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Rare Plant Status Review: *Botrychium tunux*

Proposed New Add to Rank 2.1, G3? / S1

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Changes made to original document appear in blue text.

Three *Botrychium* species (*B. paradoxum*, *B. tunux*, and *B. yaaxudakeit*) are new to California and were recently discovered by Alison Colwell in the vicinity of Yosemite National Park. They are individually discussed in separate status review proposals; however, all of the proposals contain the same background information on the *Botrychium* genus, which is outlined in the first section below.

Background on the *Botrychium* genus

The genus *Botrychium* is a group of ferns in the Ophioglossaceae that are perennial rhizomatous herbs. Understanding the unique *Botrychium* morphology is important to differentiating species. The aboveground sporophyte, which only emerges some years, consists of a single leaf divided into a sporophore (spore-bearing segment) and trophophore (vegetative segment). The majority of *Botrychium* spp. are cryptic, owing to their paucity of morphological features, the plasticity of those features, and the fact that many morphologically similar species are separated by genetic isolating mechanisms (Hauk and Haufler 1999). Because of this, all but one of the known California occurrences of the three species have been confirmed through genetic testing by Dr. Don Farrar (D. Farrar pers. comm. 2011).

Some general threats and management considerations for these three species can be inferred from studies done on other *Botrychium* spp. The California occurrences are highly disjunct from neighboring populations (D. Farrar pers. comm. 2011). Many such plants would be considered at risk of inbreeding depression or genetic drift; *Botrychium* spp., however, reproduce almost exclusively by intragametophytic self-fertilization, eliminating these concerns (J. Clines et al. 2009, D. Farrar, and C. Johnson 2011).

These plants are highly dependent on endomycorrhizal associations with fungi in the genus *Glomus* throughout their life cycle. The *Glomus* fungi are dependant on other green plants for photosynthetic nutrition, and they strongly prefer to associate with perennial herbs (as well as trees in the Cupressaceae and a few broadleaf tree species; D. Farrar pers. comm. 2012). Perennial herbaceous vegetation can be a short-lived successional stage following anthropogenic disturbances. Therefore, some individuals and populations of rare *Botrychium* spp. as a whole tend to be ephemeral, growing only after the herbaceous vegetation has had time to colonize and before other vegetation has taken over (generally 15 to 50 years post-disturbance). Three different *Botrychium* spp. (including *Botrychium paradoxum*) studied over 6 years had relatively short life spans of individuals after sporophyte emergence, with half-lives ranging from one to three years (Lesica and Ahlenslager 1995). However, *Botrychium* spp. also grow

in habitats with perennial herbaceous vegetation that is not maintained by anthropogenic disturbance, such as mountain meadows and prairies. Recent observations from naturally-formed habitats have shown that individuals can have significantly longer life spans, ranging from 20 to more than 44 years (D. Farrar pers. comm. 2012). The high-elevation populations of *B. yaaxudakeit*, *B. tunux*, and *B. paradoxum* are more likely to be longer-lived, given that they occur in more stable, natural habitats.

~~Also, many populations of *Botrychium* spp. undergo routine extirpations and colonizations of new areas, which could be attributed to their affinity for a moderate degree of disturbance (Clines et al. 2009). However, *Botrychium* spp. populations are usually highly buffered, with a “seed bank equivalent” consisting of spores, gametophytes, and underground sporophytes (Clines et al. 2009). While similar demographic data are not available for *Botrychium tunux* and *Botrychium yaaxudakeit*, the possibility of natural extirpation of the California occurrences of these 3 species over time should be considered. Because of these typical population dynamics, the California occurrences of these rare *Botrychium* spp. should be monitored frequently, and surrounding lands with potential habitat should be surveyed and managed for the potential colonization of spores to form new populations (Clines et al. 2009).~~

Background on *Botrychium tunux*

Botrychium tunux is distributed intermittently from Alaska south to California and ~~eastwest~~ to Montana and Colorado, with some populations also occurring on Norwegian islands (Stensvold and Farrar 2008, *TJM 2*). It was first described by Stensvold et al. (2002) and is included in *TJM 2* (available online at http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=91732), but was not included in *Flora of North America, Vol. 2* or *The Jepson Manual* (1993). This diploid species is closely-related to and can co-occur with *Botrychium lunaria*. *Botrychium tunux* is distinguished by its “short stature, short common stalk, frequently-stalked ovate trophophore, asymmetrical pinnae with their basiscopic side expanded, entire margins commonly cleft by shallow incisions with rounded sinuses, and sporophore stalks seldom exceeding the height of the trophophore” (Stensvold et al. 2002). Prior to its description by M.C. Stensvold et al. in 2002, *B. tunux* specimens would have likely been treated as stunted individuals of *B. lunaria*. The phenology of this plant in California is unknown, but given the elevation of the occurrence and the phenology of other *Botrychium* spp. in California, the aboveground sporophytes were likely observed in August or September.

Botrychium tunux occurs in alpine boulder and rock fields, growing in a moist turf on calcareous substrates. It is found at an elevation of approximately 3,050 meters (Taylor 2010).

Botrychium tunux is known from only a single occurrence in California, ~~although earlier observations could have been confused with *B. lunaria*~~. It was found on Mount Hoffman in Yosemite National Park (Mariposa county; Taylor 2010). Most of the known collections of *Botrychium lunaria* have been confirmed by D. Farrar through review of

herbarium specimens; of the California specimens examined, none have proven to be *B. tunux* (D. Farrar pers. comm. 2011). However, five occurrences of *B. lunaria* in the California Natural Diversity Database (CNDDDB; EO #s2, 5, 6, 7, and 8) are known only from field survey forms or literature, with most of the surveys occurring prior to the description of *B. tunux*. These sites should be revisited, and specimens should be collected and analyzed to confirm their identity. Additional surveys should also be conducted in appropriate habitats in the vicinity of the Yosemite occurrence.

Botrychium tunux is ranked Critically Imperiled (S1; generally <5 occurrences) in Montana and the Yukon Territory in Canada, and Imperiled (S2, generally 5-20 occurrences) in Alaska (NatureServe 2011), where it is most abundant (Farrar 2011). [The rankings in the Yukon Territory and Alaska are likely not representative of the actual number of occurrences, as *B. tunux* is quite common Wrangell-St. Elias National Park, Kluane National Park, and along the Alaksa Highway \(Farrar 2008, D. Farrar pers. comm. 2012\)](#) It is not ranked in other states where it is known to occur (California, Colorado, Nevada, New Mexico; *TJM* 2, D. Farrar pers. comm. 2011), and is not rare throughout its entire range (D. Farrar pers. comm. 2011).

Threats to the only California occurrence are not known, but given its occurrence in a National Park, it should be relatively well-protected. However, given the scarcity of the species in California, as well as the ephemeral nature of some populations of *Botrychium* taxa, CNPS and CNDDDB recommend that *Botrychium tunux* be added to California Rare Plant Rank 2.1 of the CNPS Inventory. If some of the California *Botrychium lunaria* populations are discovered to actually be *B. tunux*, its threat rank may be re-evaluated at that time.

Recommended Actions

CNPS: Add *Botrychium tunux* to 2.1

CNDDDB: Add *Botrychium tunux* to G3? / S1

Draft CNPS Inventory Record

Botrychium tunux Stensvold & Farrar

moosewort

Ophioglossaceae

Rank 2.1

Mariposa

Alaska, Colorado, New Mexico, Montana, Nevada

Yosemite Falls or Tenaya Lake quad

Alpine boulder and rock fields / calcareous; elevation 3050 meters.

Perennial rhizomatous herb. Fertile in August to September.

Discovered in California in 2008 by Alison Colwell; known only from Mt. Hoffman in Yosemite NP. Similar to *B. lunaria*. Not in *The Jepson Manual* (1993). See *American Fern Journal* 92(2):150-160 (2002) for original description.