ARIZONA GAME AND FISH DEPARTMENT
HERITAGE DATA MANAGEMENT SYSTEM

Plant Abstract **Element Code:** PPOPH010M0
Data Sensitivity: No

CLASSIFICATION, NOMENCLATURE, DESCRIPTION, RANGE

NAME: *Botrychium echo*
COMMON NAME: Reflected Moonwort, Echo Moonwort, Reflected Grapefern
SYNONYMS: none
FAMILY: Ophioglossaceae

AUTHOR, PLACE OF PUBLICATION: Wagner, Warren Herbert. American Fern Journal 73: 57. 1983.

This publication identifies the new species, *B. echo*, as distinct from *B. hesperium*. The authors state that their interpretation is based upon over 200 specimens of *B. hesperium* studied in the field in seven localities, and over 300 of the new species, *B. echo*, in ten localities. The two species grow in such similar habitats that one description of the habitat will suffice for both. They tend to occur together, often side-by-side. The two most productive localities were in Arizona at Mount Baldy and at San Francisco Peaks. In the former locality, *B. hesperium* was absent, but at the latter we recorded 88 individuals of this species. A

TYPE LOCALITY: Colorado: Boulder: Glacier Lake. 2800m.

TYPE SPECIMEN: US 135832 (holotype). E Bethel and I.W. Clokey, #3987a. July 20, 1921.

TAXONOMIC UNIQUENESS: According to NatureServe (2016), there are 35 species, two varieties and one named hybrid of *Botrychium* in the United States and Canada. Ten of these species and one of the varieties occur in Arizona. *B. echo* is reported to hybridize with *B. hesperium.* NatureServe also states that the report for northern Arizona needs to be verified. Presumably this is due to the fact that the species has not been collected in Arizona for 40 years, and is not an identification issue because the species' author collected specimens from both of the known Arizona occurrence sites.

DESCRIPTION: Trophophore stalk 0--4 mm; blade shiny green, broadly oblong to oblong-deltate, 1--2-pinnate, to 4 × 3cm, firm. Pinnae to 4 pairs, spreading or only moderately ascending, well separated, distance between 1st and 2d pinnae not or slightly more than between 2d and 3d pairs, basal pinna pair approximately equal in size and cutting to adjacent pair, oblanceolate to linear-spatulate, ± parallel-sided, divided to tip, shallowly lobed or rarely 2-cleft, basal pinna cleft into single basiscopic projection and large acroscopic projection,

margins entire, apex acute, venation pinnate. Sporophores 1--2 pinnate, 1--2 times length of trophophore rachis. 2 n =180. Flora of North America 2016.

AIDS TO IDENTIFICATION: A perennial fern that produces a shiny green leaf (the trophophore) and a taller, erect spore-bearing spike (the sporophore). Both arise from a common stalk and can be thought of as a single, highly modified fern frond. This species tends to have a reddish brown stripe along the common stalk from the base of the trophophore stalk. Mature plants are 3-15 cm tall. *B. echo* produces clusters of minute, spheric gemmae at the root bases.

Botrychium echo is one of four moonwort species that commonly produce clusters of minute, spheric gemmae at the root bases. This species tends to have a reddish brown stripe along the common stalk from the base of the trophophore stalk.

The following key to the species of the *Botrychium lanceolatum* group is taken from Wagner and Wagner 1983:

1. Sterile lamina broadly deltate, sessile to subsessile; sporophores of full-sized plants usually composed of several major upright axes; plants of northern North America .....*B. lanceolatum*
1. Sterile lamina mostly oblong to oblong-deltate, subsessile to stalked; sporophores of full-sized plants usually with one major upright axis, sometimes with one or two upright laterals.
   2. Sterile segment mostly conspicuously stalked, the stalk 20-30% of the blade length; segment tips usually serrulate or crenulate; living lamina pale blue-green, dull; sporophore commonly twice as long as sterile lamina; plants of eastern North America .....*B. matricariifolium*
   2. Sterile segment short-stalked or subsessile, the stalk 5-20% of the blade length; segment tips usually entire, repand, or pointed; living lamina color various; sporophore usually only 1.5 times as long as sterile segment (except in B. hesperium); plants of western North America.
      3. Pinnae and lobes well separated, not approximate or overlapping, mostly more or less parallel-sided, linear to oblanceolate; pinna tips pointed; basal pinnae, except in the smallest and largest fronds, usually deeply cleft into a single lower projection and larger upper projection; lamina shiny green in life .....***B. echo***
      3. Pinnae and lobes usually approximate or overlapping, the large ones abruptly contracted at base, oblong-lanceolate to ovate to deltate; pinna tips blunted or rounded; basal pinnae not cleft into two projections; color and luster various.
         4. Pinnae with few lobes, these mainly on the basal side; lowest pinnae exaggerated, ascending and subclasping, strongly asymmetrical, the lower side with coarse basiscopic lobe; segments broadly adnate at base; lamina gray-green, dull in life .....*B. hesperium*
         4. Pinnae with numerous lobes, these roughly equal in number on the upper and basal sides; lowest pinnae mostly equal to or slightly larger or smaller than next distal pair, not ascending or clasping, nearly symmetrical, the lower side with small lobes subopposite to those on upper side; segments narrowly adnate at base; lamina bright green, shiny in life…. *B. pinnatum*

ILLUSTRATIONS:
Photos and Herbarium Mount:
http://swbiodiversity.org/seinet/taxa/index.php?taxon=Botrychium%20echo.
http://eol.org/pages/488495/media.

TOTAL RANGE: Northern Utah (a single, and questionable, historical occurrence), throughout the central Colorado Rocky Mountains, into northern New Mexico, and Arizona. There is also a report from British Columbia.

RANGE WITHIN ARIZONA: Collected from two locations: San Francisco Mountain north of Flagstaff in Coconino County, and Mount Baldy, Apache County.

SPECIES BIOLOGY AND POPULATION TRENDS

GROWTH FORM: A short perennial fern.

PHENOLOGY: Leaves appearing in June, dying in September.

BIOLOGY:

HABITAT: Grassy mountain slopes, snow fields, road ditches, edges of lakes, and sand dunes. Also disturbed subalpine forest sites such as avalanche chutes, gravel bars and logged areas). Usually in gravelly soils. (Flora of North America 2016 and EOL 2016).

The two species (*B. hesperium and B. echo*) grow on grassy slopes, roadsides, and at edges of lakes. The soil is usually rocky, the substrate including decomposed granite as well as other rock types. In the southern Rockies the plants grow at elevations between 8,500 and 11,500 ft. The easiest way to find them is to drive along roads at proper altitudes and to seek flat roadside ditches with gravelly soil and scattered shrubby vegetation, *Picea* saplings and *Salix* shrubs dominating. Plants are sometimes found growing even in the gravel of the road shoulder (Wagner and Wagner 1983, publication describing the species). Seek- ers of these plants should be warned that only one out of ten or twenty seemingly appropriate habitats yield these *botrychiums*.

ELEVATION: 8200 – 12135 feet (2500-3700m) range-wide. Arizona collections range from 9600 – 11200 feet (2925-3415m).

EXPOSURE: Apparently fairly open. Two of the Arizona collections noted full sunlight or partial shade from trees.

SUBSTRATE: Gravelly soil.

PLANT COMMUNITY: In addition to spruces and willows, other woody associates encountered are *Lonicera involucrata, Potentilla fruticosa*, and species of *Abies, Juniperus*, and *Ribes*. The herbaceous associates include weeds and involve such genera as *Achillaea, Antennaria, Arenaria, Carex, Cerastium, Epilobium, Festuca, Fragaria, Frasera, Mertensia, Penstemon, Potentilla, Saxifraga, Sedum, Selaginella, Setaria, Solidago, Trifolium, Valeriana,* and *Zygadenus* (Wagner and Wagner 1983).

Plants noted at Arizona collection sites include open meadows in spruce-aspen forest or scattered *Pinus aristata*, spruce and fallen logs. Others species include: *Potentilla, Castilleja, Fragaria, Lonicera, Arenaria, Carex, Bromus, Cystopteris, Lupinus, Penstemon, Achillea, Sedum rhodanthum, Pseudotcymopteris, Draba.*

POPULATION HISTORY AND TRENDS: Unknown for Arizona. There are 3-5 historic occurrences but these have not been re-verified for 40 years. At the time of collection, all sites noted that the species was common. The range-wide distribution tallies around 60 occurrences, with the vast majority in Colorado, where the species is ranked between vulnerable and secure. B. echo is ranked critically imperiled in Arizona because of its very limited distribution. NatureServe defines the short-term trend as relatively stable (<=10% change).

SPECIES PROTECTION AND CONSERVATION

ENDANGERED SPECIES ACT STATUS: None.
STATE STATUS: None.
OTHER STATUS: None.

MANAGEMENT FACTORS: This species naturally occurs on disturbed sites, therefore it is somewhat tolerant. However, it cannot withstand trampling from sheep grazing and it can be a forage plant for animals (NatureServe 2016).

PROTECTIVE MEASURES TAKEN: *Botrychium echo* is not listed or proposed. All occurrences within Arizona are within Forest Service Wilderness Areas, which offer some level of protection.

SUGGESTED PROJECTS: Since the species has not been verified as extant in Arizona for 40 years, field surveys at known collection locations should be undertaken.

LAND MANAGEMENT/OWNERSHIP: USDA Forest Service: Coconino (Kachina Peaks Wilderness) and Apache-Sitgreaves (Mount Baldy Wilderness) National Forests.

SOURCES OF FURTHER INFORMATION

REFERENCES:

Encyclopedia of Life (EOL), accessed 5/25/2016, http://eol.org/pages/488495/details.

Flora of North America (eFloras.org), accessed 5/24/2016, http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=233500276.

JStor|Global Plants, accessed 5/24/2016, https://bioticsaz.natureserve.org/biotics/services/page/Eo/23330.html.

NatureServe Explorer, accessed 5/25/2016, www.natureserve.org.

Tropicos, accessed 5/24/2016, http://www.tropicos.org/Name/26604469.

Wagner, W.H. Jr. and Florence S. Wagner. 1983. Two Moonworts of the Rocky Mountains: *Botrychium hesperium* and a New Species Formerly Confused with It. American Fern Journal 73(2): 53-62.

MAJOR KNOWLEDGEABLE INDIVIDUALS:

ADDITIONAL INFORMATION: The Greek specific epithet echo is used here in apposition. It was chosen to reflect the fact that this moonwort seems to repeat the characteristics of other, similar species. One of the best areas to study it is where we first recognized its distinctions from *B. hesperium*, namely Echo Lake on the slopes of Mount Evans, Colorado (Wagner and Wagner 1983)

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