

Underwater tongue-flicks by a non-aquatic snake species, the nose-horned viper *Vipera ammodytes*

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The nose-horned viper *Vipera ammodytes* (Linnaeus, 1758) is a sedentary ambush predator (Saint Girons, 1952) that typically inhabits dry, rocky, sandy slopes with scrubs and sparse forests, karst terrains with limited vegetation, and occasionally vineyards and smallholder pastures (Stojanov et al., 2011; Dyugmedzhiev et al., 2024). The species is mainly terrestrial with some observations of arboreal behaviour (Dyugmedzhiev et al., 2025) but with very limited records of swimming behaviour (PalomaClassic, 2023; authors' personal observation). Furthermore, in the case of viperids generally, there is little information about diving behaviour or underwater tongue-flicking, although these topics have been researched extensively in aquatic and semi-aquatic snakes (Heatwole & Seymour, 1975; Heatwole, 1999; Aubret et al., 2007; Udyawer et al., 2020; Ryerson & Schwenk, 2022).

The tongue of a snake gathers odorant molecules from the environment and transports them to the vomeronasal organs as part of an accessory olfactory system that enhances the chemical information received by the nose and nasal olfaction (Halpern, 1992). Our observation of underwater tongue-flicking is based on a single adult female *V. ammodytes* (SVL = 58.6 cm, TL = 5.7 cm, W = 71.18 g) from a group that had been collected from a population in the area of Karlukovo, NW Bulgaria (43° 10' N, 24° 3' E (DDM)) for experimental behavioural assays to test responses to different compounds relevant to intrasexual chemical communication. The specimen was maintained for two months in its own terrarium (50L x 30W x 30H cm) with beech chips for substrate, a constantly running heating coil at one end and a shelter at the other. Temperature was maintained between 30–32 °C during the day (09:00 h to 20:00 h) and approximately 17 °C

at night. The viper was fed at 10–15 day intervals with a dead laboratory mouse and water was provided from a water bowl. Testing of the compounds was done by presenting them to the snake on a paper towel and behavioural responses were recorded by video. During one of these behavioural assays, to a heptacosane-soaked paper towel, the female plunged its head into the water bowl (Fig. 1; [BHS video, 2026a](#)). This behaviour was observed 6:11 minutes after the start of the test. We observed underwater tongue-flicking, which is currently not recorded for this species. The viper flicked its tongue underwater a total of three times. It stayed underwater for nine seconds and flicked its tongue once, took a breath, and dived again for four seconds with one underwater tongue-flick. After another break, the female took a final dive for five seconds with another underwater tongue-flick ([BHS video, 2026a](#)). It should be noted that heptacosane is not reported to be a part of the sex pheromone, and no records of its intersexual attractiveness have been observed.

While tongue-flicking serves multiple functions in snakes, its occurrence in this context likely reflects exploratory behaviour. This is noteworthy, considering that the species is not aquatic, its diet does not typically include aquatic prey, and it is rarely found in aquatic habitats (Beshkov, 1977; Anđelković et al., 2021). Tongue-flicking is an important part of the chemosensory perception of snakes. Previous studies, on aquatic and semi-aquatic snakes, have suggested that underwater tongue-flicking behaviour is an adaptation typical for aquatic snakes, and that the vomeronasal organs are adapted to underwater perception (e.g. Ryerson & Schwenk, 2022). Currently, there is only one record of underwater tongue-flicks of a snake that is not regarded as

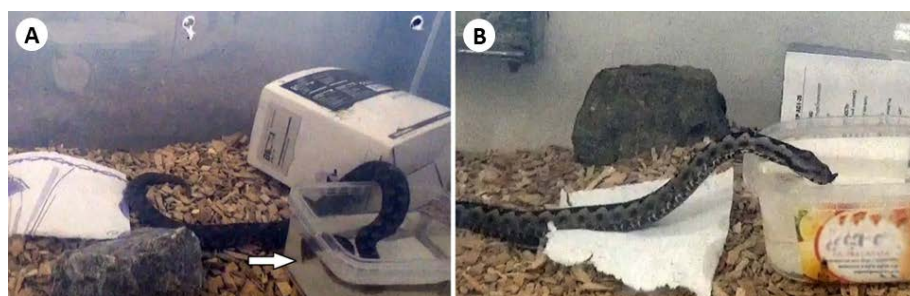


Figure 1. Stills from videos taken during a laboratory behavioural bioassay of *Vipera ammodytes* - **A.** An underwater tongue-flick of an adult female, the white arrow indicates the tongue, flicking under the water, and **B.** Drinking water by an adult male

specifically aquatic or semi-aquatic, the arboreal pit viper *Craspedocephalus malabaricus* (Bhaisare & Pelling, 2015).

There are three main types of tongue-flicking described based on the movement of the tongue, i.e. simple downward extensions, single oscillations and multiple oscillations, which might have different contexts and be used in different situations such as trailing, feeding, recognition of conspecifics, etc. (Gove, 1979; Gove & Burghardt, 1983). Although it's difficult to categorise the observed tongue-flicks in a liquid environment, they most closely resemble simple downward extensions, which are typically linked to responses to non-volatile cues (Daghfous et al., 2012). Water itself can be an effective chemical stimulus, provoking tongue-flicking in case the individual is thirsty (Loop, 1970). Loop (1970) considered that water effectively stimulates the snake's chemoreceptors, but it only triggers a response when the snake is deprived. We believe that this is not the case for the herein-described observation since there has been a full water bowl in the terrarium constantly and water was changed every 2–3 days. Also, the behaviour of an individual drinking water looks completely different (Fig. 1; BHS video, 2026b).

Some studies have suggested that underwater tongue-flicking is an adaptation of aquatic snakes (e.g. Ryerson & Schwenk, 2022), but given that this behaviour has now been reported in at least one terrestrial and one arboreal species, underwater tongue-flicking in non-aquatic snakes should be investigated further in order to compare tongue-flick kinematics and chemosensory mechanisms of aquatic and non-aquatic snake species.

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