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Antipredator mechanisms of the hylid tree frog *Ololygon trapicheiroi* (A. Lutz and B. Lutz, 1954)

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INTRODUCTION

Amphibians serve as important prey for both invertebrates and vertebrates, including arachnids and snakes (Toledo, 2005; Toledo et al., 2007). In these interactions, various antipredatory mechanisms have evolved, encompassing behavioral, physiological, and morphological adaptations aimed at enhancing survival odds (Duellman & Trueb, 1994; Ferreira et al., 2019). Anurans can detect the presence of a predator through visual, acoustic, or substrate vibration cues (Ferreira et al., 2019). Consequently, when a threat is perceived, they can employ defensive strategies that fall into three categories: (i) mechanisms that avoid detection by the predator, (ii) strategies that prevent the attack, and (iii) counter-attack strategies (Toledo et al., 2011; Ferreira et al., 2019).

Ololygon trapicheiroi belongs to the Hylidae family, within Scinaxini in the *Ololygon catharinae* species group (Araujo-Viera et al., 2023). It inhabits mountainous areas of southeastern Brazil, in the states of Rio de Janeiro, Minas Gerais and São Paulo, making it endemic to the Atlantic Forest biome (Folly et al., 2020). It is a small arboreal frog, commonly found in shrub vegetation or in rock crevices, characterized by a brown dorsum with hidden areas of metallic blue surrounded by black netting on the thighs and black

spots on the flanks (Lutz, 1954). This paper describes previously unreported antipredatory mechanisms displayed by *O. trapicheiroi* and analyzes how these mechanisms could help the species avoid predation, broadening our understanding of anuran antipredatory behaviors.

METHODS

During herpetofaunal monitoring in an area of the Rio do Braço river, in the district of Lídice, municipality of Rio Claro, state of Rio de Janeiro, southeastern Brazil (22°46'53.75" S, 44°13'54.07" W; WGS 84, 658 m), four individuals of *Ololygon trapicheiroi* were found in bushes near water bodies. They were initially detected by their vocalization, which ceased as we approached. Observations of antipredator mechanisms were made on May 30, 2010; August 7–8, 2013; April 18, 2015; and September 30, 2023. The mechanisms were identified following the study by Ferreira et al. (2019), which proposes a classification of defensive strategies in anurans. One specimen (MNRJ 76632) was collected, euthanized and deposited in the amphibian collection of the National Museum, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil under the authorization number 02001.007602/2002-83 issued by Brazilian Institute of Environment and Renewable Natural Resources.

RESULTS

On 30 May 2010, at 7:59 p.m., an individual of *Ololygon trapicheiroi* was found perched on a branch. Upon capture, it immediately escaped from the collector's hands, flipping onto its back with its belly exposed (Fig. 1A) and remaining in this position for approximately ten seconds before returning to its regular resting posture. On 7 August 2013, at 6:35 p.m., another individual was located on a bush branch. As the collector approached to photograph the frog, it contracted its body, lowering both the head and torso against the branch, and closing its eyes (Fig. 1B). The individual was subsequently collected and transported to an improvised field laboratory. The following day, at 11:34 a.m., when the collector simulated a predator attack by prodding the individual, it contracted its limbs and tucked its head towards its belly, again flipping onto its back but with its eyes open (Fig. 1C); it remained in this posture for about 20 seconds until it was handled for photography. On 18 April 2015, another individual was discovered near a water body and brought to the field laboratory. At 12:12 p.m., when touched by the collector, it initially exhibited a contraction behavior similar to that observed on 7 August 2013. Approximately nine minutes later, when handled again, it displayed a mouth-gaping antipredatory behavior (Fig. 1D). On 29 Septem-

ber 2023, at 10:22 a.m., another individual was observed on a bush. As the collector approached, it ceased vocalizing, contracted and lowered its body and head against the trunk, and remained motionless with its eyes open. When touched, it performed a defensive maneuver resembling that of the first individual in this study, flipping onto its back with its belly exposed and remaining completely still in this belly-up position on the leaf litter for two minutes, before resuming a belly-down position, remaining motionless for an additional minute. The following day, on 30 September 2023, at 12:29 p.m., while being handled for photographic purposes, the same individual crossed its hind limbs in an "X" shape over its back, revealing its hidden conspicuous coloration (Fig. 1E). In addition to these defensive mechanisms, some individuals displayed immobility or attempted to jump away; however, these responses were not captured in photographs.

DISCUSSION

In response to our approach or handling, individuals of *Ololygon trapicheiroi* exhibited a variety of defensive mechanisms, suggesting a perception of humans as potential predators. Our observations revealed that *O. trapicheiroi* employed strategies to avoid detection by predators, including immobility while preparing to jump away. This behavior has been previously reported only once within the genus by Gomes et al. (2002), specifically in *O. hiemalis* (Haddad & Pombal, 1987). Additionally, *O. trapicheiroi* exhibited several mechanisms aimed at deterring attacks, such as death feigning, body contraction, limb interweaving, and mouth-gaping displays, consistent with the behaviors described by Ferreira et al. (2019).

Death feigning is the most common mechanism in *Ololygon* (Duellman & Trueb, 1994; Toledo et al., 2011). This behavior involves the contraction of the limbs combined with the head flexed ventrally, with the back or belly facing the substrate. Similar postures have been documented by Ferreira et al. (2019) in other species within the family, such as *Scinax fuscovarius* (Lutz, 1925) and *Scinax ruber* (Laurenti, 1768), indicating a widespread use of this mechanism as a defense strategy. Although death feigning is most often exhibited by amphibians that possess toxins, it is also associated with more complex, derived behaviors following subjugation, aimed at minimizing vital damage and facilitating escape once trapped (Toledo et al., 2011). Limb interweaving is a behavior that has previously been reported by Vieira et al. (2022) for *Ololygon tripui* (Lourenço, Nascimento e Pires, 2010). This mechanism is typically associated with aposematic coloration or the release of toxins (Toledo et al., 2011). How-

ever, *O. trapicheiroi* lacks aposematic coloration, and we did not observe any toxin excretion, suggesting that it displayed limb interweaving to disrupt the silhouette of the anuran, altering its body shape, behavior observed by Channing & Howell (2003) for *Hylambates keithae* (Schiøtz, 1975). This behavior may feign an injury, dissuading the predator or complicating its identification, allowing the individual to avoid detection or being swallowed (Rojas-Padilla et al., 2019; Vieira et al., 2022).

The body size of anurans significantly influences the defensive strategies employed. Smaller species, such as *O. trapicheiroi*, have limited advantages in physical confrontations and in actively escaping from predators. Consequently, they often develop alternative strategies, including mouth gaping. This behavior can be interpreted as a warning signal or an attempt to intimidate the predator, thereby reducing the likelihood of predation (Toledo et al., 2011; Ferreira et al., 2019). Often, this mechanism is displayed in conjunction with defensive vocalization, aposematic coloration, or biting (Toledo et al., 2011; Lourenço-de-Moraes et al., 2014; Lourenço-de-Moraes et al., 2016). However, we did not observe any of these behaviors other than mouth gaping, suggesting that this may function as an independent defense mechanism. This study represents the first documented instance of mouth gaping behavior within a genus that currently encompasses 52 known species (Frost et al., 2025), underscoring the significant gap in our understanding of defensive repertories among anurans.

Death feigning, a behavior extensively documented in anurans (Toledo et al., 2011), suggests a conserved strategy within the genus. In contrast, mouth gaping, observed for the first time in *Ololygon*, may indicate an adaptation to specific pressures. This diversity of mechanisms allows *O. trapicheiroi* to enhance its chances of survival, particularly given its small size and vulnerability to predators. These mechanisms are particularly relevant when compared to closely related anuran clades, such as *Scinax*, which also exhibit a variety of defensive strategies (Ferreira et al., 2019). Strategies such as death feigning and jumping away, shared between clades, exemplify convergent evolution, demonstrating how different groups of anurans develop similar behaviors in response to analogous predatory pressures. By integrating these observations, we can gain a more comprehensive understanding of the diversity and specificity of defensive behaviors in anurans.

Ololygon trapicheiroi exhibited a range of antipredatory mechanisms, showcasing the diversity and complexity of the defense strategies used

by anurans. These behaviors documented in this study—including immobility, death feigning, limb contraction, limb interweaving, and mouth gaping—highlight the adaptability of this species to predatory pressures.

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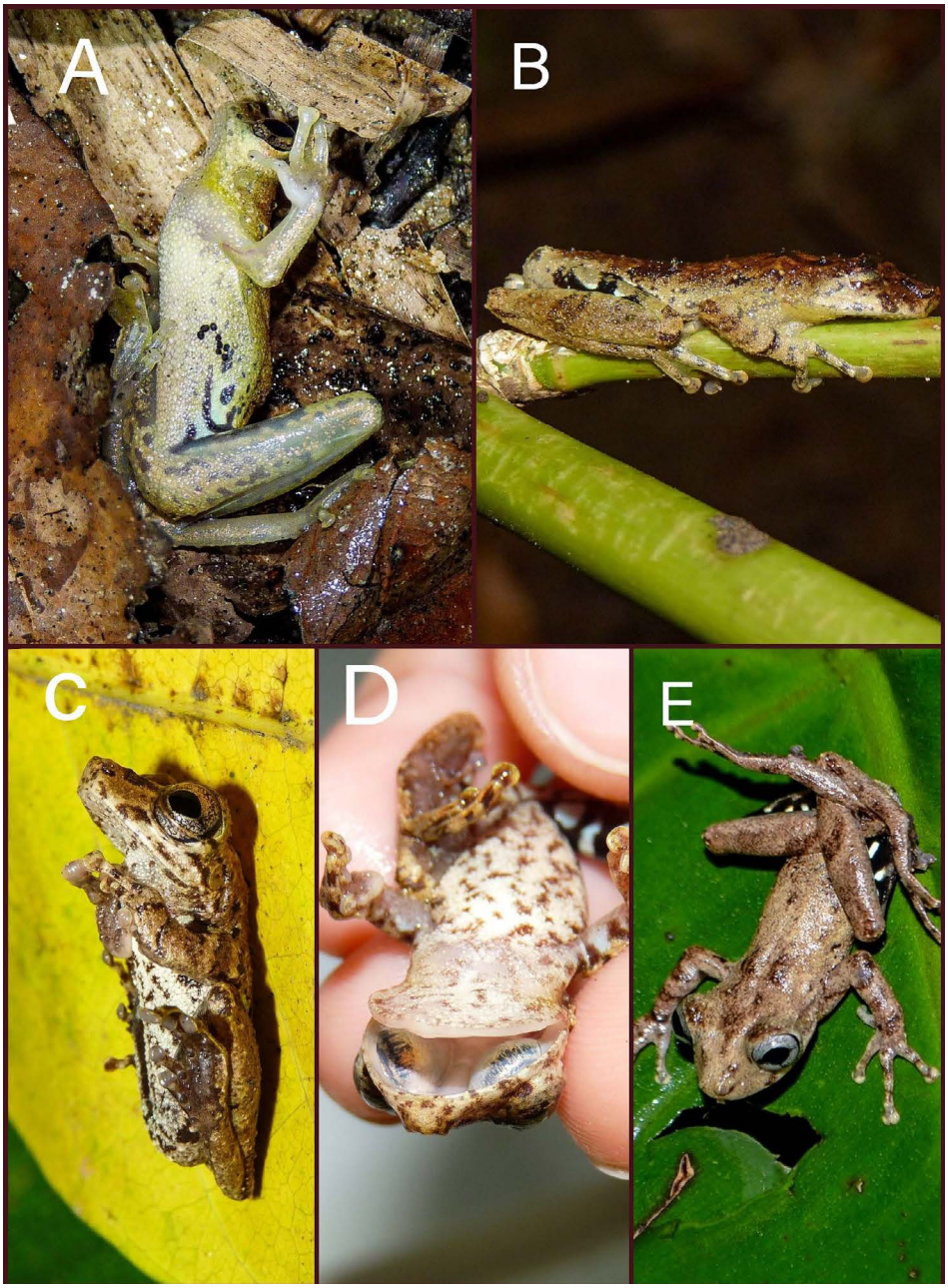

Figura 1. Defensive mechanisms exhibited by *Ololygon trapicheiroi*: (A) death feigning; (B) contraction of body, lowering it against the branch with eyes closed; (C) contraction with belly facing upwards and eyes open; (D), mouth gaping; and (E) limb interweaving.

Photos by Thiago Silva-Soares.

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