Defensive Behavior in *Rhinella bergi* and *Rhinella mirandaribeiroi* (Anura: Bufonidae)

Comportamiento defensivo en *Rhinella bergi* y *Rhinella mirandaribeiroi* (Anura: Bufonidae)

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**ABSTRACT**

Here we report two cases of defensive behavior known as “stiff-legged”, unprecedented for the species *Rhinella bergi* and *R. mirandaribeiroi*. We registered the behavior at localities in Mato Grosso do Sul and Minas Gerais states, Brazil. With our records, there are now five species from open areas that exhibit this behavior. We assume that the species that inhabit these areas exhibit this avoiding predation behavior simulating a dead body on the ground, behavior known as “death feigning”, unlike forest species, which use this strategy to camouflage themselves between the leaves.

**Keywords:** Amphibians, defensive strategy, stiff-legged posture.

**RESUMEN**

Reportamos aquí dos casos de comportamiento defensivo conocido como “stiff-legged”, sin precedentes para las especies *Rhinella bergi* y *R. mirandaribeiroi*. Los registros se realizaron en localidades de los estados de Mato Grosso do Sul y Minas Gerais, Brasil. Con nuestros registros, ahora hay cinco especies de áreas abiertas que exhiben este comportamiento. Asumimos que las especies que habitan estas áreas despliegan este comportamiento que evita la depredación simulando un cadáver en el suelo, comportamiento conocido como “fingir la muerte”, a diferencia de las especies forestales, que utilizan esta estrategia para camuflarse entre las hojas.

**Palabras clave:** Anfibios, estrategia defensiva, postura “stiff-legged”.

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Anurans exhibit several defensive behaviors, including sound emission (e.g., release calls and agonistic calls) and visual displays, such as thanatosis and stiff-legged (Duellman and Trueb 1986, Toledo et al. 2011). The last one is characterized by a posture with the legs stiff and back extended, remaining the individual static in this position for a few minutes after the disturbance caused by a potential predator (Sazima 1978, Schlüter and Salas 1991, Bertoluci et al. 2007).

This behavior is mainly known for groups that inhabit forests: species of the genera Proceratophrys, Macrogenioglottus, Odontophrynus (Odontophrynidae), Scythrophrys (Leptodactylidae), Arcovomer, and Ctenophryne (Microhylidae) (Toledo and Zina 2004, Menin and Rodrigues 2007, Giaretta and Martins 2009, Maffei and Ubaid 2016, Mira-Mendes et al. 2016, Rolim 2017, Borteiro et al. 2018). However, the stiff-legged behavior was also recorded for species that are typical of non-forested environments, such as the toads Rhinella granulosa (Spix, 1824) and R. pygmaea (Myers and Carvalho, 1952) (Mângia and Santana 2013, Figueiredo-de-Andrade and Silveira 2018), both from the R. granulosa species group (Narvaes and Rodrigues 2009). In this note, we report two cases of stiff-legged behavior in additional species of the R. granulosa species group.

On 23 November 2017, we observed a male individual of Rhinella bergi (Céspedes, 2000) in a Chacoan area, in the Porto Murtinho municipality (21º41 South, 57º44 West), Mato Grosso do Sul state, Brazil. When we handled the specimen, at approximately 21:00h, it exhibited the stiff-legged defensive behavior (Fig. 1a). Right after we placed the individual on the floor, it continued exhibiting the behavior, keeping the hind limbs stretched and back extended, with the body flattened dorso-ventrally. The second record was registered on 19 December 2018, in the São Gonçalo do Pará municipality (19º59 South, 44º51 West), Minas Gerais state, Brazil. We collected a male individual of R. mirandaribeiroi (Gallardo, 1965), which exhibited the same stiff-legged behavior, while being handled (Fig. 1b). We collected both specimens and housed at the Zoological Collection of the Federal University of Mato Grosso do Sul (ZUFMS-AMP13336; ZUFMS-AMP13283; collection permits: SISBio 45889-1).

The defensive stiff-legged behavior is usually combined with the anuran cryptic coloration resembling dead leaves (Toledo et al. 2011). Nevertheless, both species recorded in the present study have terrestrial habits and inhabit open areas (Narvaes and Rodrigues 2009). Rhinella bergi occurs in Chaco regions of Paraguay, northwestern Argentina and Mato Grosso do Sul in Brazil (Céspedes 2000), while R. mirandaribeiroi occurs in Cerrado areas.
Table 1. Records of stiff-legged behavior for Brazilian anuran species from forest environments and open areas.

| Taxon                                      | Habitat       | References                                      |
|--------------------------------------------|---------------|-------------------------------------------------|
| **Bufonidae**                              |               |                                                 |
| *Dendrophryniscus berthaultzai* Izecksohn, 1994 | Forest-floor  | Toledo *et al.* 2011                           |
| *Dendrophryniscus brevipollicatus* Jiménez de la Espada, 1870 | Forest-floor  | Bertoluci *et al.* 2007                        |
| *Dendrophryniscus carvalhoi* Izecksohn, 1994 | Forest-floor  | Cassimiro *et al.* 2010                       |
| *Dendrophryniscus leucomystax* Izecksohn, 1968 | Forest-floor  | Bertoluci *et al.* 2007                        |
| *Rhinella bergi* (Céspedez, 2000)          | Open areas    | Present study                                   |
| *Rhinella granulosa* (Spix, 1824)          | Forest-floor  | Mângia and Santana 2013                        |
| *Rhinella marina* (Linnaeus, 1758)         | Open areas    | Ferrante *et al.* 2020                        |
| *Rhinella mirandaribeiroi* (Gallardo, 1965) | Open areas    | Present study                                   |
| *Rhinella pygmaea* (Myers and Carvalho, 1952) | Open areas   | Figueiredo-de-Andrade and Silveira 2018         |
| **Craugastoridae**                         |               |                                                 |
| *Euparkerella cochranae* Izecksohn, 1988   | Forest-floor  | Toledo *et al.* 2011                           |
| **Cycloramphidae**                         |               |                                                 |
| *Cycloramphus parvulus* (Girard, 1853)     | Forest-floor  | Rocha *et al.* 1998                            |
| **Leptodactylidae**                        |               |                                                 |
| *Paratelmatobis poecilogaster* Giaretta and Castanho, 1990 | Forest-floor  | Toledo *et al.* 2011                           |
| *Physalaemus gracilis* (Boulenger, 1883)   | Forest-floor  | Rocha and Martins 2013                         |
| *Pleurodema bibronii* Tschudi, 1838        | Forest-floor  | Kolenc *et al.* 2009                          |
| *Scythrophrys sawayae* (Cochran, 1953)     | Forest-floor  | Garcia 1999                                    |
| **Microhylidae**                           |               |                                                 |
| *Arcovomer passarelli* Carvalho, 1954      | Forest-floor  | Giaretta and Martins 2009                      |
| *Chiasmocleis ventrimaculata* (Andersson, 1945) | Forest-floor  | Schlüter and Salas 1991                        |
| *Ctenophryne geayi* Mocquard, 1904         | Forest-floor  | Schlüter and Salas 1991, Menin and Rodrigues 2007 |
| *Microhyla berdmorei* (Blyth, 1856)        | Forest-floor  | Shahrudin 2014                                 |
| *Stereocyclops incrassatus* Cope, 1870     | Forest-floor  | Tonini *et al.* 2011                          |
| *Stereocyclops parkeri* (Wettstein, 1934)  | Forest floor  | Sazima 1978                                   |
| **Odontophrynidae**                        |               |                                                 |
| *Macrogenioglottus alipioi* Carvalho, 1946 | Forest floor  | Mira-Mendes *et al.* 2016                      |
| *Odontophrynus americanus* (Duméril and Bibron, 1841) | Open areas  | Maffei and Ubaid 2016, Rolim 2017, Borteiro *et al.* 2018 |
| *Proceratophrys appendiculata* Günther, 1873 | Forest floor  | Sazima 1978                                   |
| *Proceratophrys boiei* (Wied-Neuwied, 1824) | Forest-floor  | Toledo and Zina 2004, Costa *et al.* 2009       |
| *Proceratophrys mantiqueira* Mângia, Santana, Cruz and Feio, 2014 | Forest-floor  | Moura *et al.* 2010 (cited as *P. melanopogon*) |
| *Proceratophrys melanopogon* (Miranda-Ribeiro, 1926) | Forest-floor  | Toledo *et al.* 2011                          |
| *Proceratophrys moehringi* Weygoldt and Peixoto, 1985 | Forest-floor  | Weygoldt 1986                                 |
| *Proceratophrys renalis* (Miranda-Ribeiro, 1920) | Forest-floor  | de Amorim Peixoto-M *et al.* 2013, Peixoto *et al.* 2013 |
Our records add up to five species of open areas exhibiting this defensive strategy (Maffei and Ubaid 2016, Rolim 2017, Borteiro et al. 2018, Figueiredo-de-Andrade and Silveira 2018, Ferrante et al. 2020) (Table 1). Mira-Mendes et al. (2016) demonstrated the occurrence of this behavior for 23 forest-floor species. Although Pleurodema bibroni Tschudi, 1838 is categorized as a species from the forest-floor in the Mira-Mendes et al. (2016) study, Kolenc et al. (2009) showed that this species also inhabits non-forested environments, suggesting that P. bibroni exhibit the stiff-legged behavior as camouflage, rather than camouflage.

In total, 29 anuran species from six families show the stiff-legged behavior, with the family Bufonidae having the largest number of species that exhibit this defensive strategy (n=9), from which four species are from open areas (Table 1). Forest species that exhibit the stiff-legged behavior use this strategy to camouflage themselves among the leaves, once they present cryptic coloration, thus avoiding predation (Sazima 1978). With this, we can assume that the species of open areas perform stiff-legged behavior to look like dead body on the ground (death feigning).

AUTHOR’S CONTRIBUTION

IKRN and PSC design and writing; SM and DJS obtaining data, descriptions and photographs. All authors reviewed drafts of the paper and approved the final draft.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

LITERATURE CITED

Amorim Peixoto MA, Mângia S, Rodrigues R, Santana DJ. 2013. Defensive behavior in Proceratophrys renales (Miranda-Ribeiro, 1920) (Anura, Odontophrynidae). Herpetol. Notes 6:479–430.

Bertoluci J, Brassaloti RA, Sawakuchi HO, Ribeiro JW, Woehl-G JR. 2007. Defensive behavior with stiff-legged posture in the Brazilian tree toads Dendrophryniscus brevipollicatus and D. leucomystax (Anura, Bufonidae). Alytes 25(1–2):38–44.

Borteiro C, Rosset SD, Kolenc F, Barrasso DA, Lescano JN, Baldo D. 2018. Stereotyped defensive behaviours in frogs of the genus Odontophrynus (Amphibia: Anura: Odontophrynidae). Curr. Herpetol. 37(2):172–179. doi: https://doi.org/10.5358/hsj.37.172

Cassimiro J, Verdade VK, Rodrigues MT. 2010. Dendrophryniscus carvalhoi (Carvalho’s Tree Toad). Defensive behavior. Herpetol. Rev. 41:472.

Céspedez JA. 2000 “1999”. Una nueva espécie de Bufo del grupo granulosus (Anura: Bufonidae) do Nordeste Argentino. FACE-NA 15:72–91.

Costa-P N, Silva-Soares-T, Bernstein-L B. 2009. Defensive behaviour of Proceratophrys boiei (Wied-Neuwied, 1824) (Amphibia, Anura, Cycloramphidae). Herpetol. Notes 2:227–229.

Duellman-W E, Trueb-L. 1986. Biology of Amphibians. New York (NY): McGraw-Hill Book Company.

Ferrante L, Najar T, Kafer IL. 2020. Four new anuran defence behaviours observed in the cane toad Rhinella marina. Ethol. Ecol. Evol. 32(6):590–595. doi: https://doi.org/10.1080/03949370.2020.1769737

Figueiredo-de-Andrade CA, Silveira LS. 2018. The defensive behavior of Rhinella pygmaea (Myers and Carvalho, 1952) Herpetol. Notes 11:205–207. doi: http://orcid.org/0000-0002-7663-6852

Garcia, PCA. 1999. Scythrophrys sawayae. (NCN). Defensive behavior. Herpetol. Rev. 30(4):224.

Giaretta AA, Martins L. 2009. Notes on the call and behavior of Arcovomer passarellii (Anura: Microhylidae). Herpetol. Notes 2: 91–93.

Kolenc F, Borteiro C, Baldo-D, Ferraro-D P, Prigioni-C. 2009. The tadpoles and advertisement calls of Pleurodema bibroni Tschudi and Pleurodema kriegeri (Müller), with notes on their geographic distribution and conservation status (Amphibia, Anura, Leiuperidae). Zootaxa 2016:1–35.
Maffei-F, Ubaid FK. 2016. Defensive behavior of *Odontophrynus americanus* (Duméril & Bibron, 1841). Neotropical Biol. Conserv. 11(3):1951–97. doi: https://doi.org/10.4013/nbc.2016.113.10

Mângia-S, Santana-D J. 2013. Defensive behavior in *Rhinella granulosa* (Spix, 1824) (Amphibia: Anura: Bufonidae). Herpetol. Notes 6:45–46.

Melo M, Fava F, Pinto HBA, Bastos RP, Nomura F. 2013. Diversidade de Anuros (Amphibia) na reserva extrativista lago do Cedro e seu entorno, Aruanã, Goiás. Biota Neotrop. 13(2):205–217. doi: https://doi.org/10.1590/S1676-06032013000200020

Menin M, Rodrigues DJ. 2007. *Ctenophryne geayi* (Brow Egg Frog). Behavior. Herpetol. Rev. 38:182.

Mira-Mendes CV, Ruas DS, Castro I, Sole M, Baumgarten JE. 2016. Defensive behaviour in the Bahia forest frog *Macrogenioglottus alipioi* Carvalho, 1946 (Anura: Odontophrynidae), with a review of the stiff-legged posture. Herpetol. Notes 9:91–94.

Moura MR, Santana DJ, Mângia S, Feio RN. 2010. *Proceratophrys melanopogon* (Black-bearded Horned Leaf Toad). Defensive Behaviour. Herpetol. Rev. 41:479.

Narvaes P, Rodrigues MT. 2009. Taxonomic revision of *Rhinella granulosa* species group (Amphibia, Anura, Bufonidae), with a description of a new species. Arq. Zool. 40(1):1–73. doi: https://doi.org/10.11606/issn.2176-7793.v40i1p1-73

Peixoto MAA, Mângia S, Rodrigues R, Santana DJ. 2013. Defensive behavior in *Proceratophrys renalis* (Miranda-Ribeiro, 1920) (Anura, Odontophrynidae). Herpetol. Notes 6:479–430.

Rocha CFD, Sluys MV, Bergallo HG, Alves MAS, Vrcibradic D. 1998. *Zachaenus parvulus* (Leaf frog): defensive behavior and color pattern. Herpetol. Rev. 29:232–234.

Rocha SB, Martins FL. 2013. *Physalaemus gracilis* (Graceful Dwarf Frog). Defensive Behaviour. Herpetol. Rev. 44:299.

 Rolim DC. 2017. Defensive behaviour in *Odontophrynus americanus* (Duméril & Bibron, 1841) (Amphibia, Anura, Odontophrynidae). Herpetol. Notes 10:67–69.

Sazima I. 1978. Convergent defensive behavior of two leaf-litter frogs of southeastern Brazil. Biotropica 10(2):158. doi: https://doi.org/10.2307/2388020

Schlüter AS, Salas AWL. 1991. Reproduction, tadpoles, and ecological aspects of three syntopic microhylid species from Peru (Amphibia: Microhylidae). Stuttg. Beitr. Naturkd. (A):1–17.

 Shahrudin S. 2014. Defensive Behaviour of *Microhyla berdmorei* (Blyth, 1856) (Anura: Microhylidae) from Peninsular Malaysia. Herpetol. Notes 7:787–789.

 Toledo LF, Nazima I, Haddad CFB. 2011. Behavioural defenses of anurans: an overview. Ethol. Ecol. Evol. 23(1):1–25. doi: https://doi.org/10.1080/03949370.2010.534321

 Toledo LF, Zina JP. 2004. *Proceratophrys boiei* (Smooth Horned Toad). Defensive behavior. Herpetol. Rev. 35(4):375.

 Tonini JFR, Mendonça IS, Coutinho AB, Gasparini JL. 2011. Anurans from Costa Bela, state of Espirito Santo, southeastern Brazil: inventory at an urban area and the rediscovery of *Allobates* in the state. Herpetol. Notes 4:435–444.

 Weygoldt P. 1986. Beobachtungen zur Ökologie und Biologie von Fröschen an einem neotropischen Bergbach. Zool. Jahrb. Abt. Syst. Geog. Biol. Tier 113:429–454.