

# First record of hypopigmentation in the snake *Erythrolamprus mossoroensis* (Hoge & Lima-Verde, 1973) in northeastern Brazil

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Animal colouration arises from a complex interplay between pigmentary and structural elements in the skin, with specific patterns determined by their presence, absence, and distribution (Bechtel, 1978; Kardong et al., 2016; Borteiro et al., 2021). The pigments are produced and distributed by specialized cells called chromatophores, which originate in the neural crest before migrating to the skin (Bechtel, 1978; Kardong et al., 2016). There are various types of chromatophores, which are generally grouped into the following categories: melanophores (black/brown), xanthophores (yellow), erythrophores (red), and cyanophores (blue). In contrast, structural colours are generated by iridophores and leucophores, which create iridescent, metallic, and white appearances by scattering and

reflecting light (Bagnara, 1966; Kardong et al., 2016; Schartl et al., 2016; Allain et al., 2023).

Snake colouration, a trait shaped by environmental selective pressures, exhibits significant phenotypic interspecific diversity (e.g., Norris and Lowe, 1964; Bechtel, 1978). Although some species exhibit polychromatism, the colour pattern of most species is conservative and shows a narrow range of variation (Neill, 1963; Allen et al., 2013; Pizzatto and Dubey, 2012) so that prompt recognition at the species level is usually straightforward (e.g., Allen et al., 2013; Farooq and Uetz, 2020). This limitation not only aids in interspecific recognition but has also become a factor when it comes to camouflaging a snake in its environment, by concealing it from both predators and prey and enhancing its fitness (Bechtel, 1978; Allen et al., 2013; Kardong et al., 2016; Borteiro et al., 2021; Goldenberg et al., 2024). In fact, skin pigmentation has various functions related to fitness and survival, acting in protection against solar radiation, vitamin D synthesis, heat absorption, and protection of the nervous system (Hadley, 1972). Therefore, a colour anomaly could impose unspecified risks to an individual and could challenge its survivorship (Bechtel and Bechtel, 1981; Krecsák, 2008). For example, an albinistic individual is more conspicuous against a darker substrate, which raises its risk of predation by visually oriented predators, such as birds, and can simultaneously make it more visible to potential prey and potentially reduce foraging success.

The mechanisms that cause chromatic anomalies are still poorly understood, but they may be hereditary (Wolf and Werner, 1994) or originate early in development (Clause and Becker, 2015). In natural populations, unusual colour patterns occur at low frequencies, even though they have been recorded for a variety of species (Abreu et al., 2013; Lopes and Freitas, 2017; Allain et al., 2023; Almeida et al., 2024; Paschoal et al., 2024), with hypopigmentation among the most common cases (Borteiro et al., 2021).

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Borteiro et al. (2021) reviewed colour anomalies in neotropical snakes and established a standardized nomenclature by categorizing two primary groups: hyperpigmentation, characterized by an excess of a given colour (e.g., melanism), and hypopigmentation, defined by the reduction of colour (e.g., axanthism). In their study, these authors defined nine hypopigmentation types, five of which are related to melanin reduction: albinism (complete absence of any pigments, including in the eyes), amelanism (absence of melanin expression, including in the eyes), hypomelanism (reduced expression of melanin, pigmented eyes), leucism (whiteness along with a lack of dark patterning, pigmented eyes), and piebaldism (patchwork of spots, pigmented eyes). Here, we document the first record of hypopigmentation in *Erythrolamprus mossoroensis*, a small, diurnal, semi-aquatic, frog-eating snake, whose natural history is poorly known (Lima-Verde, 1971; Vanzolini et al., 1980; Vitt, 1983; Vitt and Vangilder, 1983; Guedes et al., 2014).

On 18 August 2024, a local resident found a dead *E. mossoroensis* in a shrubland area near a lake in Morada Nova Municipality, Ceará State, Brazil (4.8304°E, 38.4344°W, WGS 84, elevation ca. 121 m). The region is characterized by open shrubby Caatinga vegetation with a hot, semi-arid climate, with annual temperatures reaching 28°C and an average annual rainfall of 742.5 mm (IPECE, 2017; Gameiro et al., 2022). After tissue collection, the specimen was fixed in 10% formalin and subsequently transferred to 70% ethanol. The voucher specimen has been deposited into the Ceará Natural History Museum Prof. Dias da Rocha (MHNCE) under accession number MHNCE-REP 986.

The initial taxonomic identification of the specimen was hampered by its atypical cream colouration, which distinguished it from all known species in the region. Our identification process involved three steps: (1) We consulted the reptile species list for Ceará State (Borges-Nojosa et al., 2021; SEMA, 2022) to establish a pool of candidate species. (2) We compared the specimen's pholidosis with the diagnostic characters provided in key taxonomic references (Hoge and Lima-Verde, 1973; Vanzolini et al., 1980; Dixon, 1983, 1989). (3) The colour anomaly was categorized according to the standardized nomenclature of Borteiro et al. (2021).

The specimen is a female with 590 mm snout–vent length and 120 mm tail length; eight supralabials (SL), with SL4 and SL5 contacting the eye; nasal divided, loreal present, two preoculars, two postoculars, and 1+2 temporals; ten infralabials. Dorsal scales 17-17-15, smooth without apical pits, 161 ventrals, cloacal

plate made of two scales, 50 subcaudals. Based on this combination of features (Hoge and Lima-Verde, 1973), we were able to identify the specimen as *E. mossoroensis*.

The specimen exhibits hypopigmentation, as indicated by the complete absence of melanin throughout the integument, the presence of xanthic pigments, and transient ocular pigmentation. Its body colouration is uniformly light cream, with two faded yellowish longitudinal lines, each approximately two scales wide, running along the dorsum (Fig. 1A, B).

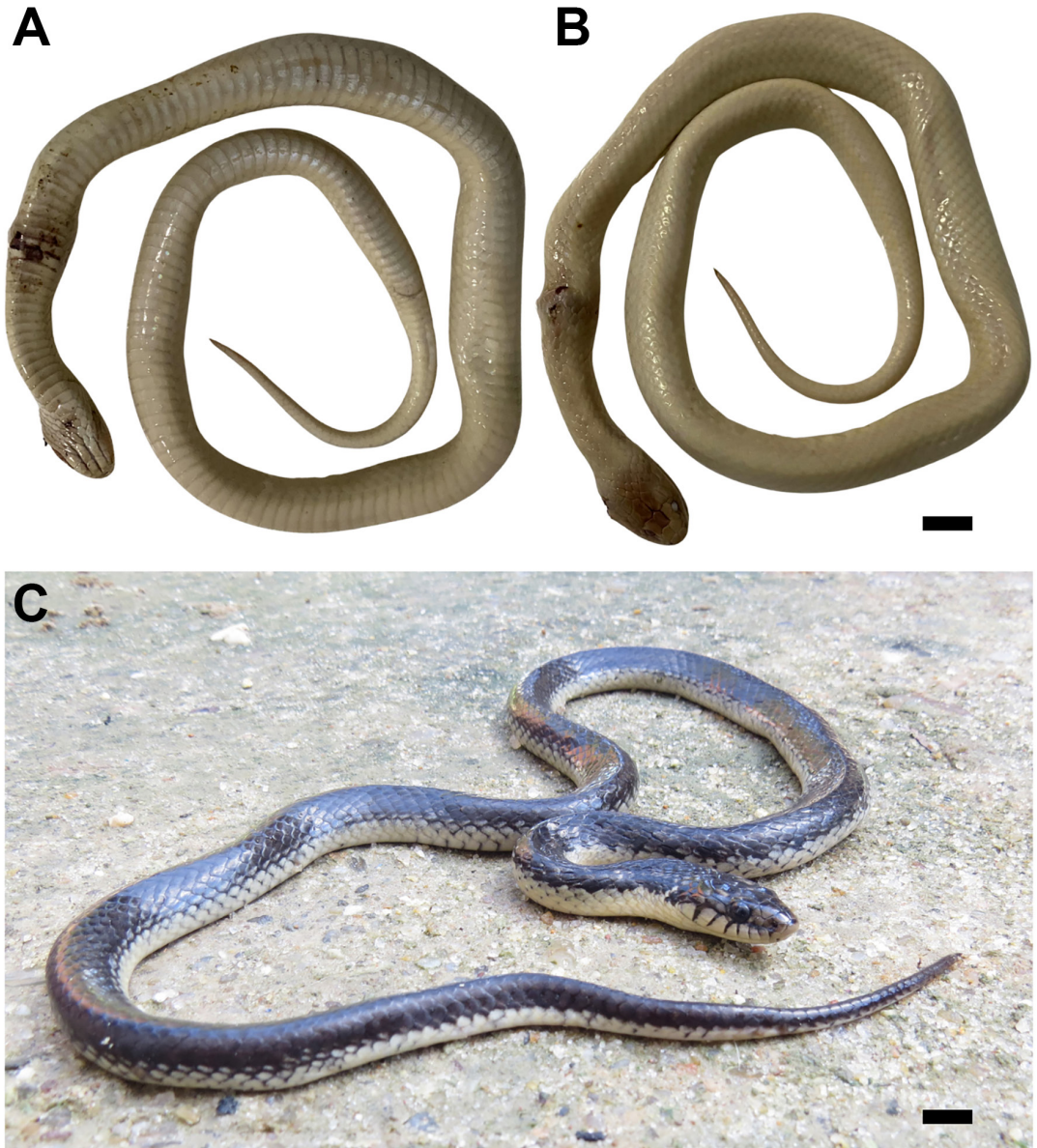
This record not only documents an anomaly colour for an individual of this species, it also adds another site of occurrence in Ceará, where it was previously known only nine out of the 184 municipalities of the state from Boa Viagem, Crato, Fortaleza, Jaguaribe, Limoeiro do Norte, Pentecoste, Quixelô, Russas, and Várzea Alegre Municipalities (Roberto and Loebmann, 2016; Nogueira et al., 2019).

The normal colour pattern of *E. mossoroensis* exhibits a dark brown to black dorsum with an inverted V-shaped mark on the nuchal region and two light brown longitudinal paravertebral stripes (Lima-Verde, 1971). Except for keeping the dorsal longitudinal stripes, now yellowish, the colour of the individual described herein is strikingly different from this pattern (Fig. 1C). The complete absence of melanin combined with the presence of xanthic pigmentation (yellow and red carotenoids) allows us to classify this snake as amelanistic (Borteiro et al., 2021). In amelanistic animals, the lack of only dark pigments leave space for the other pigments to stand out more intensely (Borteiro et al., 2021). This is one of the differences with albinism, in which all pigments are missing (Bechtel, 1991; Borteiro et al., 2021). Amelanism has been documented in other species of neotropical snakes, such as *Erythrolamprus miliaris* (Da Silva et al., 2010), *Pseudablabes patagoniensis* and *Amerotyphlops brongersmianus* (Mira-Mendes et al., 2017), but it was often incorrectly classified as albinism (Da Silva et al., 2010; Borteiro et al., 2021).

In the context of ecology, many authors believe that colour anomalies might impose risks to an individual's survival, because it could increase predation risks, warn prey, and enhance the susceptibility to solar radiation (Bittner et al., 2002; Brenner and Hearing, 2008). However, some research has shown that deviations from the regular colour pattern seem to have little to no impact on an animal's survival (Borteiro et al., 2021; Stephenson et al., 2022). Stephenson et al. (2022) tested bird and rodent predation on Eastern Gartersnakes,

*Thamnophis sirtalis* (Linnaeus, 1758), with normal and albino colour patterns and found no differences in bird predation rates between chromatically anomalous and normal individuals. They concluded that albinism did not increase bird predation rates but could still exert an important selective pressure on snake colouration (Stephenson et al., 2022).

The individual we describe here reached adulthood and therefore managed to survive its daily challenges in the wild. It appears that anomalies persist despite their presumed negative fitness effects because, depending on an animal's lifestyle, they can have neutral or perhaps even adaptive roles in certain environmental contexts. For example, in *Stegonotus iridis* and *S. aplini* from



**Figure 1.** A hypopigmented female *Erythrolamprus mossoroensis* (MHNCE-REP 986) from Morada Nova Municipality, Ceará State, Brazil, in (A) ventral and (B) dorsal views, showing its natural colouration prior to fixation. (C) The common colour pattern for the species is provided for comparison. Scale bar = 5 mm. Photographs by Silvio J.S. Rocha (A, B) and Leticia Silva (C).

New Guinea, the predominantly white body coloration does not appear to negatively affect survival (Ruane et al., 2017; O'Shea and Richards, 2021).

Finally, while *E. mossoroensis* is distributed across seven Brazilian states, it has been considered rare throughout its range and many aspects of its basic biology remain unknown (Mesquita et al., 2013; Coelho-Lima et al., 2020; Guedes et al., 2023). In Ceará State, for example, this species was only documented from nine of 184 municipalities (Roberto and Loebmann, 2016; Nogueira et al., 2019). Our record represents not only the first documented case of colour anomaly in *E. mossoroensis*, but it is also the first record for Morada Nova Municipality, whose fauna has received little attention in regional studies (Mesquita et al., 2013; Coelho-Lima et al., 2020). This discovery was made possible through the dialogue created with local communities through citizen science, which is becoming a valuable source of information for biodiversity monitoring and aids the conservation of rare and threatened species (Todd et al., 2017; Wangyal et al., 2020; Fontaine et al., 2022).

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