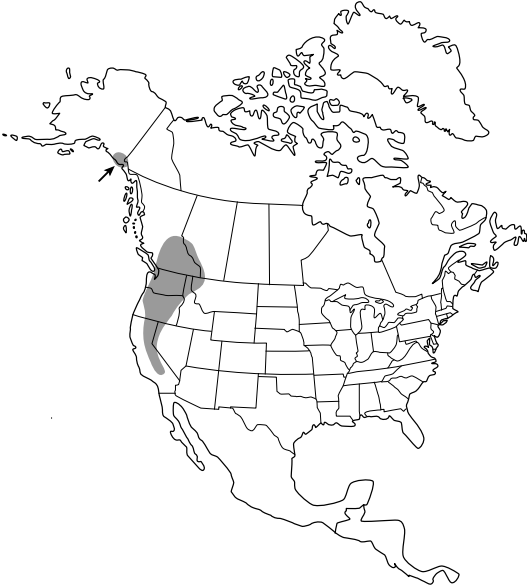


Botrychium montanum

Family: Ophioglossaceae
Genus: *Botrychium*
Species: *Botrychium montanum* W. H. Wagner
Common names: Western goblin, Mountain moonwort
Ploidy: Diploid



Technical description—Leaf 8.7 (4-12.5) cm tall, herbaceous, glaucous, dull; the common stalk making up 60 (40-90) per cent of the total length; sterile segment oblong to linear, 2.1 (0.7-4.0) cm long, 5.5 (2-9) mm wide, the stalk 0.7 (0.3-1.5) cm long; lobes 3 (1-6) pairs, irregular, narrow and pointed, oblong, square, often grouped or confluent, the distal margins irregularly toothed to lacerate, frequently with linear teeth, basal lobes lacking tendency for enlargement; the blade tip usually with 2-4 angular, triangular to oblong teeth or lobes; fertile segment 3.7 (1-6.5) cm tall, not (or only rarely) branched below the upper two-thirds; sporangia not sunken, opening in July and August, the aperture wide, 40-90 μ ; spores 54 (47-57) micrometers in diameter; chromosomes $2n = 90$. (Wagner and Wagner, 1981; F.S. Wagner, 1993)



Taxonomy

Botrychium montanum was described as a new species in 1981, based on specimens from Lake Co., Montana (Wagner and Wagner, American Fern Journal 71:20-30). Photographs and silhouettes of the species are included in that publication.

Western goblin is so named because of its gray-green appearance and occurrence in dark moist habitats. Moreover its common name refers to its similarity to *Botrychium mormo*, the eastern goblin or little goblin moonwort of the Great Lakes Region. Because of the similarities between the two species, Wagner and Wagner (1993) noted in Flora North America that "*Botrychium montanum* may come to be recognized as a subspecies of the eastern *B. mormo*."

Identification

In the publication describing both species, Wagner and Wagner (1981) listed eight morphological differences between *B. montanum* and *B. mormo* as well as differences in range, habitat and phenology. The most distinctive features of *B. montanum* (relative to *B. mormo*) are a glaucous surface, irregularly and more deeply cut pinnae, confluence of pinnae, and broadly opening sporangia.

Among other western moonworts, *B. montanum* most closely resembles small forms of *B. simplex*. It differs from *B. simplex* in having a sporophore-trophophore union well above ground level, rhomboid pinnae with toothed outer margins, and basal pinnae that are seldom enlarged and further divided. Both trophophore and sporophore of *B. montanum* stand stiffly erect whereas both segments tend to be lax in *B. simplex*. The rectangular shape of the upper pinnae, their broad (adnate) attachment to the rachis and straight outer margins, as well as distinct marginal teeth also serve to distinguish *B. montanum* from small forms of *B. minganense* and similar species.

Distribution and Abundance

Botrychium montanum has a relatively narrow range of distribution from southern California northward through Oregon and Washington to British Columbia and southeastern Alaska. Eastward it extends through northern Idaho and northwestern Montana.

The largest populations of *B. montanum* often contain hundreds of individuals and in parts of its range (e.g., northeastern Washington) it is among the more predictable of moonworts, regularly being present under riparian old growth cedar (*Thuja plicata*). Elsewhere it becomes less common and often occurs in small populations or as isolated individuals.

Because of its distinctive morphology and its conspicuous occurrence in areas of sparse vegetation, *B. montanum* is unlikely to have been frequently overlooked in its habitat under dense old-growth forest. In dense herbaceous vegetation of fens and meadows, its small size makes it very inconspicuous. Thus significant new discoveries of *B. montanum* are most likely to be made in the latter habitats in areas outside the range of inland western red cedar.

In California, *B. montanum* populations in Kern, Modoc and Tehama Counties have been genetically confirmed. Collections from Butte County are also undoubtedly of this species. In Butte, Tehama and Kern Counties, *B. montanum* occurs under stands of *Calocedrus decurrens*. Possibly the litter from these trees creates a substrate similar to that of the *Thuja plicata* habitats of this species in Washington. Species of the Cupressaceae are also known to support endomycorrhizal fungi which are required by species of *Botrychium*.

Habitat

The preferred habitat of *Botrychium montanum* in the northern part of its range is under old growth western red cedar (*Thuja plicata*) on alluvial terraces along small to moderate sized streams where the soil is moist and high in organic matter. In most of its known locations in California it grows in similar soils under incense cedar (*Calocedrus decurrens*). It should be sought in such habitats at high elevations throughout the state.

The other primary habitat of *B. montanum* is in fens, seeps and meadows along streams where the substrate is saturated. Though these habitats of dark forest and open meadows have opposite extremes of light, they have in common a continuous supply of moisture and a high mineral content. Leaf litter of *Thuja* is well known for supporting species of bryophytes and ferns that elsewhere grow on calcareous substrates including fens and limestone/dolomite cliffs. Species of Cupressaceae are also highly supportive of the species of fungi that form mycorrhizal associations with species of *Botrychium*.

A recent discovery of large populations of *B. montanum* in mountain meadow habitat on Mt. Baker in Washington indicates another potentially underexplored habitat for this species. High elevation meadows composed primarily of herbaceous perennial vegetation are productive habitats for many *Botrychium* species throughout western North America. Perennial herbaceous vegetation is well documented as supportive of endomycorrhizal fungi.

Population Genetics

Considered on a range-wide basis, *Botrychium montanum* is among the more variable of moonworts. The number of loci that are polymorphic, at 40 %, and the average number of alleles per locus, at 1.40, is exceeded only by *B. campestre* and

B. simplex and European *B. lunaria*. These numbers are low in comparison to other ferns (avg. 60.2% polymorphic loci and 2.3 alleles per locus) and reflect the high degree of intragametophytic selfing in most *Botrychium* species. Variation within populations is virtually absent.

Plants from saturated fen habitats in the Wallowa Mountains of northeastern Oregon, while not differing greatly from non-fen plants either morphologically or genetically, are of interest because they possess an allele for phosphoglucose isomerase (PGI) otherwise unique to *B. mormo*. All populations of *Botrychium mormo* in Minnesota and Michigan are fixed for this allele. This could indicate that western fen plants were the original source of plants that differentiated into *Botrychium mormo*. As expressed by Wagner and Wagner (1993), the close relationship between these taxa might be more appropriately expressed as different varieties or subspecies of a single species.

Phylogenetic Relationships

Botrychium montanum is genetically very similar to *Botrychium mormo*. Although allele frequencies differ between the two species, neither possesses alleles not also present in the other. Among other moonworts, the closest relative of these two species is *B. simplex*.

Botrychium montanum is not known to have participated in the formation of any allotetraploid species. Presence of several gene alleles unique to *B. montanum* and *B. mormo* make it unlikely that such parentage has gone undetected.

Additional images of *B. montanum*

