

## Hibernation refuge of *Thamnophis scalaris* COPE, 1861, in Central Mexico

The genus *Thamnophis* FITZINGER, 1843 (garter snakes) includes the most low-temperature-tolerant snake species in North America. The northern species of this group are among the most studied and well known snakes; e.g., *T. sirtalis* (LINNAEUS, 1758), selects specific traits of hibernation refuges and congregates in thousands as a strategy for hibernation (ROSSMAN et al. 1996). However, the hibernation process is scarcely known in southern populations.

*Thamnophis scalaris* COPE, 1861, the Mexican Alpine Blotched Garter Snake, ranges from West-Central Veracruz across the Mexican Transvolcanic Belt to Morelos State, in Central Mexico (ROSSMAN et al. 1996; ROSSMAN & LARA 1997) where it occurs associated with pine-oak and pine forest (ROSSMAN et al. 1996). In Central Mexico, peaks of activity in spring to early summer and in autumn are reported for some populations (VENEGAS-BARRERA & MANJARREZ 2001). Nonetheless, hibernation strategies and refuge characteristics remained unknown. In this note the authors describe the structural characteristics of a refuge used by *T. scalaris* in Central Mexico, at the beginning of the cold season.

On October 18, 2014, at 12:16 h in the Sierra Morelos State Park, eight individuals of *T. scalaris* were observed to gather at the entrance of an underground refuge. The park, a protected area for wildlife, particularly small species, is surrounded by the urban city of Toluca. The site (geographic coordinates: 19°18'45"N, 99°41'22"W) is located on a hill at 2,760 m a.s.l., faces 220° SW, and has a slope of 28.5°. The surrounding habitat (100 m<sup>2</sup>) is dominated by grassland and some trees (*Quercus* sp., *Eucalyptus* sp., and *Pinus* sp.). No bushes were found; rocks and herbaceous plants covered 95 % of the surface. At the moment of observation, eight snakes were disturbed and dispersed; six fled into the refuge through an opening in the ground that was about 10 mm by 14 mm in diameter, the remaining two moved away into the grassland. Ten minutes later, two individuals



Fig. 1: Two aspects of *Thamnophis scalaris* COPE, 1861, at the opening of the hibernation refuge detected in the Sierra Morelos State Park, City of Toluca, Mexico.

(probably those that previously escaped to the grassland) moved into the refuge. For an hour the snakes were observed through the access hole moving inside the refuge and occasionally approaching the entrance (Fig. 1), however, they did not come out again. The air temperature just inside the entrance of the hibernaculum ( $22^{\circ}\text{C}$  within 10 cm) and outside at 5 cm above the entrance ( $19^{\circ}\text{C}$ ) was measured using a wired thermometer/hygrometer Radioshack® model 08A14.

The authors returned to the site five times between October 2014 and January 2015 to look for snakes. All visits occurred between 11:00 h and 13:00 h and each time included measuring temperatures inside and outside the refuge. In addition, an area of approximately  $2,500\text{ m}^2$  around the refuge was surveyed for snakes, however without finding any. Mean temperature inside the refuge ( $17.46 \pm 3.16^{\circ}\text{C}$ ; range:  $13.1 - 22.0^{\circ}\text{C}$ ,  $N = 6$ ) was colder but more stable than outside ( $21.55 \pm 6.16^{\circ}\text{C}$ ;  $12.3 - 28.7^{\circ}\text{C}$ ,  $N = 6$ ).

The mean temperature, its variation, and the presence of the snakes, suggest that the refuge provided the appropriate charac-

teristics for thermoregulation and shelter during the cold season, and support the hypothesis that this site is a hibernation refuge. *Thamnophis sirtalis* uses wide ( $2\text{ m} \times 10\text{ m}$  and  $5\text{ m} \times 10\text{ m}$ ), deep ( $2\text{ m}$ ), and rocky cavities, with many openings and adjacent smaller cavities ( $1\text{ m} \times 1\text{ m}$ ), located mainly in grassland areas (SHINE & MASON 2004). *Thamnophis elegans* has been reported in hibernation sites that include rocky slopes, rock cracks, rock piles and rocky edges of roads (HUEY et al. 1989) and *T. marcianus* (BAIRD & GIRARD, 1853) can use the shelters of other species such as tarantulas (HAMILTON & CRAIG 2008). The authors refrained from measuring the inside dimensions of the refuge because doing so would have destroyed it. However, its depth exceeded the length of the probe used ( $1\text{ m}$ ). Other habitat characteristics such as grassland as the primary vegetation cover, a very rocky substrate, and several deep openings in the ground which may provide ingress and egress to other refuges, resemble those reported in other studies for the genus *Thamnophis*. Hibernation in the northern species of *Thamnophis* lasts from Novem-

ber to March. It is thought that in southern species, this span may be shorter (ROSSMAN et al. 1996), allowing the snakes to be active for a longer annual period due to more consistent favorable thermal conditions (i.e., temperature fluctuations are smaller than in the north). The observation site reported is located in a temperate climate and has temperatures down to minima of 0 °C and below in December and January according to SERVICIO METEOROLÓGICO NACIONAL (2010). Furthermore, snakes were located in a grassland area on a hill. In *T. sirtalis* some observations show that individuals can disperse as far as 20 km from foraging to hibernation areas, and can locate and use the same refuge for several years (GREGORY & STEWART 1975; LAWSON 1989). Prior to the above observation, the authors surveyed the Sierra Morelos State Park with regard to reptiles throughout two years without finding *T. scalaris* in the hills. However, many sightings of this snake were acquired while it was foraging and mating close to water bodies that are one km from the site of the refuge observation. This proximity to a permanent water source also supports the idea that the observed snakes may use the refuge for hibernation.

The Mexican habitats of the genus *Thamnophis* are extensively fragmented and its populations are diminishing on a local scale (CONANT 2003; VENEGAS-BARRERA & MANJARREZ 2011). This is the main threat for the species and is led by desiccation of permanent and temporal water bodies, grazing, deforestation, burning and human settlements. The Mexican Alpine Blotched Garter Snake populations in Central Mexico may be specifically threatened due to the intensity of human activities. Identification and characterization of the refuges of these snakes may be crucial for conservation in their southern range.

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