



NOTA

THE GREAT ESCAPE: THANATOSIS AS AN EFFECTIVE ANTI-PREDATOR STRATEGY IN *LEPTODACTYLUS* SP. AGAINST *PHILODRYAS PATAGONIENSIS* IN NORTHEAST BRAZIL

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Date of receipt: December 9, 2024

Date of acceptance: June 11, 2025

ABSTRACT

A relatively large number of defense mechanisms against predation are known for amphibians. Herein, we report an unsuccessful case of predation of *Philodryas patagoniensis* upon *Leptodactylus* sp. resulted from a species thanatosis behavior.

Key words: Defensive mechanisms, Atlantic Forest, Snake, Anura.

RESUMEN

El gran escape: la tanatosis como una eficaz estrategia anti-depredador en *Leptodactylus* sp. contra *Philodryas patagoniensis* en el nordeste de Brasil. Los anfibios presentan diferentes mecanismos de defensa contra la depredación. Aquí reportamos un caso de depredación no exitosa por parte de *Philodryas patagoniensis* sobre *Leptodactylus* sp. asociado a una defensa a través de un comportamiento de tanatosis.

Palabras clave: Mecanismos de defensa, Bosque Atlántico, Serpiente, Anura.

Anuran amphibians exhibit a wide range of anti-predator mechanisms, which can be categorized into

three distinct defensive phases: avoiding detection, preventing attacks, and triggering counterattacks (Ferreira et al., 2019). Among the vertebrates, anurans have been pinpointed as the groups with highest number of anti-predator behaviors (Ferreira et al., 2019). This remarkable adaptability is a direct result of the intense predation pressure to which they are constantly subjected (Haddad et al., 2013).

One such defensive strategy is thanatosis, or death-feigning, where the animal pretends to be dead to deter predators (Toledo et al., 2010). This behavior has been observed in a variety of taxa, including invertebrates and vertebrates such as mammals, birds, reptiles, fish, and amphibians (Humphreys & Ruxton, 2018; Gonzalez-Candia, 2023; Silva et al., 2024).

Thanatosis behavior has the function of protecting the individual from predation, in interspecific or intraspecific interactions. There are records of its successful use by Western toad (*Anaxyrus boreas*) when threatened by the Foothill yellow-legged frog (*Rana boylei*) (Alvarez & Wilcox, 2022) and also by male Nursery web spiders (*Pisaura mirabilis*) avoiding predation by females during the reproductive period (Hansen et al., 2008).

The performance of thanatosis has already been observed in different genera of amphibians, however, in most cases, this behavior occurs after the individual is handled by the researcher or in controlled



environments (Gonzalez-Candia, 2023; Santos et al., 2024; Silva et al., 2024). In natural conditions, records of thanatosis resulting from predation interactions are scarce in the literature. Therefore, records of these interactions are essential to evaluate the effectiveness of the strategy in nature.

Leptodactylus comprises 84 species, with 61 occurring in Brazil (Segalla et al., 2021; Frost, 2024). Many defensive behaviors are known for the genus (e.g. Toledo et al., 2005; Sales et al., 2015; Costa & Trevelin, 2020), including those that exhibit thanatosis, show an adaptability that enhances their survival in various environments by reducing predation risk (Santiago, 2021).

The Patagonian green racer *Philodryas patagoniensis* (Girard, 1858) has a generalist diet that includes arachnids, small mammals, birds, fishes, reptiles, and amphibians (Hartmann & Marques, 2005; Quintela & Loebmann, 2019; Chuliver & Scanferla, 2024). Among amphibians, the family Leptodactylidae constitutes a significant portion of their diet, representing 13% of the total documented prey items (Machado-Filho, 2015).

On February 13, 2020, an adult *P. patagoniensis* (~1 m total length) was observed attempting to prey on an individual of the *Leptodactylus* aff *vastus* in a restinga environment within the Barra do Rio Mamanguape Environmental Protection Area, Rio Tinto, north coast of Paraíba, northeast Brazil (6° 46' 42.32" S, 34° 55' 20.35" W; WGS 84; altitude 7 m). At 7:18 am, the snake started the predation attempt by biting the amphibian abdomen, which emitted an agonistic vocalization. After approximately 10 seconds, the amphibian ceased vocalizing and displayed thanatosis, at this point, we start recording, the snake continues biting the amphibian's head for another 14 seconds.

While the amphibian remained in thanatosis, *P. patagoniensis* bits the head region (Fig. 1A), immobilizing it for approximately 15 seconds. The snake then bitten to the left forelimb (Fig. 1B) for four seconds, followed by an attempt to ingest the amphibian from the lower limbs (two seconds), another an attempt to ingest the amphibian head-first for three seconds and a brief bite to the left forelimb (<one second) And the frog did not stop the thanatosis behavior. The snake then repositioned frog belly on the back of the frog for nine seconds. Shortly thereafter, the snake returned, biting the amphibian head region for 14 seconds, dragging its body for less than 1 meter, and ultimately retreating in the opposite direction.

Despite its behavior of death-feigning, the frog, at all times, presents movements in its vocal sac, indicating continuous breathing and makes a discreet movement of its legs when the snake passes over it (Fig. 1C; see 1:01 min of the video), indicating that it was alive throughout the entire process of attempted predation. In the present study, the frog showed a slight

movement when the snake passed over it, shrinking its legs and tilting its head slightly, adopting a potential escape behavior (Ferreira et al., 2019), however, after the movement, the amphibian returned to the thanatosis posture. Apparently, breathing is not impaired in the behavior of playing dead, given that the amphibian remained breathing throughout the predation attempt, which was also reported for *Pristimantes ramagii* (unpublished data) and *Silverstoneia flotator* (Klank et al., 2023).

The thanatosis behavior lasted one minute and 30 seconds (video: <https://youtu.be/r-r1dqFwu6Q>). After the snake left, the recording was stopped, and approximately 10 seconds later, the amphibian resumed its normal posture and jumped toward the sandbank.

Although snakes have been documented preying on dead animals (Barbosa et al., 2022), active prey is generally more susceptible to predation than inactive prey (Macdonald, 1973). Anuran amphibians can sustain thanatosis for up to five minutes, during which they may camouflage with their surroundings or release odorous secretions to enhance the illusion of being dead (Toledo et al., 2011; Lourenço-de-Moraes et al., 2016). However, this *Leptodactylus* remained still, with only movements of the vocal sac, until the snake moved away completely, resuming the jumping position and leaving the site of the attempted predation.

We believe that the "cameraman" had no influence on the snake's decision to leave, as he remained still, away from the snake, following the process, only zooming the camera in and out, where the snake releases the frog and moves away calmly, not showing signs of running away.

Our observation highlights the effectiveness of thanatosis as an anti-predator strategy in *Leptodactylus* under natural conditions. The event underscores the significance of this behavior on the individual's survival, contributing to the growing body of knowledge on the death-feigning in anurans. Future studies and the record of field observations like that, could help to understand the prevalence and adaptive advantages of thanatosis across different populations and environmental contexts, further elucidating its role in predator-prey dynamics and its connection with amphibian respiration, whether the immobility of the limbs would be more important than the total reduction of respiration.

We thank Rafael de Brito Costa for the imagens and video recordings and the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBIO) for the collection permit (SISBIO nº 74327-1). VNB, EFS and LNR thank the National Council for Scientific and Technological Development (CAPES) for PhD scholarship and master's scholarship (grant numbers 88887.713778/2022-00, 88887.935257/2024-00 and 88887.956872/2024-00).

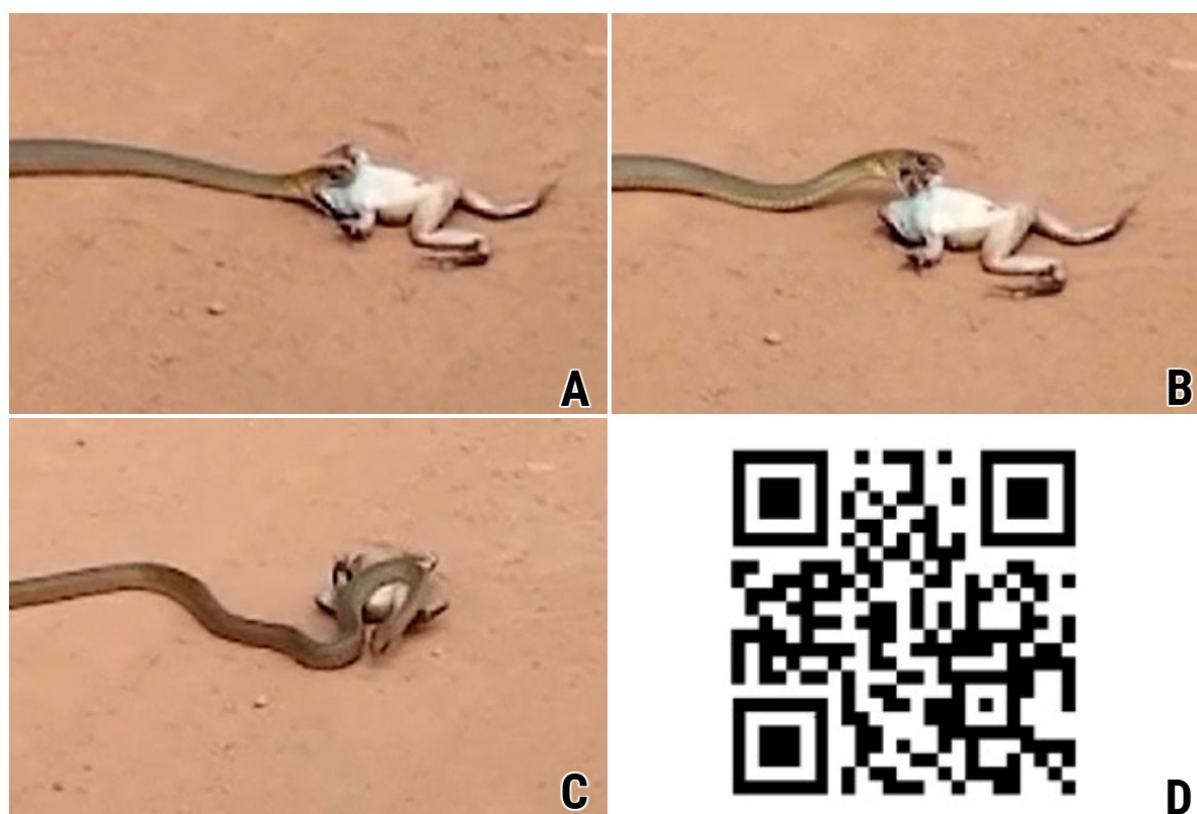


Fig. 1. *Philodryas patagoniensis* attempting to prey on a *Leptodactylus* sp. exhibiting thanatosis behavior in a restinga environment of northeast Brazil. A- Snake's attempt to ingest the head of the *Leptodactylus*; B- Snake's attempt to ingest the amphibian through its front leg; C- Discreet movement of the amphibian's legs when the snake passes under its belly; D- QRcode to watch the full video (available at <https://youtu.be/r-1dqFwu6Q>).

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Section Editor: Raúl Maneyro