Corallorhiza trifida Chatel

Early Coral-Root

Orchidaceae

(Lindman, C.A.M.)

***Corallorhiza trifida* Rare Plant Profile**

New Jersey Department of Environmental Protection
Division of Parks and Forestry
New Jersey Forest Service
Office of Natural Lands Management
New Jersey Natural Heritage Program

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Life History

Corallorhiza trifida, early coral-root, is a member of the orchid family, Orchidaceae. *C. trifida* is found in wet, mixed deciduous and coniferous forests, swamps, and wetland margins (Gleason & Cronquist, 1991; Native Plant Trust, 2019). The name coral-root refers to the underground portion of the plant resembling ocean coral (US Forest Service, 2019). *C. trifida* is what is known as a myco-heterotroph, obtaining most or all of its nutrients from a parasitic relationship with ectomycorrhizal fungi and, arguably, a small amount from photosynthesis (Zimmer et al. 2008; Cameron et al. 2009). While *C. trifida* does utilize a small amount of chlorophyll, it is entirely leafless, save some "sheaths" on the stem, producing a single or multiple flowering scapes directly from the roots (Gleason & Cronquist, 1991; US Forest Service, 2019; Claessens & Kleynen, 1998). The glabrous, bright yellow-green scape is roughly 10-30cm tall, with a raceme inflorescence 2-8cm long, bearing between 3 and 18 yellowish-green flowers, occasionally light purple, with singly nerved sepals and petals and no spur. Sepals are 4-5mm in length; the labellum is white, frequently spotted purple in the northern portion of its range, and 3.5-5mm long (Gleason & Cronquist, 1991; Flora of North America Vol. 26, 2019). *C. trifida* is easily identified and differentiated from other spring blooming orchids by its total lack of leaves and bright yellow stem. There are two other species of *Corallorhiza* present in New Jersey, *C. maculata* and *C. odontorhiza* (Kartesz, 2015). However, *C. trifida* can be differentiated using both temporal and morphological traits. *C. trifida* emerges and flowers from May to mid-July, whereas *C. maculata* flowers from mid-July to the end of August and *C. odontorhiza* flowers from late August to late September (Brown, 1997; Gleason & Cronquist, 1991). Furthermore, *C. trifida* can be differentiated from *C. maculata* by the lack of a spur, the lack of purple spots on the petals, and a bright yellow-green stem in stark contrast to the pinkish-purple stem of *C. maculata* (Gleason & Cronquist, 1991). The best time to find and identify *C. trifida* is in early May, as it is one of the first orchids to bloom in the spring (Brown, 1997). Another species, *C. wisteriana* is known historically from New Jersey, but is assumed extirpated.

Myco-heterotrophy and Host Specificity in *Corallorhiza*

Myco-heterotrophy is the symbiotic relationship between a plant and fungi in which the plant parasitizes a fungal host to obtain all or most of its nutrients (Leake, 1994). All orchids rely initially on myco-heterotrophy to establish, going through an achlorophyllous stage early on in their life cycles (McKendrick et al. 2000b). In the case of *C. trifida*, there is a tripartite symbiosis involving *C. trifida*, canopy trees such as *Betula sp.*, and the ectomycorrhizal fungi connecting the two (Cameron et al. 2009; McKendrick et al. 2000a). *Corallorhiza*, largely lacking any photosynthetic capability, as a genus depends almost entirely on myco-heterotrophy to obtain nutrients from germination to maturity. *Corallorhiza* seedlings are colonized by fungi well before the seedling has even swollen enough to split the testa and have been shown to begin accumulating fungi-borne starch within cells by the time the testa is split and the seedling emerges (McKendrick at al. 2000b). In addition to reliance on a fungal host, *C. trifida* displays significant host specificity. Multiple studies have shown that *C. trifida*, as well as other species

in the genus *Corallorhiza,* form mycorrhizal associations with the *Thelephora-Tomentella* complex of ectomycorrhizal fungi in the family Thelephoraceae from germination through adulthood and flowering (McKendrick et al. 2000b; Barrett et al. 2010).

C. trifida is the only member of its genus capable of producing chlorophyll and obtaining nutrients through autotrophy, making it a partial myco-heterotroph (Zimmer et al. 2008). However, the degree to which *C. trifida* photosynthesizes is still in question. Two studies (Cameron et al. 2009 & Zimmer at al. 2008) examine the photosynthetic abilities of *C. trifida.* Zimmer et al. (2008) makes the assertion that *C. trifida* only gains ~50% of its nitrogen and ~75% of its carbon from a fungal associate, even though it shows tremendous specificity in fungal hosts. Furthermore, *C. trifida* contains a large amount of chlorophyll when compared to other *Corallorhiza* species (Zimmer et al. 2008; Cameron et al. 2009). *C. trifida* also contains genes coding for chlorophyll production as well as a clear presence of chlorophyll *a* and *b* (Zimmer et al. 2008; Cameron et al. 2009). However, many observations of photosynthesis and carbon fixation in *C. trifida* have been through indirect inference; specific and directly observed numbers concerning just how much *C. trifida* photosynthesizes and how much it relies on its fungal host are harder to come by. Cameron et al. (2009) shows that while *C. trifida* is definitely capable of autotrophy, the amount of carbon it fixes is negligible compared to another partial myco-heterotroph living in the same exact environment. In addition to this, the quantum efficiency of photosystem II in *C. trifida* is significantly reduced compared to a full autotroph, possibly due to an alternative electron pathway and subsequent dissipation as heat (Cameron et al. 2009). Therefore it is likely that *C. trifida*, being capable of some measure of autotrophy, represents a late stage in the evolutionary move from autotrophy to full myco-heterotrophy.

Pollinator Dynamics

Pollination in *C. trifida* is largely autogamous, with reproductive structures adapted for self-pollination (Claessens & Kleynen, 1998). It should be noted, however, that much of the research involving reproduction and ecology, especially observations of potential pollinators, comes from the study of European populations. A study examining autogamy in Eastern Canadian orchids observed a 17% rate of autogamy among native Canadian *C. trifida*, which is lower than the >50% among European *C. trifida*, but still much higher than the family average of 3% (Catling, 1982). Multiple researchers have observed insects such as syrphid flies (Syrphidae), dungflies (Scathophagidae) as well as various Hymenopterans visiting *C. trifida*, but none confirmed whether or not these visiting insects were actually pollinating the flowers (Summerhayes, 1951; Lang, 1989; Silen, 1906; Claesens & Kleynen, 1998).

Seed Dispersal

Fruit capsules are ellipsoid and 4.5-15 x 4.6-6mm in size (Flora of North America Vol. 26, 2019). *C. trifida,* like many orchids, produces a large number of extremely small seeds sometimes referred to as "dust seeds" that are well suited for dispersal by wind (Keale, 1994). These seeds are largely undifferentiated with only 4-200 cells and barely any stored nutrients. As such, germination and subsequent survival depends on the immediate connection of an ectomycorrhizal symbiont (McKendrick et al. 2000b).

Habitat

The habitat of *C. trifida* is variable throughout its North American range. Generally, it occupies wetland margins, damp woods, and swamps with humus rich soils (Gleason & Cronquist, 1991; Native Plant Trust, 2019; US Forest Service, 2019). There are 14 known occurrences in New Jersey, 9 of which are assumed destroyed or have not been seen in many decades. The 5 remaining occurrences are found in the northern portion of the state in the Highlands and Ridge and Valley geographic provinces (New Jersey Natural Heritage Program, 2019).

More specifically, *C. trifida* in New Jersey is often found alongside seeps, stream margins, and in hemlock (*Tsuga canadensis*) and mixed hardwood/shrub swamps growing on damp, but firm moss hummocks within the swamp or on the margins. The habitat around known occurrences is described as well shaded and damp with a full canopy. Soil pH is seldom mentioned in occurrence records and reference sources, but a single New Jersey occurrence was found in an acidic swamp at the base of the Kittatinny Ridge with a pH of 5.5 (+/- 0.5), suggesting that *C. trifida* can tolerate slightly acidic soils. Associated shrubs and herbaceous species include *Rhododendron maximum, Carex folliculata, Clethra alnifolia, Osmundastrum cinnamomeum, Dryopteris cristata, Sambucus canadensis, Anemone canadensis, Polyganum arifolium, Uvularia sessilifolia, Arisaema triphyllum, Osmunda regalis, Coptis trifolia, Sphagnum sp., Carex sp., Trillium erectum, Onoclea sensibilis, Symplocarpus foetidus,* and *Trientalis borealis*. Associated tree species include *Acer rubrum, Betula allegheniensis, Nyssa sylvatica, Tsuga canadensis,* and *Pinus strobus* (New Jersey Natural Heritage Program, 2019).

Wetland Indicator Status

FACW:
C. trifida is classified as a facultative wetland species, indicating that it usually occurs in wetlands, but can be found in non-wetland habitat as well (USDA, 2019).

USDA Plants Code

COTR18

“Each symbol is composed of the first two letters of the genus+first two letters of the species+first letter of the terminal infraspecific name+tiebreaking number (if needed)” (USDA, 2019).

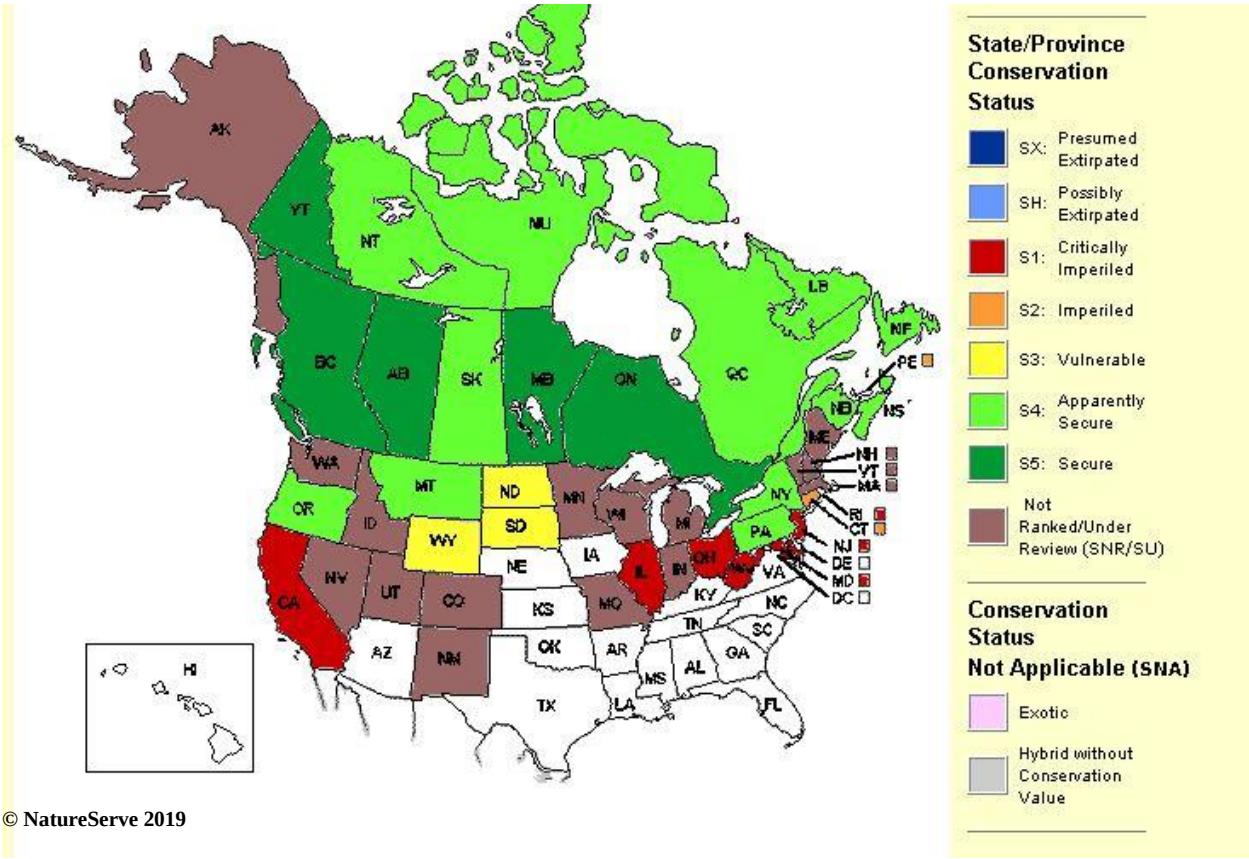
https://plants.usda.gov/core/profile?symbol=COTR18

Coefficient of Conservatism (Walz et al. 2018)

CoC = 9; Native with a narrow range of ecological tolerances, high fidelity to particular habitat conditions, and sensitive to anthropogenic disturbance.

Distribution and Range

Figure 1: C. trifida Range Map with S Ranks (NatureServe, 2019)



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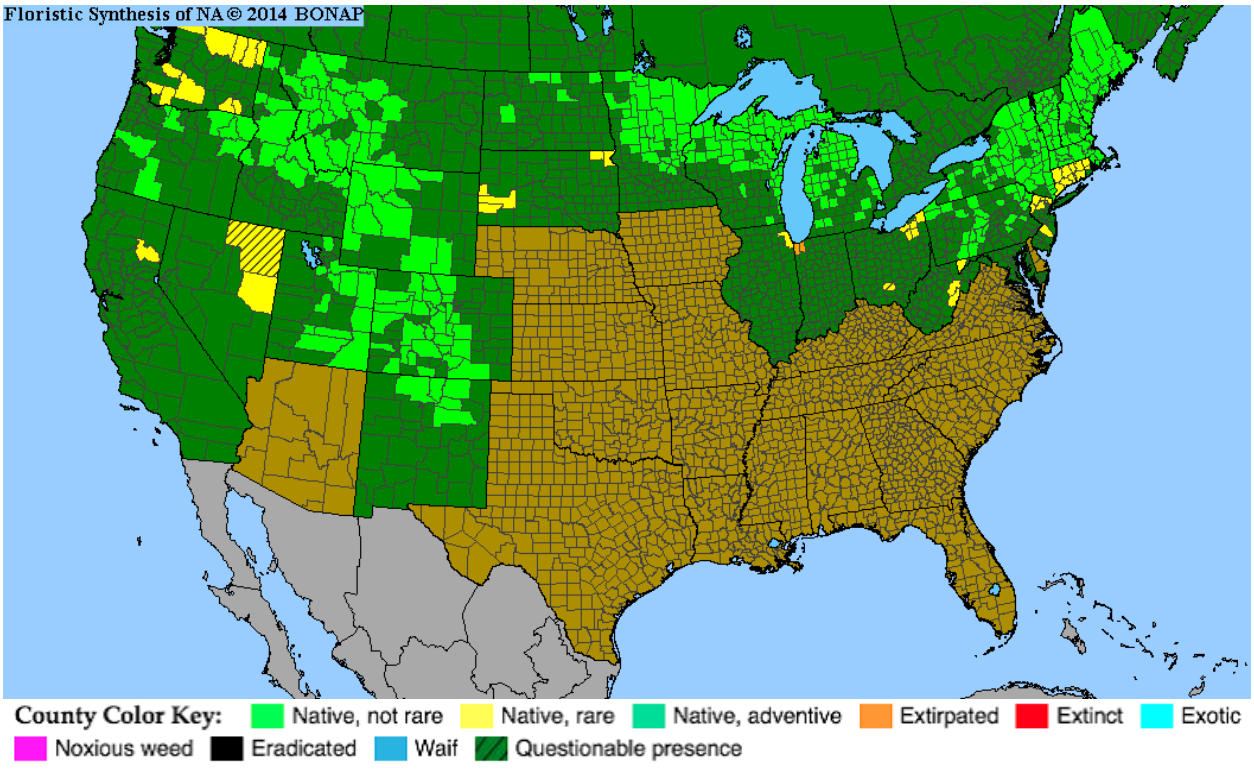
C. trifida has a circumboreal distribution, present in Eurasia and North America, found from Greenland to Alaska and south to California in the west and West Virginia in the east. The southern terminus of its range exists along the Rocky Mountains in New Mexico (Kartesz, 2015; NatureServe, 2019). While it is widespread throughout most of North America, it can be regionally rare, especially on the southern fringes of its range (Kartesz, 2015). *C. trifida* is the only species in the genus *Corallorhiza* that also exists outside of North America. Conservation ranking for each state/province within the range is as follows: Alaska (SNR), California (S1), Colorado (SNR), Connecticut (S2), Idaho (SNR), Illinois (S1), Indiana (SNR), Maine (SNR), Maryland (S1), Massachusetts (SNR), Michigan (SNR), Minnesota (SNR), Missouri (SNR), Montana (S4), Nevada (SNR), New Hampshire (SNR), New Jersey (S1), New Mexico (SNR), New York (S4), North Dakota (S3), Ohio (S1), Oregon (S4), Pennsylvania (S4), Rhode Island (S1), South Dakota (S3S4), Utah (SNR), Vermont (SNR), Washington (SNR), West Virginia (S1), Wisconsin (SNR), Wyoming (S3), Alberta (S5), British Columbia (S5), Labrador (S4), Manitoba (S5), New Brunswick (S4), Newfoundland Island (S4), Northwest Territories (S4), Nova Scotia (S4), Nunavut (S4), Ontario (S5), Prince Edward Island (S2), Quebec (S4S5), Saskatchewan (S4), Yukon Territory (S5) (NatureServe, 2019; Kartesz, 2015).

Geographic Range of *Corallorhiza trifida* (Kartesz, 2015)



Conservation Status

Status for New Jersey:
(S1) (HL)

S1 indicates critically imperiled in New Jersey because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres). Elements so ranked are often restricted to very specialized conditions or habitats and/or restricted to an extremely small geographical area of the state. Also included are elements which were formerly more abundant, but because of habitat destruction or some other critical factor of its biology, they have been demonstrably reduced in abundance. In essence, these are elements for which, even with intensive searching, sizable additional occurrences are unlikely to be discovered. HL indicates protection by the Highlands Water Protection and Planning Act within the jurisdiction of the Highlands Preservation Area (New Jersey Natural Heritage Program, 2019).

Global Status:
(G5)

Demonstrably secure globally; although it may be quite rare in parts of its range, especially at the periphery (NatureServe, 2019).

Threats

Threats to this species include invasive species, logging/habitat loss, changes to hydrology, and trampling in occurrences near well used trails. Several of the occurrence reports mention site invasion by species like *Berberis thunbergii, Microstegium vimineum,* and *Phragmites australis*. Due to the vulnerability of *C. trifida* in New Jersey and the relatively small population size at each known occurrence, the presence of invasive species should be dealt with immediately to prevent the loss of any occurrences. Many known occurrences are found on or adjacent to land subject to logging activity. Recently logged areas can attract deer, create opportunities for biological invasion, and alter the hydrology and movement of sediment in the landscape. Herbicides commonly used after logging can potentially affect occurrences or habitat of *C. trifida* as well. Finally, *C. trifida* is most often found in cool, shady habitat with full canopy. Logging operations on or near *C. trifida* habitat can dramatically alter the amount of light reaching the forest floor (New Jersey Natural Heritage Program, 2019).

Management Summary and Recommendations

C. trifida thrives in shaded swamps, seeps, and stream corridors. Management should be directed towards conserving contiguous forest surrounding *C. trifida* occurrences and removing invasive plants before they become well established.

Synonyms

- *Corallorhiza corallorhiza* (L.) Karst., nom. inval.
- *Corallorhiza trifida* Chatelain var. verna (Nutt.) Fernald
- *Corallorrhiza corallorrhiza* (L.) Karst., orth. var., nom. inval.
- *Corallorrhiza trifida* Chatelain var. verna (Nutt.) Fernald, orth. var.
- *Corallorrhiza trifida* Chatelain, orth. Var.

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