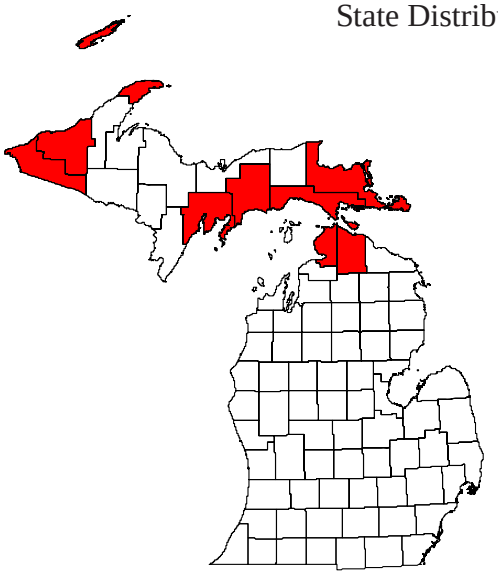
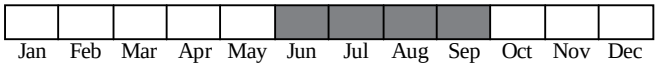
Vertigo paradoxa Sterki — mystery vertigo

Photo by Jeffrey C. Nekola

State Distribution



Best Survey Period



Status: State special concern

Global and state rank: G3G4/S3

Family: Pupillidae

Range: The mystery vertigo has a widespread but spotty distribution (NatureServe 2007). In the U. S., this species is known from nine states ranging from Maine west through the Upper Midwest to South Dakota and Wyoming (NatureServe 2007). This species also has been documented across Canada from Nova Scotia, Newfoundland, Quebec, Ontario, and Alberta (NatureServe 2007). Fossil remains of this species also have been found in Kansas and Nebraska (Anderson 2004, NatureServe 2007).

State distribution: In Michigan, the mystery vertigo has been reported recently from only seven counties in the Upper Peninsula (Nekola 1998, Michigan Natural Features Inventory (MNFI) 2007a). These include Chippewa, Delta, Gogebic, Keweenaw, Mackinac, Ontonagon, and Schoolcraft counties (Nekola 1998, MNFI 2007a). This species also has been reported from Cheboygan and Emmet counties in the northern Lower Peninsula (Hubricht 1985, Burch and Jung 1988). However, it is unknown if it still occurs in these counties. 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 mystery vertigo is a minute land snail with a **cinnamon-colored**, **cylindrical or "beehive-shaped shell"** that is about **1.75 mm (0.07 in) in height** and about 1 mm (0.03 in) in width with 4.5 to 5 whorls (Pilsbry 1948 and Frest and Johannes 2002 in Anderson 2004). The **aperture**, or main opening of the shell, **has four lamellae or "teeth"** (calcareous plates, ridges, or folds on the inside of the shell opening) (Anderson 2004). The **lower palatal lamella or tooth along the outer lip of the aperture is set deeper in the aperture than the upper palatal lamella above it** (Pilsbry 1948 in Anderson 2004). A **basal lamella along the bottom of the aperture is often absent**, and there also is **only a parietal lamella**, and no angular lamella next to it, **along the top of the aperture** (Pilsbry 1948 in Anderson 2004).

Best survey time: Surveys for the mystery 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

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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 mystery vertigo has been documented in several different habitat types including igneous bedrock outcrops and shorelines, carbonate or limestone cliffs and lakeshore ledges, rocky woodlands, and tamarack-sedge (*Larix laricina-Carex* spp.) wetlands (Nekola 1998). This species was predominantly found on carbonate outcrops in the eastern Upper Peninsula and from basalt outcrops near Lake Superior (Nekola 1998). The igneous bedrock outcrops were comprised of 2 to 20-m (7 to 66 ft) tall, forested, basalt, rhyolite, or basalt-derived conglomerate outcrops as well as talus slopes under cliffs in the northwestern Upper Peninsula (Nekola 1998). The igneous bedrock shorelines consisted of sites along the Lake Superior shoreline in the Keweenaw Peninsula where basalts or basalt-derived conglomerates were exposed (Nekola 1998). These sites were mostly treeless with minimal soil development and a number of western and arctic disjunct plants (Nekola 1998). Carbonate cliffs were 2 to 20-m tall, forested, limestone or dolomite outcrops with moss- or fern-covered ledges, while lakeshore carbonate ledges consisted of < 3 m (10 ft) tall, forested limestone or dolomite outcrops within 1 km (0.6 mi) of Lake Michigan or Lake Huron (Nekola 1998). Rocky woodlands were comprised of upland forests with talus slopes, exposed bedrock, or glacial-erratic boulders (Nekola 1998). The tamarack-sedge wetlands in which this species has been found have consisted of open stands of tamarack with thick sedge ground cover, little or no *Sphagnum* moss, and speckled alder (*Alnus rugosa*) as a common shrub (Nekola 1998). These wetland habitats are not common in Michigan's Upper Peninsula, and appear to be restricted to areas underlain by Niagaran Escarpment carbonate bedrock (Nekola 1998). Natural community types in Michigan with which this species has been associated include granite bedrock glade and lakeshore, granite cliff and lakeshore cliff, limestone bedrock glade and lakeshore, limestone cliff and lakeshore cliff, and northern fen (MNFI 2007b). In other parts of the species range, the mystery vertigo also has been found in high quality northern white-cedar (*Thuja occidentalis*) swamp forests, balsam fir-white spruce (*Abies balsamea-Picea glauca*) forests, and black ash (*Fraxinus nigra*)-dominated wetlands (Nekola 2002a).

Biology: Little information is available about the specific biology and life history of the mystery 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 dessication, 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 (Fourníe and Chétail 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. 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 mystery vertigo, appear to respond strongly to soil surface architecture (Nekola 2003). The mystery vertigo and a number of other land snails in the Great Lakes basin prefer soils with a deep (> 4 cm/1.6 in) organic horizon underlain by a loose upper soil horizon comprised primarily of humus and mineral soil (i.e.,"duff specialists") (Nekola 2003). However, some land snails appear to favor soils with a thin organic horizon (< 4 cm) underlain by an upper soil horizon firmly bound by plant roots (i.e., "tuff specialists") (Nekola 2003). 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 large number of land snails associated with soils with deeper organic horizons may be due to a thicker layer of organic litter in these areas (Nekola 2003). The abundance, diversity (Locasciulli and Boag 1987), and composition (Cameron and Morgan-Huws 1975, Barker and Mayhill 1999) of land snail communities have been found to correlate positively with organic litter depth (Nekola 2003). The architecture of the organic litter layer and the underlying soil also may impact land snails (Cameron 1986, Nekola 2003).

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).

Land snails exhibit a number of different sexual systems and reproductive strategies, behaviors, and anatomy (Martin 2000). The mystery vertigo is hermaphroditic (i.e., possesses both male and female sex organs) (Martin 2000). Although such land snails can self-fertilize, they commonly exhibit reciprocal mating or outcrossing in which each hermaphroditic partner acts as both male and female and exchange sperm during copulation (Martin 2000). The mystery vertigo also is likely oviparous (i.e., lays eggs) (Martin 2000).

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 mystery vertigo has been documented from only a small number of sites in Michigan, all known populations of this species should be protected and monitored. The mystery vertigo also may warrant listing as a Federal endangered species based on its limited distribution in the U. S. and its association with rare and fragile rock outcrop habitats (Frest and Johannes 1991 in Nekola 1998). Land-use activities that impact critical habitat components including suitable microclimate, soil surface architecture, adequate moisture, calcium, food, and/or refuge should be avoided at known occupied sites (MNFI 2007b). Such activities would include, but are not limited to, timber harvesting, residential development, road construction, and mining. This species also is sensitive to excessive trampling (e.g., from recreational hiking), 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 (Nekola 2002b). Use of prescribed fire in occupied sites should be avoided, if possible, or applied conservatively, maintaining multiple refugia and using a burn interval of at least 15 years (Nekola 1998, Nekola 2002b, MNFI 2007b). Rock climbing also may impact this species as it has been found to negatively impact land snail density, richness, and diversity (McMillan et al. 2003).

Carbonate cliff, carbonate lakeshore ledge, and tamarack-sedge wetland habitats have been found to harbor a number of rare land snails, including the mystery vertigo, and some of the richest land snail communities in the Upper Peninsula of Michigan (Nekola 1998). Forested carbonate cliffs and calcareous bedrock outcrops, in general, have been identified as "hotspots" of land snail biodiversity regionally and globally (Nekola 1999). These habitats should be prioritized for surveys and potential management or protection for the mystery vertigo and other land snails. Tamarack-sedge wetlands also should receive particular attention as these wetlands are uncommon in Michigan's Upper Peninsula.

Research needs: A systematic survey for the mystery vertigo is needed to identify additional populations and determine this species' status and distribution in Michigan. Additional surveys and monitoring of known sites are warranted to determine the status, extent, and viability of these populations. Research is needed to obtain information about the mystery 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, including rock climbing, off-road vehicle use, and prescribed fire, on the tapered 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 morsei, Vertigo nylanderi, Vertigo modesta parietalis, Vertigo elatior, granite bedrock lakeshore, limestone bedrock glade, limestone bedrock lakeshore

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