-17 vein endings along outer margins of larger pinnae; margins deeply and sharply dentate and serrate, often two- to five-lobed; sporophore branches mostly simple except for lower ones with 1-3 branchlets; spores finely verrucose, [40]44-47[54] micrometers in diameter; chromosomes  $n = 90$  (Wagner and Wagner, 1986).

## Identification

Plants of this species are most similar to *B. lunaria* var. *crenulatum*, *B. minganense*, *B. spathulatum* and *B. campestre*. *Botrychium ascendens* differs from these species in its more strongly ascending (upwardly angled) basal pinnae, pinna margins that are sharply dentate to cleft (into two to four spreading lobes), a sporophore stalk that is much shorter at maturity than the length of the trophophore but longer than that of *B. campestre*, and frequent occurrence of sporangia on the basal pinnae of the trophophore. [This character of 'supernumerary' sporangia must be used with caution because they are not always present in *B. ascendens*, and are occasionally present on the basal pinnae of all moonwort species!] The basal pinnae of *B. ascendens* are cuneate, usually spanning an arc of 90° or less, whereas basal pinnae of *B. lunaria* var. *crenulatum* typically span an arc of nearly 180°. Forms of *B. ascendens* with unusually narrow pinnae have been confused with both *B. campestre* var. *campestre* and *B. campestre* var. *lineare* which have pinnae spanning an arc of less than 45°. Narrow forms of *B. ascendens* can be differentiated from both varieties by its sporophore stalk length which, at maturity, is approximately half the length of the trophophore. In *B. campestre* the sporophore stalk length is typically 1/3 or less the length of the trophophore. The range of pinna span in *B. minganense* is similar to that in *B. ascendens*, but the trophophore stalk in *B. minganense* is typically longer and the pinna margins are more entire (sometimes lobed). The sporophore and its branches in *B. ascendens* are stiffly upright as compared to the more lax and spreading sporophores of *B. lunaria* var. *crenulatum* and *B. minganense*. Pinnae of *B. spathulatum* have margins that are entire to scalloped.

Aboveground leaves of *B. ascendens* average 6 -10 cm tall. Smaller plants (which are not necessarily younger) typically have fewer pinnae that tend to be smaller and less dissected than those of larger plants. Plants growing in full sun tend to be more robust and stiffly upright than plants growing in partial shade or among dense herbaceous vegetation. Plants growing at treeline and above tend to be small, resembling the smallest plants at lower elevations.

## Distribution and abundance

*Botrychium ascendens* ranges widely across North America, extending from southern Nevada north to Alaska and eastward across Canada to Quebec and Newfoundland, and in the US to northern Minnesota and Vermont. Presence of similar genotypes in coastal Alaska and eastern Canada suggests that *B. ascendens* may be more common across central Canada than indicated by the few known localities in northern Ontario. Historical collections of the Newfoundland (Fogo Islands) and Quebec (Mingan Islands) plants were first thought to be *B. campestre* (Wagner 1990), but recent collections from these sites have been confirmed by genetic analysis to be *B. ascendens* (Zika and Farrar 2009), as have been plants from Minnesota and Vermont.

In California *B. ascendens* is probably less common than previously assumed. Many of the ascendens-like plants examined genetically from southern California have proven to be narrow-pinna sun forms of *B. lunaria* var. *crenulatum*. These can be differentiated morphologically from *B. ascendens* by their more spreading pinnae and generally longer trophophore and sporophore stalks.

## Habitat

*Botrychium ascendens* is primarily a plant of open habitats. In Alaska and Newfoundland it occurs in sandy ocean beach herbaceous communities. It has recently been found in mountain meadows near Kluane Lake in Yukon province in Canada. In Washington and Oregon it occurs in well-drained natural and artificially maintained habitats including avalanche meadows, pastured forest meadows and grassy roadsides at elevations from 5000 to 6360 feet in Oregon and 2100 to 6360 feet in Washington. In Colorado and California it occurs in mountain meadows and shrublands above 10,000 feet. In southern California and Nevada, *B. ascendens* can be found around seep fens and streams. Minnesota plants are known from transition meadows between forest and lake shores in the northwest and on sediments of old iron tailings ponds in the northeast, growing in sparse to dense cover of grasses, forbs and small shrubs. Similarly, Vermont plants are known only from an old quarry site.

## Population Genetics

Genetic analysis of *B. ascendens* across its range has revealed two distinctive genotypes. The most common and widespread genotype is shared by all known populations in the contiguous western United States and the coastal populations in Alaska and Newfoundland and Quebec. A second genotype is found in the Minnesota and Vermont plants. The genetic differences between these types result primarily from differential silencing, at some gene loci, of alleles from one or the other of the species' diploid ancestors (see general discussion). It is possible that these elements are derived from different initial hybridization events. Maintenance of these different genetic entities implies historical and continued isolation of these eastern US plants due to differences in habitat requirements that prevent intermixing of genotypes.

Although some genetic variation exists among populations of *B. ascendens*, within-population variation is essentially non-existent. This likely results from a high level of inbreeding as well as some vegetative reproduction via underground gemmae. High genetic uniformity among populations within each of the two genotypes discussed above suggests relatively recent spread of each genotype to its current distribution (Zika and Farrar 2009).

## Phylogenetic Relationships

*Botrychium ascendens* is an allotetraploid species ( $n=90$ ). Its morphological intermediacy and its allelic constitution indicate probable derivation from an original hybridization between the diploid species *B. lunaria* var. *crenulatum* and *B. campestre*, followed by restoration of fertility through chromosome doubling. Because of the genetic and morphological similarity between *B. campestre* var. *campestre* and *B. campestre* var. *lineare* it is not possible to determine conclusively which of these varieties is the most probable ancestral parent of *B. ascendens*. The Midwestern range of *B. campestre* var. *campestre* might be considered to favor that species as the parent of Minnesota and Vermont populations (var. *campestre* is also present in both sites) and the recent discovery of *B. lunaria* var. *crenulatum* in northern Minnesota supports such an origin. *B. campestre* var. *lineare* and *B. lunaria* var. *crenulatum* overlap throughout the western range of *B. ascendens*. Perhaps the best resolution of the parentage question is to assume the non-*crenulatum* ancestor of *B. ascendens* to be the same as the ancestor of both *B. campestre* varieties.

Additional photographs of *Botrychium ascendens*:

