



ANTIPREDATOR MECHANISMS IN *Proceratophrys cristiceps* (ANURA, ODONTOPHYRYNIDAE) (MÜLLER, 1883)

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Abstract: Anurans exhibit a wide array of antipredator mechanisms in response to predation, including morphological traits such as cryptic coloration and body inflation that enhance camouflage, and conspicuous traits like aposematic coloration that serve to deter or warn predators. Physiological and behavioral responses include toxic skin secretions and defensive postures, functioning across all stages of the predation process, from detection to ingestion. These strategies are generally categorized as primary or secondary defenses. Primary defenses aim to avoid detection, whereas secondary mechanisms are triggered during predator-prey interactions and include escape behaviors, postural displays, and vocalizations. Here, we report a set of antipredator mechanisms observed in *Proceratophrys cristiceps*, including the first record of body contraction and death feigning in the species. The documentation of this behavior expands the known defensive repertoire of *P. cristiceps* and underscores the importance of continued natural history observations in Neotropical amphibians.

Keywords: Anurans; Caatinga; Death feigning; Contraction; Predation.

Anurans exhibit a remarkable diversity of antipredator mechanisms, encompassing morphological, behavioral, and physiological traits. Morphological defenses such as cryptic coloration and body flattening improve concealment, while aposematic coloration deters predators through warning signals (Duellman & Trueb 1994). Physiological and behavioral adaptations, including toxic secretions and postural displays, serve multiple functions throughout the stages of predation, from avoiding detection to actively repelling an attack (Wells 2007, Ferreira et al. 2019).

These mechanisms are broadly classified into primary defenses, which aim to prevent detection (e.g., camouflage, immobility, interrupting calls), and secondary defenses, which are elicited during or after direct predator contact (e.g., escape behavior, defensive postures, distress vocalizations) (Edmunds 1974, Ruxton et al. 2007, Ferreira et al. 2019). Among secondary responses, body contraction remains a rarely reported but potentially significant antipredator behaviors. It is thought to occur during close predator encounters and may be associated with muscular stiffening

that impedes ingestion and/or with the release of chemical defenses. (Sazima 1974, Toledo et al. 2011, Lourenço-de-Moraes et al. 2016).

The genus *Proceratophrys* Miranda-Ribeiro, 1920, includes 43 species distributed across South America (Frost 2025). These frogs are often characterized by cryptic coloration and dermal appendages that mimic decomposing leaf litter, favoring camouflage in forest floor habitats (Prado & Pombal 2008, Toledo & Haddad 2009). Within the Caatinga biome, five species are currently recorded: *P. cristiceps*, *P. minuta*, *P. ararype*, *P. renalis*, and *P. redacta* (Frost 2025). *Proceratophrys cristiceps* is endemic to northeastern Brazil and is morphologically distinguished by its variable dorsal coloration (light brown to orange, sometimes with a triangular dorsal mark), absence of visible tympanum, and reduced vocal sac (see Mângia et al. 2019).

Despite its broad distribution, the natural history and behavioral ecology of *P. cristiceps* remain poorly understood. Defensive behaviors have been documented for only a few individuals and include cryptic coloration, body elevation and inflation, hindlimb elevation, mouth gaping, escape responses, and distress calls (Costa et al. 2009, Peixoto et al. 2013, Zocca et al. 2022). However, mechanisms such as death feigning and contraction have not been previously recorded. This study aims to expand the known antipredator repertoire of *P. cristiceps*, with emphasis on the novel observation of death feigning and body contraction.

Field observations were conducted on April 28, 2025, at 20:30 h in Pedra da Boca State Park, located in the municipality of Araruna, Paraíba State, northeastern Brazil (6°27'8.28"S, 35°40'24.95"W). The area encompasses 160 hectares within the Caatinga biome. Individuals of *Proceratophrys cristiceps* were located on the banks of a shallow swamp (ca. 5 cm water depth), among leaf litter and low vegetation.

To simulate predatory attack, we employed the focal animal sampling (Altmann 1974) technique combined with the finger-only stimulation method, where light tactile stimuli simulate predator contact (see Lourenço-de-Moraes et al. 2016). Individuals were then collected and deposited in the herpetological collection CHUFPBRLMAR001-2 under voucher numbers PPRLM1–2. Research was conducted under license number ICMBio 91563-4. Two adult individuals of *Proceratophrys cristiceps*

were observed during nocturnal activity (at 20:30 h). Upon detection, both individuals remained immobile, partially crouched, and pressed their bodies against the substrate, a typical cryptic posture. When stimulated, they responded with body inflation, distress vocalizations, and kicking with their hindlimbs, likely aiming to startle or dissuade the simulated predator. These behaviors are consistent with previous reports for the species (Zocca et al. 2022, Silva et al. 2024).

After these initial responses, both individuals exhibited death-feigning, remaining motionless with extended limbs and showing no visible reaction to external tactile stimuli. Upon continued manipulation, a distinct contraction posture was recorded: individuals exhibited sudden and pronounced muscle contraction, drawing their limbs against the body and stiffening (Figure 1). This is the first formal record of death feigning and body contraction in *P. cristiceps* and represents a noteworthy addition to its antipredator mechanisms.

Contraction is a lesser-known defensive behavior in anurans and has been reported in few species of the genus *Proceratophrys* (six species, see Zocca et al. 2022). It may occur during close encounters with predators or as a final response after subjugation, and it is possibly associated with the mechanical difficulty of handling prey or triggering the release of skin secretions (Ferreira et al. 2019). Although no secretion was observed during our field trials, the behavior's occurrence suggests a potentially broader function in anti-ingestion defense. Death feigning is a behavior intended to discourage a predator from completing a predation event (Humphreys & Ruxton 2018) and involves the animal remaining motionless in response to external stressors (Rogers & Simpson 2014). In amphibians, this behavior serves as an important secondary antipredator mechanism (Sazima 1974).

The occurrence of death feigning and contraction in *P. cristiceps*, coupled with previously known mechanisms (e.g., camouflage, body inflation, distress calls), illustrates a complex, multi-layered defensive repertoire. Similar behaviors have been recorded in closely related species such as *P. laticeps*, *P. boiei*, and *P. renalis*, reinforcing the idea of shared ancestral antipredator traits within the genus (Zocca et al. 2022). The presence of



Figure 1. Body contraction posture displayed by *Proceratophrys cristiceps* during stimulated predator stimulation.

contraction in *P. cristiceps* may indicate that this defensive strategy is more widespread within genus than currently documented.

This study expands the known antipredator repertoire of *Proceratophrys cristiceps* by documenting distress calls, body inflation, and for the first time, death-feigning and body contraction. These findings contribute to the understanding of defensive strategies in the genus and highlight the ecological relevance of underreported behaviors such as contraction. The presence of morphologically conserved traits and shared defensive responses among *Proceratophrys* species suggests evolutionary constraints shaping their antipredator behavior. Future research should prioritize field-based behavioral documentation across broader environmental contexts to assess the frequency, function, and evolutionary history of contraction and other rarely observed mechanisms in anurans.

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