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First record of the Green Whipsnake, *Chironius exoletus* (Linnaeus, 1758), preying on an egg clutch of the Orange-legged leaf frog, *Pithecopus hypochondrialis* (Daudin, 1800)

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Predation plays a central role in the evolution of amphibian reproductive strategies (Magnusson and Hero, 1991). Among the various threats encountered during the complex life cycle of amphibians, egg predation is particularly critical (Resetarits and Wilbur, 1989; Touchon and Worley, 2015). Amphibian eggs are highly vulnerable to diverse types of predators, including insects, crustaceans, fish, reptiles, and even conspecifics or other amphibians (Wells, 2007). The susceptibility of egg clutches to predation can vary significantly depending on environmental factors, species-specific traits, and the spatial and temporal characteristics of oviposition (Wells, 2007). Many anuran species have transitioned from aquatic reproduction to laying eggs in terrestrial or arboreal environments, often on leaves or vegetation above water (Oh et al., 2024). This shift is largely interpreted as an adaptive response to high predation pressure in aquatic habitats (Duellman and Trueb, 1994; Touchon and Warkentin, 2008; Crump, 2015). Neotropical frog species of the subfamily Phyllomedusinae exemplify these complex reproductive adaptations. These arboreal frogs often construct leaf nests above waterbodies, where they deposit egg clutches that later hatch and drop into the water below (Haddad and Prado, 2005).

Snakes are known to prey on frogs, including adults and occasionally their eggs. Some reports suggest that arboreal and nocturnal snakes may actively locate and consume egg clutches deposited in leaf nests (Warkentin, 1995). In phyllomedusine frogs, where egg clutches are often exposed and accessible in the vegetation, snakes may represent a great threat to reproductive success (Warkentin, 1995; Gomez- Mestre et al., 2008; Güell et al., 2024). The diet of snakes in the genus *Chironius* primarily consists of adult frogs, although they may also prey upon lizards, birds, and rodents (Cunha and Nascimento, 1978). Duellman (2005) hypothesised that species in this snake genus may shift their dietary preferences based on prey availability, potentially feeding on frogs during the rainy season and switching to lizards during the dry season (Roberto and Souza, 2020). In this study, we document predation on a clutch of the Orange-legged Leaf Frog, *Pithecopus hypochondrialis*, by the Green Whipsnake, *Chironius exoletus*.

The observation occurred on 16 December 2022 at a seasonal pond located on Campus III of the Federal University of South and Southeastern of Pará, Marabá, Pará Municipality, Brazil (5.3349°S, 49.0885°W, elevation 92 m). As is typical for the Amazon region, the climate in December is predominantly hot and humid, with frequent rainfall (Nobre et al., 2009). The snake was observed foraging on vegetation primarily composed of Guinea grass (*Panicum maximum*), surrounding a pond measuring approximately 4.87 m in length and 2.79 m in width. This pond serves as breeding site for *P. hypochondrialis*. At approximately 14:00 h, we observed an adult *Chironius exoletus* foraging on the vegetation. On the day of observation, seven egg clutches of *P. hypochondrialis* had been recorded in the study area. We observed the snake systematically inspecting the grass blades, using its snout to investigate their surface. Although it encountered several clutches, the snake initially exhibited no predatory behaviour (Fig. 1A). It eventually selected a newly deposited clutch and used its snout to open the folded leaf nest to access the clutch. The snake reached into the clutch four times, pausing to swallow eggs until it had consumed the entire clutch (Fig. 1B).

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Figure 1. *Chironius exoletus* preying on a *Pithecopus hypochondrialis* leaf nest in Marabá, Pará, Brazil. (A) The snake is inspecting the nest. (B) The snake is consuming eggs. Photos are frames taken from a video by Paulo Nogueira-Costa.

Following documentation of the event, the snake was collected, euthanized following standard procedures, and deposited in the Herpetological Collection of the Tauari Biodiversity Museum (specimen number UNIFESSPA 306, a female, 113.4 cm in total length).

Discussion

Understanding the impact of predation on amphibian population dynamics is crucial for the development of effective conservation strategies and the mitigation of biodiversity loss (Dalpasso et al., 2021). Factors such as predator abundance, habitat characteristics, and interspecific interactions may drive shifts in amphibian populations spatially and in different environments (Dalpasso et al., 2021). Additionally, climate change and the introduction of exotic species exacerbate these dynamics by increasing pressure on native populations (Schmidt et al., 2021; Dalpasso et al., 2021). For example, phyllomedusine treefrogs, such as the Red-eyed Treefrog, *Agalychnis callidryas* (Cope, 1862), and Spurrell's Gliding Leaf Frog, *A. spurrelli* Boulenger, 1913, exhibit diverse responses to predation risks, particularly from arboreal snakes, which are known predators of their eggs and embryos (Warkentin, 1995; Caldwell et al., 2009; Güell et al., 2024). Additionally, embryos of some amphibians display notable hatching plasticity, which is the ability to modulate the timing of hatching in response to external threats (Gomez-Mestre and Warkentin, 2007). In *A. callidryas*, embryos are especially sensitive to vibrations generated by predator attacks, such as those produced by snakes, and can escape by hatching prematurely and dropping into the water below, thus avoiding the complete loss of a clutch due to predation (Warkentin, 1995, 2011; Güell et al., 2024). However, not all phyllomedusines are equally capable of hatching prematurely as an antipredation strategy. In *A. spurrelli* a lower hatching success in response to predation occurs and this can by related to biomechanical differences in egg-clutch structure and not to the sensory capacity of the embryo (Güell et al., 2024).

In our observation, the snake appeared to show a preference for a more recently laid egg clutch, where hatching plasticity cannot yet occur and leaves embryos highly vulnerable. Despite that, we observed hatching plasticity in embryos of *P. hypochondrialis* during fieldwork. However, the effectiveness of this response by *P. hypochondrialis* embryos to snake predation remains to be tested under controlled experimental conditions.

A high degree of dietary specialization is seen in members of the genus *Chironius*, with approximately 95% of species feeding primarily on frogs (Rodrigues, 2007). As with morphology, the foraging substrate and behaviour of these snakes are closely linked to their dietary composition (Rodrigues, 2007). These observations are consistent with the hypothesis proposed by Duellman (2005) that some snake species may adjust their feeding behaviour in response to prey availability including *Chironius* (Roberto and Souza, 2020).

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