



Status: State endangered

Global and state rank: G3/S2

Family: Pupillidae

Range: The range of the six-whorl vertigo extends from Maine, Massachusetts, and New York west through the Upper Midwest to Wisconsin and Minnesota (NatureServe 2007). The species also is known from Ontario in Canada (NatureServe 2007). However, distribution data for this species in the U. S. and Canada are likely incomplete as it was only recently discovered in Massachusetts and Maine (NatureServe 2007).

State distribution: In Michigan, the six-whorl vertigo has been found recently only in Mackinac County in the eastern Upper Peninsula (Nekola 1998, Michigan Natural Features Inventory (MNFI) 2007a). Hubricht (1985) also had reported this species from eight counties in the Lower Peninsula (i.e., Cass, Kalamazoo, Calhoun, Eaton, Livingston, Oakland, Kent, and Montmorency) and one additional county in the Upper Peninsula (i.e., Chippewa). However, most of these reports are old, and it is not known if this species still occurs in these counties (Nekola 1998). Systematic surveys for this species have not been conducted

throughout the state. Thus, potential exists for this species to occur at additional sites in which suitable habitat is available.

Recognition: The six-whorl vertigo is a minute land snail that has a **dark brown or chestnut brown, cylindrical (beehive-shaped) shell with 6 to 6.5 whorls** (Baker 1939, Taft 1961). The shell is **2.5 to 3.0 mm (0.10 to 0.12 in) in height** and about 1.3 to 1.5 mm (0.05 to 0.06 in) in width (Baker 1939, Taft 1961). The **middle of the outer lip of the aperture** (main opening of the shell) **is deeply indented** (Baker 1939). The **aperture** usually **has seven or eight lamellae or “teeth”** (calcareous plates, ridges, or folds on the inside of the shell opening) (Baker 1939). These include a large parietal lamella or tooth and a smaller angular lamella along the top of the aperture, a large columellar lamella with a smaller subcolumellar tooth below it along the inner margin of the aperture, a very small basal tooth along the bottom of the aperture, and **two or three palatal lamellae along the outer lip of the aperture** (Baker 1939).

Best survey time: Surveys for the six-whorl vertigo can be conducted anytime during the growing season, but the best time to survey for this species is from June through September (MNFI 2007b). Because land snails require moisture, surveys are generally most successful



in the spring (after snowmelt) and fall, particularly after rain events, when the soil is moist, and during higher relative humidity conditions and cooler temperatures (Taft 1961, Burch and Pearce 1990, MNFI 2007b). The best way to survey for this species is by soil litter sampling. This consists of collecting soil and leaf litter samples in the field and drying, sifting, and looking for snail shells in the samples in the laboratory (Nekola 1998, Nekola 1999).

Habitat: In Michigan, the six-whorl vertigo appears to be restricted to calcareous fens (Nekola 1998, Nekola 2003a). Within these sites, it is often found in areas with organic-rich soil overlaying marl (Nekola 1998). These areas also have little or no *Sphagnum* moss. This species also has been reported to occur along the edges of ponds, lakes, and marshes (Baker 1939, Hubricht 1985). In Wisconsin and Minnesota, this species has been found almost exclusively in fens and also in a wet prairie (Nekola 2002a, Nekola 2003a).

Biology: Little information is available about the specific biology and life history of the six-whorl vertigo. In general, land snails require adequate moisture, shelter, abundant food supply, and an available source of calcium (Burch 1962, Burch and Pearce 1990). Land snails require moisture or water for basic physiological processes as well as locomotion and reproduction (Burch and Pearce 1990). For example, land snails generate mucous trails as they crawl, and mucous is largely comprised of water (Burch and Pearce 1990). Also, most snail eggs are highly susceptible to desiccation, and must be deposited in moist sites to survive (e.g., moist soil, under stones, logs, or leaf litter) (Burch and Pearce 1990, Martin 2000). Most land snails can minimize water loss and survive dry conditions by aestivating and closing their shell opening with an operculum (i.e., a calcareous “lid” that seals the opening) or a mucous film that hardens over the opening (Burch 1962, Burch and Pearce 1990).

Snails require calcium to maintain their shells. As a result, snails are often associated with habitats that are rich in calcium such as areas that are abundant in limestone (e.g., limestone outcrops), or have soils derived from limestone or are otherwise high in calcium carbonate (Burch and Pearce 1990). Snails also can occur in areas in which the soils are poor in calcium if the local vegetation can provide sufficient calcium (Burch and Pearce 1990). Snails ingest soil particles

and scrape rocks or snail shells in order to obtain calcium (Fournie and Chetail 1984). Snails also can obtain calcium that is dissolved in water by absorbing the water through their skin or drinking it (Heller and Magaritz 1983 in Martin 2000).

Availability of adequate shelter or refuges also is extremely important to land snails in general. Burch and Pearce (1990) have suggested that refuges may be the most important factor limiting the abundance of land snails. Refuges provide shelter from cold and hot weather conditions and desiccation as well as protection from predators (Burch and Pearce 1990). Refuges include soil humus, leaf litter, rotting logs and other woody debris, crevices and cavities in tree bark, rocks, soil crevices, and under the soil surface. Most land snails also overwinter underground or under rocks, logs, and boards (Burch 1962).

Some land snails, including the six-whorl vertigo, appear to respond strongly to soil surface architecture (Nekola 2003b). The six-whorl vertigo appears to prefer soils with a thin (< 4 cm/1.6 in) organic horizon (soil layer) underlain by an upper soil horizon firmly bound by plant roots (i.e., “turf specialists”) (Nekola 2003b). Seventeen additional land snails across the Great Lakes basin appear to prefer similar thin soils, while twenty-eight other land snails in the region appear to prefer deeper (> 4 cm), loose soils comprised primarily of humus and mineral soil (i.e., “duff specialists”) (Nekola 2003b). Soil surface architecture may be important to land snails in general since almost 90% of land snails live within 5 cm (2 in) of the soil surface (Hawkins et al. 1998). The architecture of the organic litter layer and the underlying soil also may impact land snails (Cameron 1986, Nekola 2003b).

Temperature, moisture, and light intensity are the primary factors regulating or influencing land snail activity (Burch 1962, Burch and Pearce 1990). Land snails are primarily nocturnal, but may be active during the day following a rain event (Burch 1962, Burch and Pearce 1990). High relative humidity and cooler temperatures also can cause increased land snail activity (Burch and Pearce 1990). Land snails generally do not move much except to find food or reproduce (NatureServe 2007). They actively migrate fairly slowly and over relatively short distances (i.e., usually only centimeters or meters) under favorable environmental conditions (Burch and Pearce 1990, NatureServe 2007).



Long-distance dispersal is thought to occur passively through transport by animals (i.e., mammals, birds, or insects) or by humans such as on food, plants, or machinery (Burch and Pearce 1990, NatureServe 2007).

Most land snails are generalist herbivores (Burch and Pearce 1990). Many also feed on fungus or detritus. A few snail species are carnivorous, consuming other snails, slugs, and invertebrates in the soil (Burch and Pearce 1990). Land snails are preyed upon by various organisms including birds, small mammals, amphibians, reptiles, other snails or slugs, beetle and fly larvae, and other insects (Burch and Pearce 1990).

Conservation/management: Given that the six-whorl vertigo has been documented from only a few sites in Michigan, all known populations of this species should be protected and monitored. The six-whorl vertigo has been recommended for listing as State endangered and may even warrant Federal listing given its association with calcareous fens, which are rare and fragile wetlands, and extremely limited distribution in the United States (Frest 1990 in Nekola 1998). Land-use activities that impact or alter critical habitat requirements including suitable microclimate and soil surface architecture as well as adequate moisture, calcium, food, and refuge should be avoided at known occupied sites (MNFI 2007b). The six-whorl vertigo also is vulnerable to excessive trampling (e.g., from recreational hiking or other uses), off-road vehicle use, and hydrological alterations (MNFI 2007b). Prescribed fire also has been found to significantly reduce land snail species richness and abundance in grassland habitats and negatively impact snails that are considered “turf specialists” including the six-whorl vertigo (Nekola 2002b). Use of prescribed fire in occupied sites should be avoided, if possible, or applied conservatively, leaving multiple refugia and using a burn interval of at least 15 years (Nekola 2002b, MNFI 2007b). Additionally, fens have high conservation value for land snails because of the number of rare snail taxa associated with these habitats including the six-whorl vertigo (Nekola 1998). These habitats should be prioritized for surveys and potential management and/or protection for the six-whorl vertigo and other land snails.

Research needs: A systematic survey for the six-whorl vertigo is needed to identify additional occupied sites and determine this species’ status and distribution in

Michigan. Additional surveys and monitoring of known sites are warranted to determine their population status, extent, and viability. Research is needed to obtain information about the six-whorl vertigo’s specific habitat requirements, life history, and ecology in Michigan. An assessment of threats to the species also should be conducted. Studies to monitor and investigate the effects of various land-use and recreational activities such as off-road vehicle use and prescribed burning on the six-whorl vertigo are vital to ensure adequate management and protection of this species (Nekola 1998). It also is important to know how much buffer from management and recreational activities is needed to provide adequate protection for land snails (Nekola 1998).

Related abstracts: *Vertigo cristata*, *Vertigo elatior*, *Vertigo nylanderi*, *Vertigo modesta parietalis*, *Vertigo paradoxa*

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