

NATURAL EXPANSION OR FACILITATED INTRODUCTION? FIRST RECORD OF *BOANA RANICEPS* (ANURA: HYLIDAE) IN THE STATE OF RIO DE JANEIRO, SOUTHEASTERN BRAZIL

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Abstract: Hylidae is one of the most diverse families of Anura, comprising 1,054 species distributed across three subfamilies. The treefrog *Boana raniceps* is geographically present in almost all Brazilian territory, being currently classified as "Least Concern" according to the IUCN Red List. Here, we present a new record of *Boana raniceps* in the Área de Proteção Ambiental de Guapi-Mirim, a mangrove protected area in southeastern Brazil. Additionally, we provide an updated distribution map for the species, which was compiled from a comprehensive assessment of scientific literature, museum collections, and available online databases. We reinforce a preference of the species for open areas within the Atlantic Forest domain and modified forest patches within the biome. These areas may exhibit the highest suitability for the species'

occurrence. The newly reported records of *Boana raniceps* contribute valuable information to our understanding of this species, serving as an indicator to support conservation strategies for the Atlantic Forest.

Keywords: Amphibia; Atlantic Forest; geographic distribution; natural history; range expansion.

The Neotropical genus *Boana* Gray, 1825 currently comprises 99 species, being one of the largest genera within Hylidae (Frost 2024). These species are widely distributed throughout Central and South America (Frost 2024). Recent analyses corroborated the monophyly of *Boana albopunctata* species group, with *B. raniceps* (Cope, 1862) suggested as sister species of all the other species of the group (Fouquet et al. 2021). Although 13 of the 18 species of the *Boana albopunctata* species group are mainly associated to the Amazon Basin (Fouquet et al. 2021; Frost 2024), a few have a wider distribution, occurring in different South America morphoclimatic domains (e.g., Cerrado, Atlantic Forest, Pantanal, and Pampa [see Prado et al. 2012; Camurugi et al. 2021]).

Boana raniceps was described based on eight syntypes collected in the Vermejo River, Paraguay (Cochran 1961). The species range extends continuously from French Guiana, Colombia, Venezuela, Bolivia, and northern Brazil to northern Argentina, including records from Paraguay (Lescure & Marty 2000; Lynch & Mayorga 2011; Caramaschi & Niemeyer 2003; Frost 2024). In Brazil, *B. raniceps* has been recorded in most states except for the state of Espírito Santo, Rio de Janeiro, Santa Catarina, and Rio Grande do Sul (Fig. 1). It is commonly associated with lentic water bodies in open areas and forest borders, where calling males are found mainly in the hot and rainy season of the year (Heyer 1976; Vaz-Silva et al. 2020). The species is known to easily adapt to disturbed habitats (Souza et al. 2010; Vaz-Silva et al. 2020). Here, we reported the first record of *B. raniceps* to the state of Rio de Janeiro, southeastern Brazil, also constituting

the first record for the species within a mangrove ecosystem. Moreover, we discuss the possibility of the present record to represent a recent invasion into disturbed areas of the Atlantic Forest.

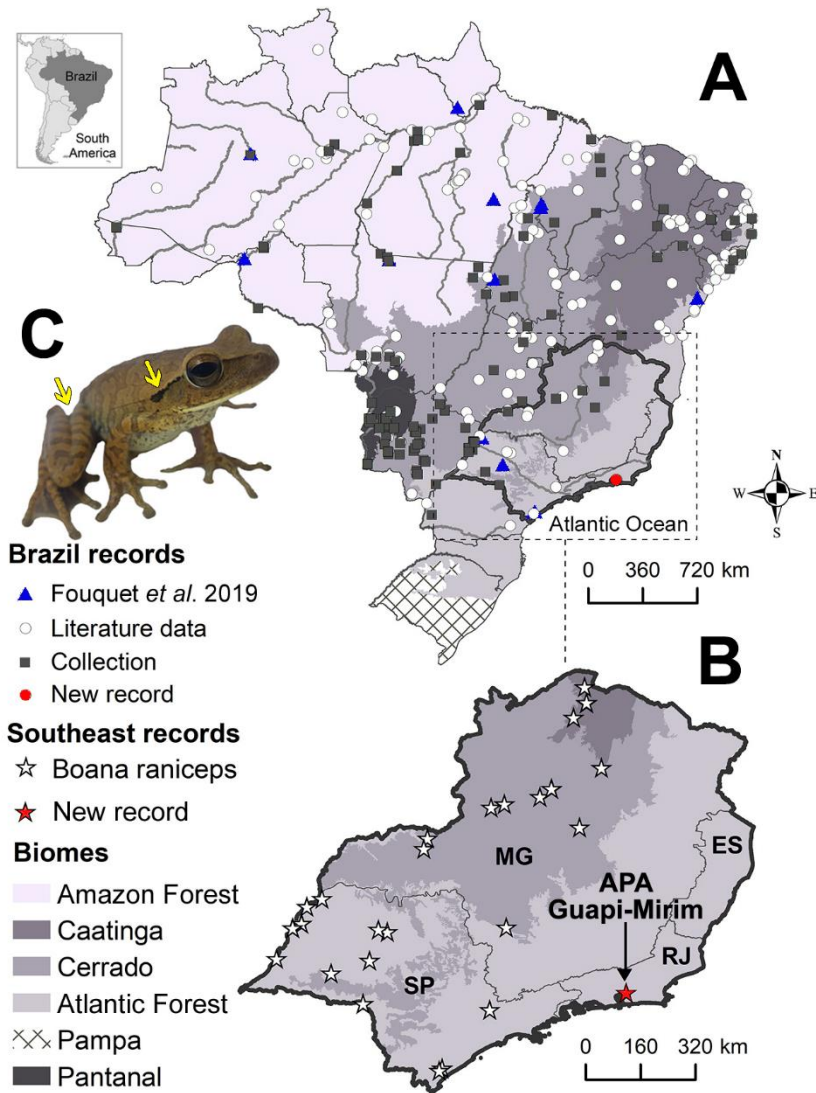


Figure 1. Distribution map of *Boana raniceps* in Brazil (A): blue triangle indicates the terminals of *B. raniceps* included in phylogenetic hypothesis to *Boana albopunctata* species group proposed by Fouquet *et al.* (2021); white circles indicate the previously known locations in available literature; black square indicate revision in amphibian collections for the species. Red circles indicate the new record (this study). Distribution of *Boana raniceps* in southeastern Brazil (B): white stars indicate the previously known locations; red stars indicate the new record in the APA Guapi-Mirim. Legends: SP = state of São Paulo; MG = state of Minas Gerais; RJ = state of Rio de Janeiro; ES = state of Espírito Santo. Adult female of *B. raniceps* (MNRJ 94102) photographed by Daniel B. Maciel (C); Yellow arrows indicate two of the diagnostic characters established by Cope (1862) for the species: dark supratympanic stripes running from the eyes and continuing to posterior margin of tympanum, and dark brown stripes on the thigh.

Sampling took place in the Área de Proteção Ambiental de Guapi-Mirim (hereafter APA Guapi-Mirim), a federal conservation unit (Environmental protection areas; Rylands & Brandon, 2005) created on September 25, 1984 by Federal Decree 90225, with the purpose of protecting the mangroves, one of the most threatened ecosystems of the world (see Beys-da-Silva et al. 2014; Ferreira & Lacerda 2016; Ottoni et al. 2021). Mangroves are coastal ecosystems characterized for their typical morphophysiological composition, directly influenced by tidal regimes and freshwater, salinity, nutrients, flooding, and soil anoxia (see Soares et al. 2003; Pires 2010; Webber et al. 2016). The area is localized in the municipality of Guapimirim, state of Rio de Janeiro, southeastern Brazil (Fig.1). The region's climate was classified following by Alvares et al. (2014) as Am (monsoon), with annual precipitation ranging between 1,300 to 1,600 mm and average annual temperature between 22 and 24 °C.

We included in our study additional distribution data obtained from a comprehensive analysis of scientific literature and available online databases (Appendix I). Complementarily, specimens of *B. raniceps* deposited at the Museu Nacional, Universidade Federal do Rio de Janeiro (MNRJ), Natural History Museum, Department of Zoology, London, UK, and National Museum of Natural History, Washington D.C, USA were examined and included in our distribution map (listed in Appendix II). A geographic range map was generated in QGIS 2.6 software and coordinates were expressed based on WGS 84 (Fig. 1).

Fieldwork was carried out in the APA Guapi-Mirim (-22.681839°; -42.986789°) (Fig. 1), on December 20, 2021. An adult female of *B. raniceps* (MNRJ 94102) was collected perched on riparian vegetation, on the banks of the Macacu River. Taxonomic identification was confirmed through the diagnoses proposed by Cope (1862) (e.g., dark supratympanic stripes running from the eyes and continuing to posterior margin of tympanum, and dark brown stripes on the thigh) and compared with specimens from MNRJ. Sex was determined through the examination of secondary sex characters (e.g., presence/absence of vocal slits and nuptial pad). On occasion, the

record was done at 20h00, with an air temperature of approximately 20°C, relative humidity above 90% and sky with scattered clouds, without rain. The mature female (between 58.13 mm and 69.72 mm; Machado et al. 2024) did not contain abdominal oocytes. Four other anuran species were observed in this same sampling area in the reproductive context: *Adenomera* aff. *marmorata* (see Cassini et al. 2020), *Boana albomarginata* (Spix, 1824), *Dendropsophus anceps* (Lutz, 1929), and *Leptodactylus spixi* (Heyer, 1983).

Although common congeners have been observed in the APA de Guapi-Mirim, such as *Boana faber* and *Boana albomarginata*, no species from the *Boana albopunctata* group had been recorded for the area until now. Dorigo et al. (2018) published an updated list of the amphibians of the state of Rio de Janeiro with 201 species that did not include *B. raniceps*. Among *B. albopunctata* species group, only *B. albopunctata* was previously known to the state of Rio de Janeiro. Herein we add to the list one more anuran species to the state of Rio de Janeiro, which also represents an increase on the geographic distribution of *B. raniceps* in the Atlantic Forest, southeastern Brazil. It is possible that the present new record may represent a recent colonization via expansion or facilitated introduction, since the nearest record of the species in the Atlantic Forest is approximately 330 km west (see Fig. 1). Recent studies suggest that the species could benefit from habitat degradation and climate change (Vasconcelos et al. 2022), since *B. raniceps* is subjected to a broad range of climatic conditions as a geographic widespread species (Bonnefond et al. 2020). No study has reported the species to the state of Rio de Janeiro, although this is one of the most scientifically explored regions in the country (for a historical view, see Dean 1996; Solórzano et al. 2021). Being a geographically widespread species, in Brazil, it is originally associated to Amazonia, Cerrado, Caatinga, and Pantanal biomes, the first records of the species in the Atlantic Forest from southeastern Brazil already raised the hypothesis of natural expansion of the species distribution in consequence of deforestation (see Zina et al. 2010). The species is associated with permanent or temporary water bodies and inhabits gallery forest and natural or anthropized open environments (Vaz-Silva et al. 2020). We recorded the female in a

mangrove habitat, thus being the first record for the species in this type of ecosystem. The APA Guapi-Mirim is localized in the metropolitan region of the state of Rio de Janeiro, and it is constituted mostly of mangrove forest with different degrees of degeneration and regeneration stages as consequence of direct and indirect human activity (Soares et al. 2003). Although this protected area is currently one of the forest remnants that constitute the Mosaic of Conservation Units of the Fluminense Central Atlantic Forest and, on a larger scale, the Serra do Mar Ecological Corridor, much of its original area was exploited for wood extraction (charcoal production) in the past. Such exploitation activity can cause loss of plant biomass, which reflects in the reduction of the basal area of the forest fragment (Kammesheidt et al. 2002). In addition, areas closer to secondary roads are more susceptible to wood extraction due to easier access (Nagendra et al. 2003), facilitating the introduction of invasive species.

APA Guapi-Mirim's localization and environmental historical context resemble those of areas in which species invasion has been already observed. The greatest number of species introductions is concentrated around urban areas, especially in the big cities (Padayachee et al. 2017; Turbelin et al. 2017). The increased traffic, trading, and cargo shipment, make these urban areas susceptible to accidental and deliberate introductions of amphibian species. In the same way, anthropogenic alteration, and degradation of habitats, along with increased urbanization, can provide corridors for the dispersal and range expansion of amphibian species (Brown et al. 2006). *Boana raniceps* is a common species, abundant in several places along its natural geographic distribution. Although nocturnal Complete Species Inventory (*sensu* Scott Jr. 2001) has been performed monthly by two researchers over three years, during two hours per night, only one specimen was found, which makes it difficult to affirm that the species is established locally. More surveys in the area are necessary to look for more individuals and eventually evaluate whether the species has an established population in the area.

Due to the difficulty of access and, consequently, the costly sampling, few studies have been conducted in mangroves, which are poorly sampled regarding the amphibian fauna.

Therefore, we here reinforce the need for further studies on the different ecological aspects of amphibian species that inhabit this ecosystem highly threatened by urban expansion and land use (Giri et al. 2011; Richards & Friess 2016). Likewise, we encourage studies focused on biodiversity inventories in mangroves, fundamental to plan actions for their effective conservation (Rog et al. 2016).

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Supplementary Material

Appendix I. Distribution data of *Boana raniceps* in available literature and new records obtained from examined materials in herpetological collections. ARG = Argentina; BOL = Bolivia; BRA = Brazil; COL = Colombia; GUF = French Guiana; PRY = Paraguay.

Appendix II. Examined materials in herpetological collections.

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