

Defensive tail waving in the Caspian Whipsnake, *Dolichophis caspius* (Gmelin, 1789)

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Snakes exhibit a wide variety of tail displays that serve different functions. Some examples include (1) catching prey, including caudal luring (*Vipera latastei* Bosca, 1878 – Parellada and Santos, 2002; *Pseudocerastes urarachnoides* Bostanchi et al., 2006 – Bostanchi et al., 2006; *Bitis arietans* Merrem, 1820 – Glaudas and Alexander, 2017) and caudal distraction (*Pantherophis alleghaniensis* [Holbrook, 1836], as *P. spiloides* – Mullin, 1999); (2) courtship (33 different snake species – Senter et al., 2014); and (3) defensive displays as warning signals, including rattling (*Crotalus* sp. – Allf et al., 2016) and deimatism (*Diadophis* sp. – Cox et al., 2021). Additionally, tail displays can act as a distraction when facing a predator to draw the predator's attention away from vulnerable body parts, such as the head. These behaviours are well documented and can include tail vibration, tail waving and even tail strikes (Greene, 1973; Johnson, 1975; Jackson, 1979; Arnold and Bennett, 1984; Kochva and Golani, 1993; Dyugmedzhiev, 2020; Di Nicola et al., 2021, 2022; Bjelica et al., 2023).

The Caspian Whipsnake, *Dolichophis caspius* (Gmelin, 1789), is a large, diurnal snake, growing to lengths of up to 2 m, with some individuals exceeding 2.5 m in length (Speybroeck et al., 2016). It has a wide range from Eastern Europe and the Balkan Peninsula

in the west to the Caucasus, southern Russia, and Kazakhstan in the east (Sahlean et al., 2014). This species is found in open steppe and forest-steppe habitats, Mediterranean shrub, rocky slopes, and deciduous forest edges at low and medium elevations (Speybroeck et al., 2016). So far, the observed arsenal of defensive behaviour of *D. caspius* includes flight and active defence (e.g., jumping at the attacker, hissing, and biting; Speybroeck et al., 2016). To our knowledge, no other reports describing defensive tail displays in *D. caspius* have been published.

On 4 May 2021, we captured an adult male *D. caspius* (total length 149.6 cm, body weight 407.4 g) in Belgrade, Serbia (44.8349°N, 20.5100°E) as part of an ongoing ecological study. After checking the individual for food, scars, and taking morphological measurements and cloacal temperature, we released it at the site of capture. Immediately upon release, the individual puffed up, hissed loudly, and struck at the first author, who had previously handled it and was still close-by (Fig. 1A). After the defensive strike, the snake tried to burrow into a hole but was impeded by the rocky substrate. During this escape attempt, the animal first displayed tail waving by quickly moving the posterior half of the body and vigorously moving the tail from side to side (Fig. 1B). The individual then reversed out of the hole and tried to burrow for the second time but got stuck and displayed tail waving for the second time (Fig. 1C). Finally, the individual reversed and pounced at the first author again (Fig. 1D). After he moved, the snake successfully found a hole where it could escape. The entire sequence of behaviours is available in video format at <https://youtube.com/shorts/8Ud4Y6LDFwU>.

Our observations suggest that whipsnakes use tail waving as a distraction as they switch from intimidation to escape by burrowing. Tail waving has been observed in other snake species as a prelude to escape by burrowing (Greene, 1973), but this has not yet been reported for *D. caspius*. During our ecological study, we processed 166 whipsnakes and had never observed tail waving independent of handling (holding the snake

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for morphological measurements usually results in the snake displaying tail waving, as seen at <https://youtube.com/shorts/jH-UwL62Smo>.

Tail waving may be a more common behaviour for *D. caspius* and many other snake species than currently known, especially in encounters with natural predators, as evidenced by the numerous scars on the tail in many snake species (Gregory and Isaac, 2005). Such a lack of reports on this behaviour is likely because tail waving is context dependent. As with many other antipredator behaviours, their occurrence is possibly determined by the type of stimuli (Cox et al., 2021), experience

(Gregory, 2013), risk perception (Bowers et al., 1993), intensity of attack (Roth and Johnson, 2004), type of predator (e.g., human researcher vs. a natural predator; Jackson, 1979; Gregory, 2016), and potentially other factors. The conditions that occurred while releasing this animal back into its habitat likely enabled us to observe tail waving in the absence of handling.

In addition to the well-documented behaviours such as lunging at an attacker, hissing, and biting (Speybroeck et al., 2016), *D. caspius* also exhibits other antipredator responses. Most commonly, we observed tail striking, especially during capture and handling,

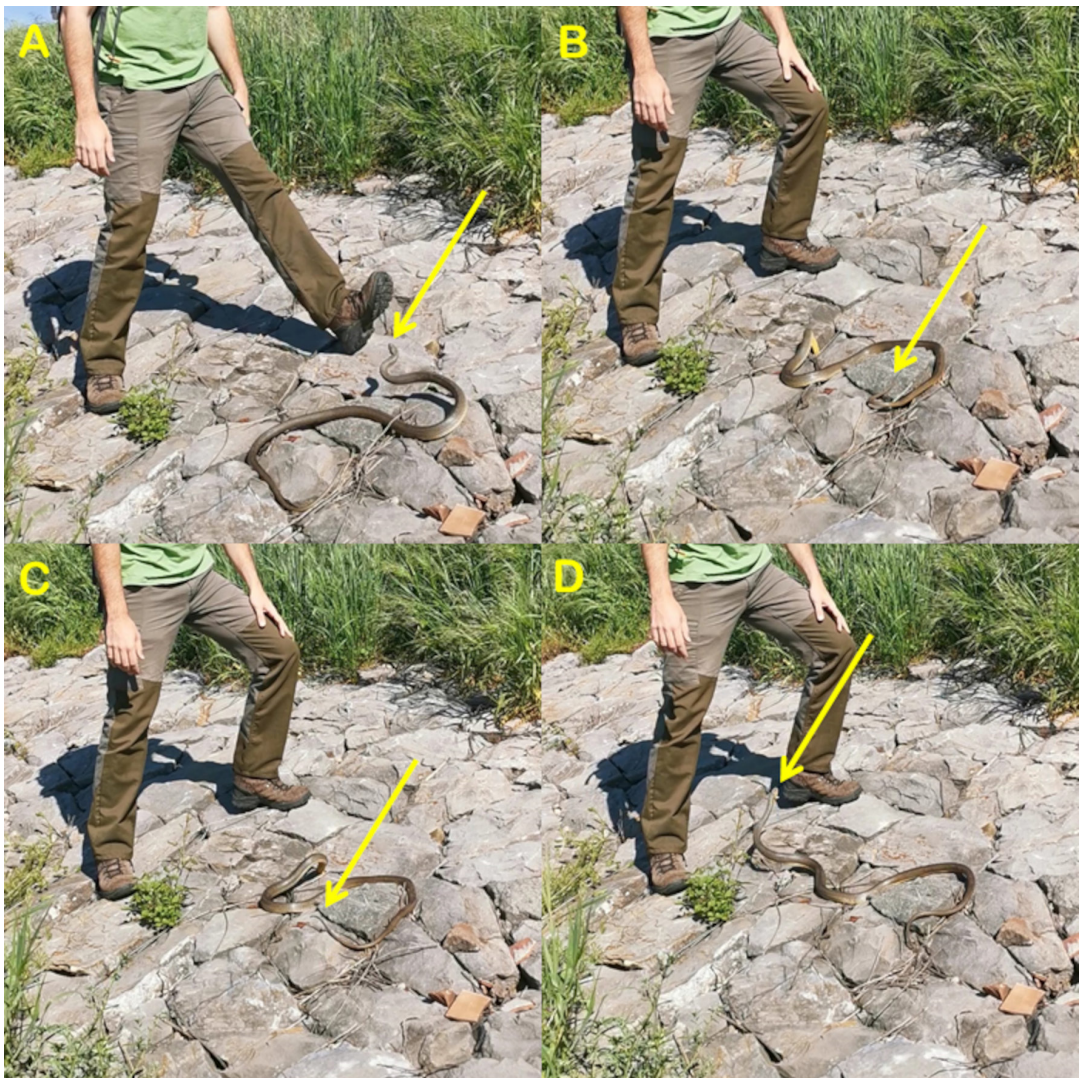


Figure 1. The sequence of behaviours displayed by a male *Dolichophis caspius* upon release by the first author. (A) The snake performs a defensive strike. (B) The snake attempts to escape by burrowing for the first time and tail waves. (C) The snake attempts to burrow for the second time and tail waves again. (D) The snake strikes a final time before escaping.

presumably as a means to persuade the predator to release the individual go, as seen at <https://youtube.com/shorts/8VWxLqagJX8>. Research on the defensive behaviours of this species could yield interesting results on mechanisms and tactics used to confront predators when escaping is not possible. Additionally, observations such as this one underscore the need for behavioural studies that are based on minimal disturbance caused by researchers (Glaudus and Alexander, 2017) and dedicated studies of behaviours that are considered “rare” (Bjelica et al., 2023).

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