REPTILES & AMPHIBIANS

An Inordinate Abundance of Snakes: Hundreds of Levantine Blindsnakes (*Xerotyphlops syriacus*) Found Following a Flood

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Blindsnakes (Squamata: Scolecophidia) are a globally distributed group of snakes with 477 described species (Caetano et al. 2022; Uetz et al. 2024). They probably are, however, the least well-studied group of reptiles (Böhm et al. 2013; Meiri and Chapple 2016; Tingley et al. 2016; Shine 2022; Guedes et al. 2023) — perhaps of land vertebrates altogether. Scolecophidian fossoriality makes them difficult to find and survey and their small size (Feldman et al. 2016), and lack of venom, patterns, or distinct coloration make them unattractive to scientists and laymen alike (Roll et al. 2016). Few herpetologists focus on scolecophidians, and much of their basic ecology and behavior remain virtually unstudied (see, however, Webb and Shine 1992, 1993; Parpinelli and Marques 2008, 2015; Akman and Gocmen 2019; Khouri et al. 2022).

Among the attributes of scolecophidians no one has bothered to study are population sizes and densities. We are aware of only one study that tried to quantify these factors; Rodda et al. (2001) estimated reptilian density on Guana Island, British Virgin Islands, using total-removal techniques in four 10 x 10-m plots. Among the seven species they found were six Virgin Islands Blindsnakes (*Antillotyphlops richardi*; Typhlopidae), which were found in two plots, resulting in an estimated density of 300 snakes/ha. They noted, however, that their method "provided a reasonable estimate of absolute population density for species that exceed a density of about 500 ha-1" (p. 333), implying that they probably did not place much confidence in that estimate. Bentz et al. (2011) estimated reptilian population sizes and densities on Union Island (Grenadines) and found two Grenada Bank Blindsnakes (*Amerotyphlops tasymicris* [as *Typhlops tasymicris*]; Typhlopidae), in leaf litter transects, but wrote "We did not calculate population density or size for *T. tasymicris* because of the very low number of sightings" (p. 43).

The largest numbers of scolecophidians reported in single studies of which we are aware were 74 Centralian Blindsnakes (*Anilios centralis*; Typhlopidae) that Schlesinger et al. (2010) caught over two years in pitfalls at eight sites at least 5 km apart, and 121 Amaral's Blindsnakes (*Trilepida koppesi*; Leptotyphlopidae) that Khouri et al. (2022: 72) collected in "1,248 person-hours of searches in different vegetation types" over the course of two years.

We herein tentatively treat the Syrian or Levantine Blindsnake as *Xerotyphlops syriacus,* as they are as poorly studied as the rest of the clade. Hoofien (1958) documented a size record, Perry (1985) discussed sexual dimorphism, and Maza et al. (2021) reported an extra-limital record. In publications

Figure 1. Some of the 336 Levantine Blindsnakes (*Xerotyphlops syriacus*) found near Haogen Junction following a flood on 18 February 2024. The snakes were photographed in a basket prior to their release into suitable habitat beyond the flooded area. Photograph by Aviad Bar.

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not dealing specifically with blindsnakes (or even snakes in general), Brickner-Braun et al. (2007) found an individual preyed upon by a domestic cat, and Dubiner et al. (2023a, 2023b) noted metabolic rates. However, *X. syriacus* is relatively common in the Mediterranean parts of Israel, including in afforested pine plantations, agricultural field margins, and even settlements, as well as natural areas. Rotem et al. (2020) found 18 individuals in 63 sampling plots (100 × 50 m each), in one of their four land units at the southern edge of the species' range. We herein report finding hundreds of *X. syriacus* in a restricted area over a short time following a recent flood.

On 17 February 2024, 60–70 mm (~10% of the annual average) of rain fell within 2 h in the Sharon Plain of west-central Israel. These rains caused local (nameless) seasonal streams, tributaries of Nahal Alexander, to flood. Two such stream, flowing from SE to NW and meeting before crossing local road 5701 just east of Haogen Junction (32.383N, 34.932E), flooded an area of 200–300 x 300–400 m (i.e., an area of 6–12 ha). The drain under road 5701 was overwhelmed and passers-by who observed snakes floating in the water alerted members of a herpetological Facebook group. GK, a certified snake rescuer, arrived at the scene at about 1640 h and rescued individuals belonging to six species. By 18 February the water had receded below the road surface but carried with it debris (mostly dry natural vegetation floating between the road and drain levels). AB and GK then raked the debris looking for reptiles, all of which were released several hundreds of meters from the flooded area.

We found individuals of 11 reptilian species: one turtle (Western Caspian Turtle; *Mauremys rivulata*), five lizards (Rueppel's Snake-eyed Skink, *Ablepharus rueppellii*; Bridled Skink, *Heremites vittatus*; a juvenile Levantine Glass Lizard, *Pseudopus apodus levantinus*; Turkish House Gecko, *Hemidactylus turcicus*; and Common Chameleon, *Chamaeleo chameleon*), and five snakes (*X. syriacus*; Dice Snake, *Natrix tessellata*; a juvenile Palestine Viper, *Daboia palaestinae;* a juvenile Black Whipsnake, *Dolichophis jugularis*; and Javelin Sandboa, *Eryx jaculus*). Of ten species, numbers of individuals ranged from 1 (*Natrix*, *Hemidactylus*, *Ablepharus*) to 13 (*Heremites*). However, we also found 377 *Xerotyphlops syriacus* (Fig. 1; 29 on 17, 336 on 18, and 12 on 19 February). All animals were released unharmed. Based on those numbers, an estimated density of *X. syriacus* in the drainage basin was 31–63 snakes/ha. This is a very conservative estimate, as it assumes that all of the snakes in the flooded area were carried away by the flood and were subsequently caught and counted (and none, for example, were washed across the road before the water subsided). GK subsequently found and rescued 38 *X. syriacus* on 19 February 2024 in nearby Ein Hahoresh (32.383N, 34.932E) under similar circumstances.

We recorded hundreds of individual *X. syriacus* from a relatively small area (but see below) following a minor flood. Floods are well known to adversely affect individual snakes, snake populations, and snake communities (e.g., Tucker 1995; Wozniak et al. 2006; Sexton et al. 2007; Janani et al. 2016; Ujvari et al. 2016; Chowdhury et al. 2022; but see Lutterschmidt et al. 2022). Furthermore, some authors have even reported more frequent snake sightings — and incidents of snakebite, following floods (e.g., Wozniak et al. 2006; and see review by Ochoa et al. 2020). We are, however, unaware of a report of so many snakes being found after a single flood. We assume that we caught so many snakes because the flood was dramatic but not too violent, much vegetation was carried over a relatively short distance and accumulated in a place amenable to searching, coupled with the poor escape ability of *X. syriacus*. Regardless, the density of *X. syriacus* must have been high for so many snakes to have been flooded from such a small area.

In the Santini et al. (2018) compilation of tetrapod population densities, only three species of snakes approached or exceeded the densities we report. One was the invasive Brown Treesnake (*Boiga irregularis*) in Guam (Rodda and Campbell 2002; density 32.7/ha estimated by mark-recapture). The other two were from Rodda et al.'s (2001) abovementioned study — the 300 snakes/ha for *Antillotyphlops richardi* (6 snakes in two 100-m^2 plots) and a 50/ha estimate for the Puerto Rican Racer (*Borikenophis portoricensis*) representing a single observation of a single snake. Given the well-known negative relationship between density and the area over which it was estimated (Blackburn and Gaston 1996; Novosolov et al. 2016; Meiri 2022), we do not consider these reliable indicators of higher densities than that reported herein.

However, some authors provided reliable estimates for potentially higher densities. For example, Seibert (1950) caught 298 Plains Gartersnakes (*Thamnophis radix*) and 78 Smooth Greensnakes (*Opheodrys vernalis*) over a period of 5.5 months (mid-May to early November) in a 13,043-m^2 area (i.e., almost an order of magnitude smaller than the area in the current observation) and used mark-recapture data to estimate population sizes of 1,093 for *T. radix* and 237 for *O. vernalis* (i.e., densities of 838 and 109 snakes/ha (see also Rossman et al. 1996). Licata et al. (2022) estimated that 43 *Madagascarophis colubrinus* (no common name) existed in a somewhat smaller 1,350-m^2 area. Trape (2023: 512) reported 9,000–30,000 Tanganyika Watersnakes (*Lycodonomorphus bicolor*) per km^2 (i.e., 90–300 snakes/ha) in "certain parts" of Lake Tanganyika without, however, providing details on the methods used. On the 18-hectare lake-island of Golem Grad (North Macedonia), Ajtic et al. (2013: 356) (see also Bonnet et al. 2023) marked over 5,000 individual Dice Snakes (*Natrix tessellata*) and estimated that "at least 10,000 snakes inhabit Golem Grad Island" (a density estimate of >500 snakes/ha). No study we are aware of, however, reported that many snakes of one species being caught over such a small area in so short a time.

Overall, we consider the density of *X. syriacus* reported herein, although not the highest reported for snakes, to be very high. While the number of *X. syriacus* individuals was much higher than of all other species found in Haogen Junction, we caution against the use of density estimates for the other species, especially the larger ones. Snakes observed in the water passing over the flooded road were large, whereas the snakes and legless lizards we found of the same species (*Daboia palaestinae*, *Pseudopus apodus*, *Dolichophis jugularis*, but not *Eryx jaculus*) were all juveniles. We suspect that large adults (and most of the semiaquatic *Natrix tessellata*) managed to swim to safety and the numbers we found were underestimates of true density. We are unsure of how well the captures represent the densities of arboreal and saxicolous lizards such as chameleons and geckos or that tiny *Ablepharus* skinks were all caught in the debris.

Regardless, the density of *X. syriacus* revealed by the flood was remarkable. That said, incidental reports often mention scolecophidians found on the surface after rains (see, for example, the metadata in Meiri 2024). Rick Shine also reported (pers. comm. to SM, 24 March 2024) that the only times large numbers of typhlopids are found near Sydney (NSW, Australia) are after heavy rains. *Xerotyphlops syriacus* was always considered common in Israel (e.g., Bar et al. 2021) — and is likely to soon be reassessed as Least Concern in Israel (Ben Shermeister, pers. comm.). The very large number of snakes we found following the flooding, however, suggest that the true abundance of these snakes, and perhaps some other scolecophidian species and other fossorial taxa elsewhere, may be seriously underestimated.

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