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Case Report



Into the Deep: Diving Record for the Dice Snake *Natrix tessellata* (Laurenti, 1768) in Lake Orta, NW Italy

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Abstract

Many snakes live close to water, with several groups displaying morphological, physiological, or behavioral adaptations to aquatic environments. Although marine snakes have been found at depths beyond 200 m, freshwater snakes are rarely reported at depths larger than a few meters. Here we report freshwater depth records for the dice snake *Natrix tessellata*, an aquatic snake belonging to the family Natricidae. Dice snake was observed at depths down to 17 m, including in habitats below the thermocline, in Lake Orta (Northern Italy). These observations open new perspectives related to the biology and physiology of Palearctic freshwater snakes belonging to the family Natricidae.

Introduction

More than 3000 snake species are known globally. Many species live close to water, and around 5% are considered strictly aquatic [1]. Elapid sea snakes and the Homalopsidae snakes are particularly well adapted to the aquatic environment. Both groups have several morphological and physiological adaptations linked to their aquatic life [2-6]. Elapid sea snakes are strictly marine snakes, with depth records beyond 200 meters reported for the genus *Hydrophis* [7]. *Homalopsidae*, on the other hand, include marine as well as brackish and freshwater species [8].

Most other freshwater snake species belong to the Natricidae and Xenodontida subfamilies with both groups including both terrestrial and aquatic species. Natricidae snakes are widely distributed in the Palearctic and Nearctic Regions and include over 250 species. Some species, such as the dice snake *Natrix tessellata*, are strictly aquatic, inhabiting several different freshwater habitats. Compared to other species of the genus *Natrix*, dice snake show particularly pronounced morphofunctional and behavioural adaptations to aquatic life [9-11].

The dice snake lives its entire life along the banks in both lentic and moderately lotic environments. It hunts fish underwater [12,13] and thermoregulates within the aquatic

environment [14]. As for other freshwater snake species, little is known about its depth use. It has been reported not to move far from the banks of the water body [15,16]. Nevertheless, Gruschwitz, et al. [13], reported occurrences at 12 m depths in lakes in Switzerland and Northern Italy. Even these snakes, however, were never observed below the thermocline (at 15 m depth) in these stratified lakes.

Case report

Based on observations made by divers in Lake Orta (NW Italy), we here report dice snake occurrences down to depths of up to 17 m, including two observations below the thermocline.

Data was collected using a Citizen Science protocol in collaboration with the Deep Green Divers Association of Pella (Novara Province). Volunteer divers were trained on species identification and depth reporting, and supplied with data collection sheets. Data collection sheets included location (site name and coordinates), depth (m), and temperature (°C) for each dice snake observation. Data collection sheets were made available both at the Association’s headquarters and in a group chat. In total, 16 independent dice snake observations were reported (Table 1).

Figure 1 shows the Punta Grunf locality and Figure 2 shows a specimen observed on date 20th September 2020. at the depth of 17 m.

Table 1: Dice snake (*Natrix tessellata*) observations reported by volunteers from Deep Green Divers Association of Pella (Novara Province). The table includes the observer (full name), date, location, coordinates, depth, and temperature.

Observer	Date	Location	Latitude	Longitude	Depth (m)	T (°C)
Paola Viviana Trovò	8 th August 2019	Ponte Sassina	45.808993	8.413048	4,5	17
Paola Viviana Trovò	13 th August 2019	Punta Grunf	45.807649	8.385473	6,5	18
Pietro Bertoldo	15 th September 2019	Punta Grunf	45.807649	8.385473	4,5	16
Renzo Fenice	22 th May 2020	Punta Grunf	45.807649	8.385473	6,5	20
Marco Fontana & Maria Restifo	23 th June 2020	La Franata	45.810654	8.386840	6,5	-
Cristian Di Cappello	27 th June 2020	Punta Grunf	45.807649	8.385473	8	-
Renzo Fenice	20 th August 2020	Punta Grunf	45.807649	8.385473	6	26
Renzo Fenice	23 th August 2020	Punta Grunf	45.807649	8.385473	4,5	25
Renzo Fenice	27 th August 2020	Punta Grunf	45.807649	8.385473	6	23
Paola Viviana Trovò	26 th August 2020	Ponte Sassina	45.808993	8.413048	4,9	25
Roberto Pozzi	6 th September 2020	Punta Grunf	45.807649	8.385473	2,8	23
Alessio Viora	20 th September 2020	Punta Grunf	45.807649	8.385473	17	-
Roberto Pozzi	13 th June 2021	Punta Grunf	45.807649	8.385473	4,5	-
Franco Montà	20 th June 2021	Ponte Sassina	45.808993	8.413048	5,5	-
Paola Viviana Trovò	19 th August 2021	Punta Grunf	45.807649	8.385473	11,5	7
Paola Viviana Trovò	16 th September 2021	Cappella del Cormorano	45.829067	8.381791	5,3	23



Figure 1: Punta Grunf, Lake Orta. Near this location, a specimen was observed at a depth of 17 m. Photo by Paola Viviana Trovò.



Figure 2: Specimen of *Natrix tessellata* swimming at a depth of 17 m. Photo taken with flash by Alessio Viora.

On the basis of these data, we conclude that the dice snake displays a more extensive depth range than previously reported, including sites at the bottom of the lake, under the thermocline (observations of 20th Sept. 2020 and 19th Aug, 2021). During summer, the thermocline in Lake Orta is located at a depth of about 10 m - 15 m. Indeed, one of

the observers PVT, on 19th August 2021, reported that the observed specimen at a depth of 11 m was even swimming along the bottom of the lake towards even deeper areas.

Conclusion

The lack of scientific literature on the use of deeper waters in *Natrix* snakes limits our ability to explain this behavior. It is, however, unlikely that the snake descend to such depths to feed. The dice snake is almost completely ichthyophagous, and preys on several small-sized fish species [10] which are decidedly more abundant and easier to catch in shallow waters along the shore. Another explanation could be that the snakes exploit deeper water for thermoregulation. Diving deep allows the snake to lower the temperature of its environment substantially, even over 20 °C, in a short time.

Alongside adaptations to brackish and even marine waters in this species (Strugariu, et al. 2011), the ability to move in very deep waters highlights its ability to adapt to a diverse range of aquatic environments. It also opens up new research perspectives. Climate change is forecasted to increase lake temperatures, particularly in superficial layers, perhaps pushing both fish and snakes to colder, deeper waters. The observation of snakes at depths even greater than 10 meters suggests that deeper dives may constitute a coping mechanism for the species. More work, however, is needed. Both behavior and time spent at larger depths remains unknown. For example, higher pressure at a larger depth could limit large-depth excursion.

Lastly, this small Citizen Science project underlines the important contribution a small group of properly trained volunteers can make to the expansion of our knowledge about the natural world. In addition to the data collected, the incentive to observe likely leads to greater awareness of our surroundings and, hopefully, greater respect for nature.

The Dice Snake *Natrix tessellata* is protected by the European Community and is included in both the Bern Convention and Annex IV of the 92/43 EEC “Habitats” Directive.

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