

Species Status Assessment
for
Clustered Broomrape
(*Orobanche fasciculata*)



Photo by Susan R. Crispin, published by Michigan Natural Features Inventory

Illinois Department of Natural Resources
March 2023

Section 1: Species Description

Taxonomy

Orobanche fasciculata Nutt. (Family: Orobanchaceae) is known by many scientific names, including *Anoplanthus fasciculatus* (Nutt.) Walp., *Thalesia fasciculata* (Nutt.) Britton, *Thalesia lutea* (Parry) Rydb., and *Aphyllon fasciculatum* (Nutt.) Torr. & A. Gray in the Illinois area. Its common names include tufted broomrape, purple broomrape, clustered cancerroot, and clustered broomrape (or broom-rape) as it is known in Illinois (IT IS, 2023; Brotherson et al., 2005). Schneeweiss et al. (2004) sought to identify several different clades in the large Orobanchaceae family and found *O. fasciculata*'s closest relative to be *Orobanche uniflora*, or the one-flowered broomrape, and was placed in the *Phelipanche* group with the *Myzorrhiza* and *Trionychnon* sects. They also pointed to the possibility of New World *Orobanche* radiating into Eurasia, although more work should be done to confirm this theory.

O. fasciculata and *O. uniflora* are proposed to be in their own clade called *Gymnocaulis* based on examination of their *rbcL* gene, which is functional in some New World species of *Orobanche* but found to be a pseudogene or nonfunctional in other Old World Species (Manen et al., 2004). Based on *matK*-only analysis, traditional Orobanchaceae (those of the family in the Old World) have one common ancestor, although the genus *Orobanche* was proposed to be diphyletic with moderately high support, implying a different common ancestor for the New World *Orobanche* than that of the Old World *Orobanche*. However, the study found that the support values for a New World clade were low, and the result should be regarded as preliminary. In a separate study, the New World *Orobanche* were moderately well-supported in a finding to be allied with *Boschniakia*, now considered a genus in the broomrape family (Young et al., 1999; Washington Department of Natural Resources, 2003).

Schneider et al. (2016) proposes that *O. fasciculata* is paraphyletic, based on Bayesian ITS/ETS analysis and analysis of three plastid regions, and separates the species into three clades. One clade of *O. fasciculata* was strongly supported to be a sister species to *O. uniflora* and parasitizes *Artemisia* plants across the currently accepted range of *O. fasciculata*, while the other two clades were proposed as sister clades that either parasitized *Galium* species in California and Oregon, or were a more generalist parasite across the Western U.S. Despite this, no taxonomic species description was provided for the three new clades at that time.

Shortly after the Schneider et al. (2016) paper however, Colwell et al. (2017) went on to describe the *O. fasciculata* clade parasitizing *Galium* species as *Aphyllon epigalium*, although it did not address the other two clades. Later, Schneider and Benton (2021) managed to provide a description for these two clades, describing the generalist species found in the Western U.S. as *Aphyllon francisanum*, and the *Artemisia* parasite found more widely as *Aphyllon fasciculatum*. Should these descriptions become more widely accepted, the Illinois populations of *Orobanche fasciculata* would be renamed as *Aphyllon fasciculatum*.

The current classification for this species is (NatureServe Explorer, 2023, *Orobanche fasciculata*):

Kingdom: Plantae

Phylum: Anthophyta

Class: Dicotyledoneae

Order: Scrophulariales

Family: Orobanchaceae

Its NatureServe Element Code is PDORO04060, its USDA Plant Symbol is ORFA, and its GenBank number is AY209296 (Schneeweiss et al., 2004; USDA, 2023; NatureServe Explorer, 2023, *Orobanche fasciculata*).

Physical characteristics

O. fasciculata is known to be a stout, holoparasitic (non-photosynthesizing and lacking in chlorophyll) root parasite that is somewhere between 3-10 mm thick and 3-15 cm long. It is purplish to yellowish in color, depending on the variety, and grows with a split stem. It has yellow-brown, scale-like leaves that are hairy and widest towards the stem base, and a fleshy stem that is mostly contained underground. At germination, the seed develops a root-like structure called a radical, which attaches itself to the inside of the host root with a haustorium, allowing it to siphon off the host's nutrients. Its inflorescence can reach up to 15 cm with "perfect, zygomorphic flowers" in a "loose, flat-topped corymb" (Reuter, 1986). It has rose-purple buds with a corolla that becomes changes color from lavender, pink, to creamy white upon anthesis. It is most visible after it forms erect fruiting capsules, when the plant turns dark brown in contrast to its typical habitat of open sand dunes (Achey, 1933; Wolfe and dePamphilis, 1998; Brotherson et al., 2005; Michigan Natural Features Inventory, 2004; Reuter, 1986). The flowering and fruiting parts of the plant would sometimes be found as far away as a foot or two from their actual host plant (Hill, 1892).

Luiza Teixeira-Costa and Charles Davis (2021) would classify *O. fasciculata* as an obligate root parasite, dependent on the host from its earliest development and growing mostly underground for long periods of time. In Illinois, it is classified as a native perennial forb (Illinois Natural History Survey, 2020). Keeping herbarium specimens is known to be difficult, as the "dried specimens lose colors and become blackish, making herbarium specimens difficult to identify" (Manen et al., 2004).

A similar, but more common species that can be mistaken for *O. fasciculata* is *Orobanche uniflora*, or the one-flowered broom-rape, which can be distinguished from *O. fasciculata* by its shorter height, hairless leaves, and fewer flowers on longer stalks that are colored violet instead of purple and/or yellow (Michigan Natural Features Inventory, 2004).

Habitat

O. fasciculata is generally found in arid grasslands or dune systems, and "tend[s] to aggregate in interdunal troughs, on the lower dune slopes, and adjacent to individuals or stands of *Pinus banksiana* Lamb. and *Salix* sp." (Reuter, 1986). It is found in open dunes in Michigan,

usually “on the leeward slope of the first or second dune ridge inland from the lake” (Michigan Natural Features Inventory, 2004; Higman et al., 2012), and favors sand deposits dominated by *Calamovifa longifolia* where its only known host in Michigan, *Artemisia campestre*, is common. In Wisconsin, the habitat includes a dune system comprised of beach dunes and foredune ridges, buttress dunes, interdune troughs with small hillocks of sand, a series of hills, a maze of compound blowouts and sand draws, and a back rim of a blowout area leading abruptly to a forest margin (Reuter, 1986).

Farther west, however, it is usually found in dry plains and prairies (Michigan Natural Features Inventory, 2004), and is known to have a variety of habitats across its wide distribution including arid shrub- and grasslands, pinyon and juniper woodlands, aspen, and fir communities. For *O. fasciculata* to germinate, it requires chemical stimulation excreted by its host’s root, and will share the same habitat as its host plant regardless of its geographical location (Brotherson et al., 2005; Hill, 1892).

In Illinois, according to the Illinois Natural History Database (2023), the plant is found in loess and sand hill prairie in and around an old sand mine and in the loose sand of a gravel pit, dry-mesic prairie in an open sandy area slightly upland from a beach, in a foredune, in sparsely vegetated dry sand ridges, and in a restored prairie area with *Schizachyrium scoparium* and *Artemisia campestris*. Other associates in Illinois include *Lobelia spicata*, *Juniperus horizontalis*, *Carex tetanica*, *Maianthemum stellatum*, and *Arctostaphylos uva-ursi*.

Life History and Reproduction

O. fasciculata is only able to germinate after being triggered by root secretions from its host plant for 1-2 weeks, after which a radicle from the seed grows towards the host root and establishes a haustorium (a parasitic structure like a root), which then invades the root of the host plant. *O. fasciculata* then develops a fleshy, tuberous structure around its apical meristem, which will then develop into flowering and fruiting stalks, seen in Illinois anywhere from April to August (Michigan Natural Features Inventory, 2004; Illinois Natural History Survey, 2020; Brotherson et al., 2005). Its flowers will open synchronously over the course of 3-7 days, with flowering continuing through late July and fruiting occurring in July and August, causing its seed to be shed throughout the winter. *O. fasciculata* seeds weigh very little and are smaller in diameter than an average grain of sand, and although most seeds remain near their parent plant, their small size and cavity-filled structure aids in their dispersal via wind and rainwater (Reuter, 1986; Michigan Natural Features Inventory, 2004). Every stage of life for *O. fasciculata* requires its host plant, unlike some other parasitic plants. (Teixeira-Costa and Davis, 2021).

Although often classified as an annual, it is unclear exactly how long *O. fasciculata* really lives. Its only known host in Wisconsin is *Artemisia caudata*, which is known to be a facultative biennial. In addition, *O. fasciculata* was primarily observed on flowering plants in the largest class size, suggesting that it prefers to parasitize the older, more mature plants that are not likely to live for another year, although it could be present under the ground on the roots of younger plants without producing flowers or fruit. However, other hosts of *O. fasciculata* are perennials,

which could mean that the plant is able to survive and reproduce on its host for multiple seasons. (Reuter, 1986).

Conservation Status

O. fasciculata is globally ranked as a G4 – Apparently Secure species, although it remains critically imperiled at the edges of its range. It remains unranked (SNR) in Arizona, California, Colorado, Idaho, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, and Washington. It is ranked as S5 – Secure in the Canadian province of British Columbia, and S4 – Apparently Secure in the Saskatchewan province and Montana, and in Wyoming it is ranked S4S5, somewhere between Apparently Secure and Secure. It is ranked as S3 – Vulnerable in the provinces of Alberta, Manitoba, and the Yukon Territory, and ranked as S2 – Imperiled in Michigan and Minnesota. It is ranked as **S1 – Critically Imperiled** in Alaska, **Illinois**, Indiana, Iowa, Kansas, and Wisconsin (NatureServe Explorer 2023). It was first listed as endangered in Illinois in 1980 due to restricted habitats or low populations, and is not listed federally (Mankowski, 2012; Michigan Natural Features Inventory, 2011)

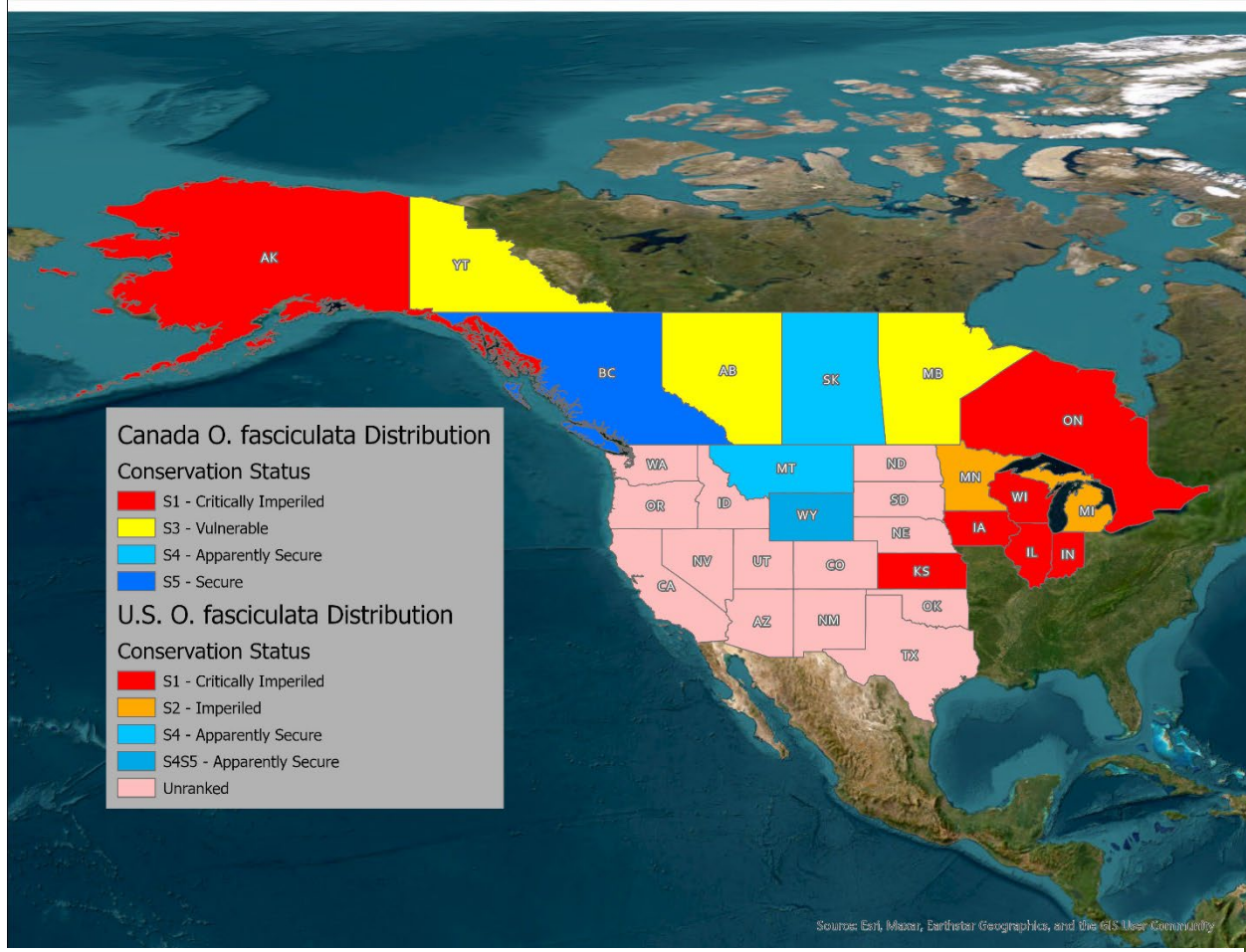


Figure 1: *Orobanchaceae fasciculata* Distribution and Conservation Status

Section 2: Range and Distribution

Range

The currently accepted range of *O. fasciculata* is widespread across North America, although its recent discovery of paraphyletic origins and descriptions of the different clades could warrant a change in the *O. fasciculata* classification (Schneider et al., 2016). With its current classification, *O. fasciculata*'s range is from Alaska and the Yukon to the north, all the way down the Pacific coast to California, south to Texas, and east to Indiana, Michigan, and Ontario, although it does not appear to be found in Missouri or Arkansas (NatureServe Explorer, 2023). Over most of this range, the *O. fasciculata* clade that relies on *Artemesia* host is most widespread, found in much of the range mentioned by NatureServe Explorer, and called *Aphyllon fasciculatum* in the descriptions provided by Schneider and Benton (2021; Schneider et al., 2016). *Aphyllon franciscanum*, another current clad of *O. fasciculata*, has a wider range of host plants and is generally restricted to areas west of and including the Rocky Mountain range (Schneider and Benton, 2021; Schneider et al., 2016). *Aphyllon epigalium*, also currently considered another clade of *O. fasciculata*, is highly restricted in its range to a narrow stretch up the Pacific coast from California to Oregon (Colwell et al., 2017; Schneider et al., 2016). See Figure 1 for a map of this species' distribution, as well as its conservation status.

Illinois Distribution

In Illinois, the distribution of *O. fasciculata* is extremely limited, mostly being found in the Chicago area and close to the border of Wisconsin, near Lake Michigan. However, one population was found in Central Illinois, although it has not been seen there for several decades (Figure 2).

Section 3: Abundance

Most Illinois populations of this plant have been ranked as historic. However, in the two locations with recent (within 10 years) observations, the plants are present in very low numbers. Abundance in the state overall is very low.

EO Number	Site Name	Last Observed Date	Plant Count at Last Observed Date	Acreage of EO
1		2000	Unknown	7.7
2		2022-06-17	2 flowering clumps	9.7
3		1988-06-10	1 fruiting plant	7.7
4		2003-06-20	1 flowering plant	0.5
5		2019-06-13	3 flowering clumps	0.5

Table 1: Abundance Measured by EO



Figure 2: Illinois Distribution and EO Rank of *O. fasciculata*

Section 4: Population Identification and Viability

This assessment uses NatureServe’s EO Rank values to determine the viability of the *O. fasciculata* populations in Illinois. Guidance for determining these Element Occurrence Records is provided by NatureServe and used by the Illinois Natural Heritage Database, using the 1-kilometer default minimum separation distance between observations of *O. fasciculata*. This means that any observation of *O. fasciculata* in Illinois that was greater than 1 kilometer away from an existing Element Occurrence would be recorded as a new Element Occurrence.

There are only 5 Element Occurrence records of this species in the state, with 3 of those 5 being ranked as H – Historical since they have not been observed for a long time and have rarely been surveyed for after their last observed date. One population is ranked as C – Fair viability as it was seen in low numbers in 2019, but not observed in a survey taken in 2021, and the other population was ranked as B – Good viability, since it has been seen consistently (albeit in small numbers) over the last several years at that site. Of the 5 EOs in the state, 3 occur on state-owned sites (Illinois Natural Heritage Database, 2023).

EO Number	EO ID Number	Site Name	Last Observed Date	EO Ranking	Justification
1	5258	[REDACTED]	2000	H	Site surveyed once since last observed date, no record of habitat destruction to imply extirpation
2	2926	[REDACTED]	2022-06-17	B	Plant consistently found in this location over many years, but in small numbers
3	1351	[REDACTED]	1988-06-10	H	Site only surveyed one other time in 1989 since last observed date
4	6011	[REDACTED]	2003-06-20	H	Site not surveyed since last observed date
5	12177	[REDACTED]	2019-06-13	C	Plant initially seen in low numbers, not observed in survey conducted in 2021

Table 2: EO Rankings of *Orobanche fasciculata*

Section 5: References

- Achey, D. M. (1933). A Revision of the Section Gymnocaulis of the Genus Orobanche. *Bulletin of the Torrey Botanical Club*, 441-451.
- Brotherson, J. D. (2005). Nutrient Relationships between Orobanche fasciculata Nutt. and its Host Artemisia pygmaea Gray in the Uinta Basin of Utah, USA. *Monte L. Bean Life Science Museum*, 242-247.
- Colwell, A. E. (2017). A New Species of Aphyllon (Orobanchaceae) Parasitic on Galium in the Western USA. *Madrono*, 99-107.
- Higman, P. J. (2012). *High Island Rare Species and Invasive Plant Survey*. Lansing, MI: Michigan Natural Features Inventory.
- Hill, E. (1892). The Host-Plants of Aphyllon fasciculatum. *Bulletin of the Torrey Botanical Club*, 17-21.
- Illinois Natural Heritage Database. (2023, 5 8). *Orobanche fasciculata*. Retrieved from Illinois Natural Heritage Database.
- Illinois Natural History Survey. (2020). *Lost Mound Field Station*. Retrieved from Illinois Natural History Survey, Prairie Research Institute: <https://www.ideals.illinois.edu/items/115422>
- ITIS. (2023, March 10). *Orobanche fasciculata Nutt.* Retrieved from Integrated Taxonomic Information System - Report: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=34290#null
- Labrousse, P. e. (2001). Several Mechanisms are Involved in Resistance of Helianthus to Orobanche cumana Wallr. *Annals of Botany*, 859-868.
- Manen, J.-F. e. (2004). Phylogeny and intraspecific variability of holoparasitic Orobanche (Orobanchaceae) inferred from plastid rbcL sequences. *Molecular Phylogenetics and Evolution*, 482-500.
- Mankowski, A. (2012). *The Illinois Endangered Species Protection Act at Forty: A Review of the Act's Provisions and the Illinois List of Endangered and Threatened Species*. Springfield, IL: Illinois Endangered Species Protection Board.
- Michigan Natural Features Inventory. (2004). *Orobanche fasciculata Nutt., fascicled broomrape*. Lansing, MI: Michigan State University Board of Trustees.
- Michigan Natural Features Inventory. (2011). *Orobanche fasciculata*. Retrieved from Michigan State University: <https://mnfi.anr.msu.edu/species/description/14485/Orobanche-fasciculata>
- NatureServe. (2023, March 3). *Orobanche fasciculata: Clustered broomrape*. Retrieved from NatureServe Explorer:

https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.148729/Orobanche_fasciculata

- Reuter, B. C. (1986). The Habitat, Reproductive Ecology, and Host Relations of *Orobanche fasciculata* Nutt. (Orobanchaceae) in Wisconsin. *Torrey Botanical Society*, 110-117.
- Schneeweiss, G. M. (2004). Phylogeny of holoparasitic *Orobanche* (Orobanchaceae) inferred from nuclear ITS sequences. *Molecular Phylogenetics and Evolution*, 465-478.
- Schneider, A. a. (2021). Morphometrics and Redescription of *Aphyllon fasciculatum* and *Aphyllon franciscanum*, Two Widespread but Previously Conflated Species in Western North America. *Systematic Botany*, 446-455.
- Schneider, A. C. (2016). Cryptic host-specific diversity among western hemisphere broomrapes (*Orobanche* s.l., Orobanchaceae). *Annals of Botany*, 1101-1111.
- Teixeira-Costa, L. a. (2021). Life history, diversity, and distribution in parasitic flowering plants. *Plant Physiology*, 32-51.
- USDA. (2023, 5 8). *Orobanche fasciculata* Nutt. Retrieved from USDA Plants Database: <https://plants.usda.gov/home/plantProfile?symbol=ORFA>
- Washington Department of Natural Resources, Washington Natural Heritage Program, UBDI Bureau of Land Management. (2003). *Boschniakia hooker Walpers*. Washington Department of Natural Resources.
- Wolfe, A. D. (1998). The Effect of Relaxed Functional Constraints on the Photosynthetic Gene *rbcl* in Photosynthetic and Nonphotosynthetic Parasitic Plants. *Molecular Biology Evolution*, 1243-1258.
- Young, N. D. (1999). The Evolution of Parasitism in Scrophulariaceae/Orobanchaceae: Plastid Gene Sequences Refute an Evolutionary Transition Series. *Annals of the Missouri Botanical Garden*, 876-893.