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The frequency of body scarring in Caspian Whip Snakes (*Dolichophis caspius* Gmelin, 1789) in south-western Hungary

Krisztián Frank[1,2], György Dudás[3]

1 *Faculty of Animal Science, University of Kaposvár, Guba Sándor u. 40., 7400 Kaposvár, Hungary*
2 *Agricultural Biotechnology Institute, National Agricultural Research and Innovation Centre, Szent-Györgyi Albert u. 4., 2100 Gödöllő, Hungary*
3 *Duna-Dráva National Park Directorate, Tettye tér 9., 7625 Pécs, Hungary*

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Corresponding author: *Krisztián Frank* (frank.krisztian@abc.naik.hu)

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Abstract

Animals can suffer injuries due to diseases, intraspecific aggression and, most of all, predation events. We present field data to provide numerical information about the injuries found in the largest Caspian Whip Snake (*Dolichophis caspius*) population in Hungary, near the northernmost portion of the species' distribution range.

Key Words

Colubridae, injury, predator-prey relationship, Szársomlyó Hill

Wild animals can suffer injuries due to diseases, intraspecific aggression and, most of all, predation events (Bonnet et al. 2010; Schenk 2017). Frequency and types of injuries have shown geographical and habitat-related differences amongst populations (Akani et al. 2002; Placyk and Burghardt 2005) and sexes (Norval et al. 2016; Pleguezuelos et al. 2018). Numerical data about the injuries found in natural populations could provide some indirect information on the life quality of populations, i.e. habitat conditions, natural status, aggressive behaviour and predation pressure. It is possible to analyse correlations between injury rates and several life-history traits or shifts in injury frequency amongst populations, ontogenetic or sex groups (Placyk and Burghardt 2005; Pleguezuelos et al. 2010).

The Caspian Whip Snake, *Dolichophis caspius* (Gmelin, 1789), is distributed on the Balkans and in adjacent west Asia. At the north-western edge of its distribution, populations tend to be isolated from the contiguous distribution area (Tóth 2002; Puky et al. 2005), which ranges from the Carpathian Basin to the west side of the Caspian Sea and covers most of the Balkan Peninsula and several neighbouring Near East countries (Puky et al. 2005).

Studying edge populations may play a crucial role in conservation issues, especially in regions where populations have been isolated from each other. We present field data to provide numerical information about the injuries found in the largest and strictly protected Caspian Whip Snake population of Hungary, near the northernmost portion of the species' distribution range.

Szársomlyó Hill is situated in southern Transdanubia, south-western Hungary. It is a strictly protected nature reserve, the most well-known habitat of *D. caspius*, harbouring the largest remnant whip snake population in the country (Majer 2000; Tóth 2002; Puky et al. 2005; Bellaagh et al. 2007). Recently, this population has also shown signs of decline (Majer 2000; Frank et al. 2012), probably due to vegetation changes, human pressure and anthropogenic habitat alteration (Majer 2000; Bellaagh et al. 2007).

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Table 1. Number and frequency of *Dolichophis caspius* with scarring. Mean (and SE) snout-vent-length (SVL) and body condition index (BCI) are also given for scarred and non-scarred animals.

	Sample size	Scarred		SVL (mm)		BCI	
		Count	Freq.	Non-scarred	Scarred	Non-scarred	Scarred
Males	25	6	0.24	1063.15	1089.13	352.29	312.17
				(123.27)	(164.28)	(62.18)	(104.75)
Females	43	9	0.21	906.42	870.43	382.95	393.84
				(209.50)	(255.03)	(62.94)	(60.40)

During the period 1998–2003, the Baranya County Section of BirdLife Hungary monitored the species on Szársomlyó Hill, under the supervision of one of the authors. Occasional road surveys were carried out from April to September. Snakes were captured by hand, weighed and measured for snout-vent-length (SVL). Captured snakes were palpated to record food items and visually examined for the presence of body injuries. Determination of sex was made by probing to detect hemipenes. After processing, snakes were released at the location of capture. Body condition was quantified as body mass scaled by SVL (Frank and Dudás 2018).

The total dataset consists of 68 captured individuals, of which 25 were males and 43 females. In total, 15 *D. caspius* individuals had scars (22.1%), mostly in the body (n = 12) and a few on the tail (n = 3); scars present on body and tail were grouped together in all analyses. Two individuals with tail breakage (2.9%) were captured, but body scars were also present on these individuals. All observed scars were superficial, indicating that the snakes had suffered injuries that healed well. The frequency of tail breakage was very low, thus it was not included in the analyses. The frequency of body scarring was similar to that found in other colubrid snakes (Akani et al. 2002; Placyk and Burghardt 2005; Pleguezuelos et al. 2010; Pleguezuelos et al. 2018).

From the 15 injured snakes, six were males and nine were females. Overall, there were no differences in the frequency of scarred individuals between sexes (chi-squared test of independence $\chi^2 = 0.005$, df = 1, p = 0.944), nor between calendar years ($\chi^2 = 3.745$, df = 5, p = 0.587). In snakes, males usually move more than females in the mating period and this difference in behaviour would expose males to greater predation pressure, resulting in higher frequency of injuries by males (Pleguezuelos et al. 2018). However, most studies of body injuries of snakes, that have considered sex as a factor, have failed to find a sexual difference (Mendelson 1992; Aubret et al. 2005; Pleguezuelos et al. 2010; Dourado et al. 2013). In Caspian Whip Snakes, the frequency of body scarring was identical between the sexes. In addition, the frequency of scarring did not show any signs of annual fluctuations.

Snout-vent-length (SVL) did not differ between snakes with body scars and those without scars (Mann-Whitney U test Z = -0.669, p = 0.503) and this result held when the sexes were considered separately (Z = -0.329, p = 0.742 in females and Z = -0.788, p = 0.431 in males). Similarly, body condition, expressed as body mass scaled by body size (Frank and Dudás 2018), did not differ between snakes with and without scars (Z = -0.486, p = 0.627), also when the sexes were considered separately (Z = -0.411, p = 0.681 in females and Z = -0.788, p = 0.431 in males). The frequency of injured snakes should be higher in larger, older individuals, because they have been exposed to potential predators for a longer period than smaller ones, with accordingly an increased cumulative likelihood of injury (Pleguezuelos et al. 2010; Dourado et al. 2013). However, for *D. caspius*, the rate of body scarring did not vary with body size or condition of individuals. This is in accordance with some previous reports and also fails to show a relationship between injury rate and body size or body condition in snakes (Aubret et al. 2005; Dourado et al. 2013; Pleguezuelos et al. 2013; Pleguezuelos et al. 2018). This may suggest that body scarring did not decrease the foraging success and the associated growth. Moreover, injuries did not affect body condition which, in turn, strongly influences survival (Shine et al. 2001; Bonnet et al. 2002; Bonnet et al. 2010). Severe injuries may, however, never heal, thus causing the death of the snakes without the snakes being noticed. Thus, lethal injuries are likely underestimated.

The analysis of body injuries can reveal some aspects of the natural history of snakes, otherwise difficult to discover for these rather elusive reptiles. There were no obvious differences found between scarred and non scarred individuals in the Caspian Whip Snake. The sample for this study was rather small, thus further studies on body injuries of *D. caspius* are encouraged, particularly studies based on large samples that can address the population-level or habitat-related consequences of injury.

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