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Clutch size and hatchling morphology of *Erythrolamprus poecilogyrus schotti* (Serpentes: Dipsadidae: Xenodontinae) from northeastern Brazil

Tamaño de puesta y morfología de neonatos de *Erythrolamprus poecilogyrus schotti* (Serpentes: Dipsadidae: Xenodontinae) en el noroeste de Brasil

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Abstract

We report on the clutch size and neonate morphology of *Erythrolamprus poecilogyrus schotti*, an oviparous snake species. A clutch of seven eggs was found in a rural area of Paraíba, Brazil. Neonates had an average total length of 181.29 mm and an average weight of 3.0 g, with females being larger sizes than males—a pattern consistent with the species' known reproductive traits. Defensive behaviors observed in the neonates included cloacal discharge and substrate-burrowing. These findings offer new insights into the species' natural history and highlight its early-life defensive strategies and developmental characteristics.

Keywords: reproductive ecology, embryonic development, sexual dimorphism, neonate behavior, Atlantic Forest.

Resumen

Se reporta el tamaño de la puesta y la morfología de neonatos de *Erythrolamprus poecilogyrus schotti*, una especie de serpiente ovípara. Se encontró una puesta de siete huevos en una zona rural de Paraíba, Brasil. Los neonatos presentaron una longitud total promedio de 181,29 mm y un peso promedio de 3,0 g, con las hembras siendo de mayor tamaño que los machos, un patrón consistente con los rasgos reproductivos conocidos de la especie. Entre los comportamientos defensivos observados en los neonatos se incluyen la descarga cloacal y el ocultamiento en el sustrato. Estos hallazgos aportan nuevos datos sobre la historia natural de la especie y destacan sus estrategias defensivas y características de desarrollo en etapas tempranas.

Palabras clave: ecología reproductiva, desarrollo embrionario, dimorfismo sexual, bosque atlántico, comportamiento de neonatos.

Introduction

Information on the timing and duration of egg-laying, clutch size, egg dimensions, incubation period, and offspring morphology is essential for studies on snake population ecology and for understanding species' life history (Qu et al., 2011; Amaral et al., 2020). However, such data are difficult to obtain due to the need to locate gravid females in the wild and/or find eggs and monitor their development through hatching. Despite these challenges, there has been a recent increase in studies documenting early reproductive traits in oviparous Brazilian snakes. These studies span various families and genera (Pizzatto & Marques, 2002; Scartozzoni et al., 2005; Morais et al., 2018; Muscat et al., 2019; Amaral et al., 2020; Guedes & Guedes, 2020; Amaral et al., 2021; Marques et al., 2021; Amaral et al., 2022; Barbosa et al., 2023).

The genus *Erythrolamprus* Boie, 1826 (family Dipsadidae, subfamily Xenodontinae) comprises 55 species distributed throughout South America and the Antilles. It represents one of the most morphologically diverse radiations of New World snakes (Dixon, 1989; Ascenso et al., 2019; Uetz et al., 2024). *Erythrolamprus poecilogyrus* (Wied-Newied, 1824) occurs from southeastern Venezuela and eastern Guyana to Pampas and Chaco regions of Argentina (Fernandes, 2006; Uetz et al., 2024). Due to its considerable variation in coloration, meristic patterns, and morphology, Dixon & Markezich (1992) recognized four subspecies: *E. p. caesius* (Cope, 1862), found in the Pantanal and Chaco; *E. p. sublineatus* (Cope, 1860), in the Pampas; *E. p. poecilogyrus* (Wied-Newied, 1825), mainly in the Central and Southern Atlantic Forest; and *E. p. schotti* (Schlegel, 1837) in the Amazon, cerrado, caatinga, and the Northeastern Atlantic Forest.

All subspecies of *Erythrolamprus poecilogyrus* are terrestrial, active both during the day and at night, and primarily feed on amphibians, with ocassional consumption of fish, lizards, and invertebrates (Prieto et al., 2012; Corrêa et al., 2016; Marques et al., 2017; Oliveira et al., 2021). Although the species is oviparous, information on its reproductive biology remains limited. Pizzatto et al. (2008) and Quintella et al. (2017) reported that follicular cycles in E. *p. poecilogyrus* and *E. p. schotti* can be continuous in southeastern Brazil, whereas in *E. p. sublineatus* from southern Brazil, reproduction is strictly seasonal and occurs during the dry season. Clutch size varies among subspecies: *E. p. poecilogyrus* may lay 2-9 or 6-15 eggs depending on the population (Pinto & Fernandes, 2004; Alencar & Nascimento, 2014); *E. p. caesius* has been recorded with 8-9 eggs (Campbell & Murphy, 1984); *E. p. sublineatus* with 2-9 eggs; and *E. p. schotti* with 3-17 eggs (Vitt & Vangilder, 1984; Mesquita et al., 2013). Herein, we present data on clutch size and hatchling morphology of *E. p. schotti* from a region of the Northeastern Atlantic Forest.

Materials and methods

On August 8, 2023, a clutch of seven eggs was found in a rural area in the municipality of Mamanguape, Paraíba, northeastern Brazil (6°39.44'S, 35°08'55'W; elevation: 30 m). According to the Köppen climate classification, the region has a hot and humid climate (type Aw), with a dry season in summer and a rainy season in winter. The eggs were partially protected inside a hole in the ground and were collected under SISBIO License 74327-1, then transported to the Laboratório de Ecologia Animal at the Universidade Federal da Paraíba. Each egg was measured for length and width using a digital caliper (precision: 0.01 mm) and weighed with a precision digital scale (0.1 g). The eggs were incubated at 20-22 °C with approximately 60% humidity, semi-buried in vermiculite (Figure 1A) in a rounded glass container (185 mm height x 130 mm diameter).

Immediately after birth, all hatchlings were measured using a digital caliper (precision: 0.01 mm), weighed using a spring scale (0.1 g), and sexed using a probe. The recorded measurements included snout-vent length (SVL), tail length (TL), body width (BW), body height (BH), head width (HW), head height (HH), head length (HL), distance between the nostrils (NW), eye diameter (ED) and mass (M). One individual was preserved in 10% formalin and deposited in the Herpetological Collection of the Universidade Federal da Paraíba (CHUFPB-32179). The remaining hatchlings were released at the Guaribas Biological Reserve in the municipality of Mamanguape.

Results

The eggs averaged 26.1 mm in length (SD = 1.2), 15.1 mm in width (SD = 0.5), and 3.9 g in mass (SD = 0.4). After 37 days of incubation, the eggs began to pip, and all snakes successfully hatched. On 13 September 2023, at 21:41, five offspring began hatching (Figure 1B). On 14 September 2023, at 08:39, the first snake fully emerged from its egg after 10 hours and 58 minutes (Figure 1C). The second snake emerged at 10:44, after 13 hours and 3 minutes. The third and fourth snakes emerged simultaneously at 11:49, after 14 hours and 8 minutes. The fifth snake emerged at 17:03, after 19 hours and 22 minutes.

The last two eggs began to pipe only on 14 September 2023, at 09:40 and 12:03, respectively. The sixth snake emerged at 04:30 on 15 September, after 18 hours and 50 minutes. The seventh snake emerged at 14:59 on 14 September, taking only 2 hours and 56 minutes to fully emerge from the egg (Table 1).

The hatchlings' mean total length was 181.29 mm (SD = 7.4), with an average mass of 3.0 g (SD = 0.2). Of the seven snakes, five were females and two were males (Table 2). All individuals displayed the typical coloration of juvenile *E. p. schotti*, characterized by a brown head with black spots, a light cream dorsum with black spots extending to the tail, and a light cream venter with sparse black edging or black bands (Figure 1D). After hatching, all the snakes exhibited escape behavior, burying themselves in the vermiculite substrate.

Discussion

Compared with data available in the literature, the clutch size of *Erythrolamprus poecilogyrus schotti* is consistent with that reported for other subspecies of *E. poecilogyrus*, which ranges from 2 to 17 eggs per clutch (Vitt & Vangilder, 1983; Pinto & Fernandes, 2004; Alencar & Nascimento, 2014). The mean snout-vent length (SVL) of the newborns was slightly higher than that reported by Vitt & Vangilder (1983), who documented an SVL of 136.3 mm for three hatchlings. Additionally, females were slightly larger than males, a pattern also observed in *E. poecilogyrus*, as distinct male-female size ratios have been reported for *E. p. poecilogyrus*, *E. p. sublineatus* and *E. p. schotti* (Alencar & Nascimento, 2014; Quintela et al., 2017).

Although *E. p. schotti* does not exhibit seasonal reproduction (Pizzatto et al., 2008), slight variations between populations in different locations may

occur. The clutch was found during the wet season in the northeastern Atlantic Forest, a period that may favor the development of eggs and hatchling survival (França et al., 2023). The high humidity characteristic of this region likely promotes adequate egg hydration, thereby optimizing embryonic development. Moreover, environments with elevated humidity may enhance phenotypic and immunological traits in some species (Ji & Du, 2001; Brown & Shine, 2006; Brown & Shine, 2018).

Snakes of the genus *Erythrolamprus* typically exhibit non-aggressive defensive behavior, generally avoiding biting even when handled—*E. aesculapii* being a notable exception—and fleeing when threatened (Marques & Sazima, 2004; Marques et al., 2019). All *E. p. schotti* newborns displayed escape behaviors: when handled, they released cloacal discharge and rotated their bodies but did not strike or attempt to bite. These observations suggest an innate preference for evasion over offensive defense mechanisms in *E. p. schotti* (Greene, 1988).

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Table 1. Hatching times and birth order of *Erythrolamprus poecilogyrus schotti* hatchlings.

ID	CR	Date CR	HT	Date HT	CR to HT
1	12:03	2023-09-14	14:59	2023-09-14	2h and 56 min
2	09:40	2023-09-14	04:30	2023-09-15	18h and 50 min
3	21:41	2023-09-13	17:03	2023-09-14	19h and 22 min
4	21:41	2023-09-13	08:39	2023-09-14	10h and 58 min
5	21:41	2023-09-13	11:49	2023-09-14	14h and 8 min
6	21:41	2023-09-13	10:44	2023-09-14	13h and 3 min
7	21:41	2023-09-13	11:49	2023-09-14	14h and 8 min

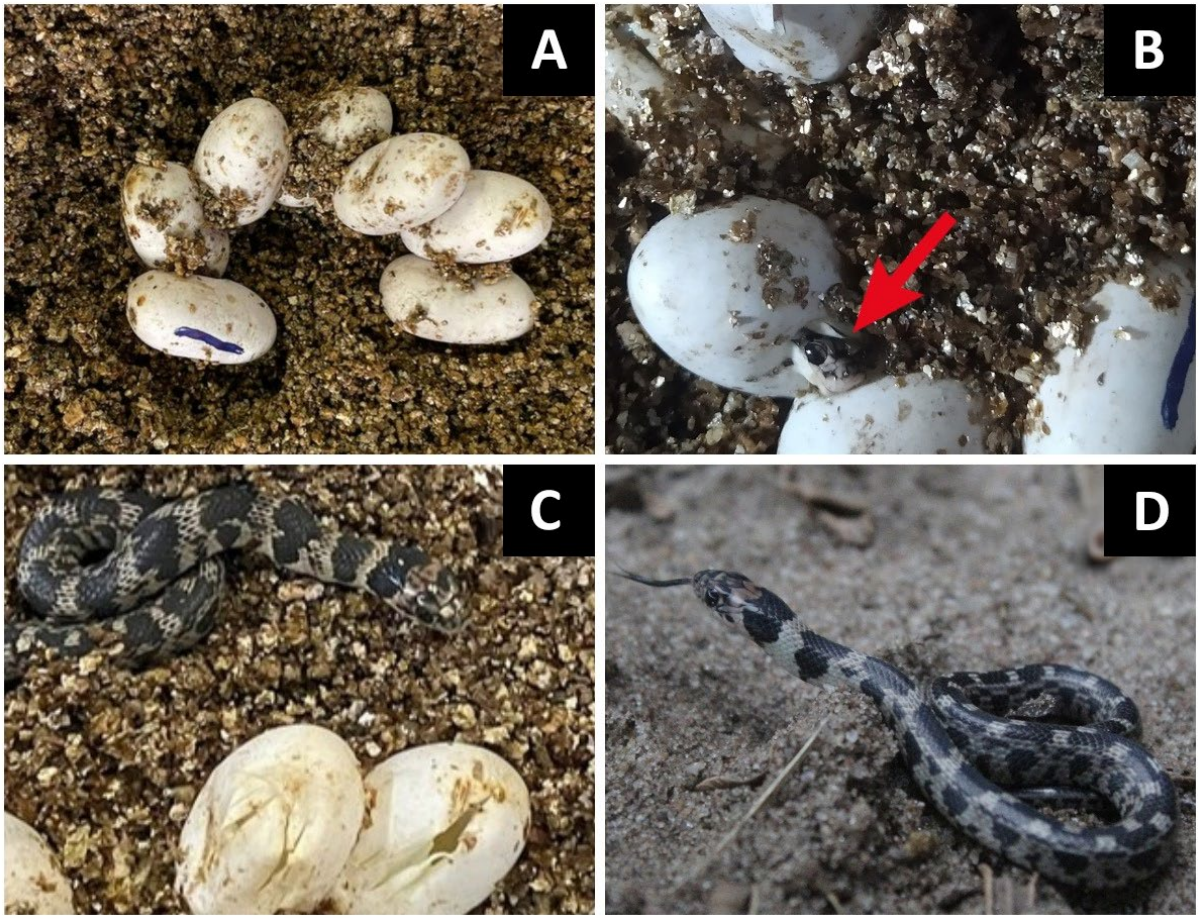
Notes. ID = egg identification; CR = time when the eggshell was cracked (pierced by the hatchling); Date CR = date when the eggshell was cracked; HT = time of hatching (emergence from the egg); Date HT = date of hatching; CR to HT = total hatching duration (time from shell cracking to complete emergence).

Table 2. Morphometry (mm) and mass (g) of *Erythrolamprus poecilogyrus schotti* hatchlings.

ID	SEX	SLV	TL	BW	BH	HL	HH	HW	NW	ED	M
1	M	144	32	4.15	5.14	12.41	4.20	6.04	2.10	3.37	2.5
2	F	152	36	4.38	5.26	11.20	3.82	5.45	2.11	2.19	3.2
3	F	148	34	4.05	4.70	12.51	3.77	5.65	2.09	2.36	3.0
4	M	142	28	4.09	4.75	11.40	4.44	6.29	2.39	2.75	3.0
5	F	155	36	5.00	5.32	12.70	3.54	5.71	2.00	2.21	3.1
6	F	146	31	4.95	5.15	11.64	4.20	5.89	2.31	2.43	3.2
7	F	153	32	4.83	5.47	12.11	3.94	6.50	1.96	2.33	3.0
Mean		148.57	32.71	4.49	5.11	11.99	3.98	5.93	2.13	2.37	3.0
SD		4.89	2.87	0.42	0.28	0.58	0.30	0.37	0.15	0.18	0.23

Notes. SVL = snout-vent length; TL = tail length; BW = body width; BH = body height; HW = head width; HH = head height; HL = head length; NW = inter-nasal distance; ED = eye diameter; DN = distance between the navel and the cloaca; M = mass; Sd = Standard deviation.

Figure 1. Eggs, pipping and hatchling of *Erythrolamprus poecilogyrus schotti*.



Notes. A) The seven eggs during incubation; B) Egg pipping. The red arrow indicates hatchling's head emerging; C) A newborn fully emerged from the egg; D) A neonate of *E. p. schotti* showing typical post-hatching coloration.

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