

Distribution and conservation status of *Physalaemus moreirae* (amphibia, anura) in southeastern Brazil

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ABSTRACT – This study reports on a new population of *Physalaemus moreirae* and compares its advertisement call to other species of the *P. signifer* group. It is discussed *Physalaemus moreirae*'s International Union for Conservation of Nature Red List (IUCN) conservation status based on the fact that the new population site is found within a protected area and the new locality extends the known range for the species.

Keywords: acoustic analysis, conservation status, distribution, *Physalaemus moreirae*

Distribuição e estado de conservação da *Physalaemus moreirae* (amphibia, anura) no Sudeste do Brasil

RESUMO – Este estudo reporta uma nova população de *Physalaemus moreirae* e compara seus cantos de anúncio com outras espécies do grupo *P. signifer*. Discute-se o seu estado de conservação na lista vermelha da *International Union for Conservation of Nature* (IUCN) baseando-se no fato do sítio em que foi encontrada esta nova população estar em uma área de proteção e essa nova localidade aumenta a extensão de distribuição para estas espécies.

Palavras-chave: análises acústicas, estado de conservação, distribuição, *Physalaemus moreirae*

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INTRODUCTION

Physalaemus moreirae was described by Miranda-Ribeiro (1937). It belongs to the phenetic species group of *P. signifer* (*sensu* Nascimento et al. 2005) and is known only from the type-locality, on the slopes of Paranapiacaba (Caramaschi; Caramaschi 1991).

Physalaemus moreirae can be considered a large-sized species within its group (pers. obs.), with a snout-vent length (SVL) of around 30 mm (Heyer 1985). It is characterized by a greyish (males) or brownish (females) dorsal coloration with a conspicuous darker marking, usually resembling an arrowhead, and two inguinal black round spots (Verdade et al. 2009).

Unfortunately, such features are shared by other species within its phenetic group. At a first morphological glance, for example, smaller individuals of *P. moreirae* can be confused with *P. atlanticus*. The latter species is morphologically characterized by its smaller size (males 20.1–22.1 mm SVL, females 21.0–23.9 mm SVL), distinct canthus rostralis, smooth to slightly rugose dorsal skin texture, orange belly in life (Haddad; Sazima 2004).

Moreover, the advertisement call of *P. moreirae* is very similar to that of other species, such as *P. angrensis* and *P. atlanticus*. The comparison of intrinsic call acoustic properties is necessary to separate their calls. *Physalaemus moreirae* has a pulsed call with duration of 0.5–0.7 s, 50 average pulses per second and dominant frequency ranging from 600 to 1600Hz (Heyer 1985). Weber et al. (2005) presented slightly different values for *P. moreirae*: a dominant frequency from 743 to 1210Hz, call duration of 0.51–0.575 s and 42 average pulses per second. For *P. angrensis* the call duration varies from 0.4–0.6 s, about 55 pulses per second and dominant frequency from 1100 to 2100 Hz (Weber et al. 2005). *Physalaemus atlanticus* also has a pulsed advertisement call with duration of 0.6–0.8 s, around 122 pulses per second and dominant frequency between 900–1800 Hz. (Haddad; Sazima 2004).

These similarities in morphology and behavior characters can easily cause misleading species identification. Currently, scarce updated information on population distribution of *P. moreirae*, *P. atlanticus* and *P. angrensis* might be a direct consequence of this fact, hindering other biological studies, like natural history and molecular ones, important tools for preservation efforts.

This study compares the vocalization of the newly discovered population of *P. moreirae* against published acoustic data and propose extending the distribution range of this species.

MATERIAL AND METHODS

A sample of 32 individuals of *Physalaemus moreirae* (CFBH 7246-50, CFBH 7670-74, CFBH 9514, CFBH 15164-66, CFBH 15168, CFBH 15171, CFBH 15975, CFBH 17405-08; CFBH 19491-92, CFBH 29051, CFBH 29058-59; CFBH 29069, CFBH 29078, CFBH 29092, CFBH 29095, CFBH 29260-62) were collected from Forte dos Andradas (Brazilian Historical Anti-aircraft Artillery Army Reserve) in the municipality of Guarujá, state of São Paulo with an area of approximately 2.1 Km² from April 2004 to October 2007. They were studied morphometrically and compared to other species of the *P. signifer* group (Cardoso 2013) (Figure 1). A sample of four individuals of *Physalaemus moreirae* (*P. moreirae*, CFBH 7246 – 7249) were recorded from a

temporary pond (24°02'08.4"S, 46°17'04.4"W). Recordings were made using an AIWA TP-500 tape recorder (4.8 cm/s) equipped with a Sony cardioid microphone (F-V10T – 50Ω). Air temperature was measured at the moment of vocalization recordings (all recordings at 23°C). Advertisement calls were digitized in a PC computer under 16-bit resolution and 44100 Hz sampling rate. All calls were analyzed with Raven v1.3. Sonograms were produced under 512 FFT (Fast Fourier Transformation), 87.5% overlap, window flat top, brightness = 70, and contrast = 70, following Pombal and Bastos (2003) and Nali (2012). Four acoustic variables were studied for the new population: dominant frequency (DF), call duration (CD), number of pulses per call (PC) and pulses per second (PS).

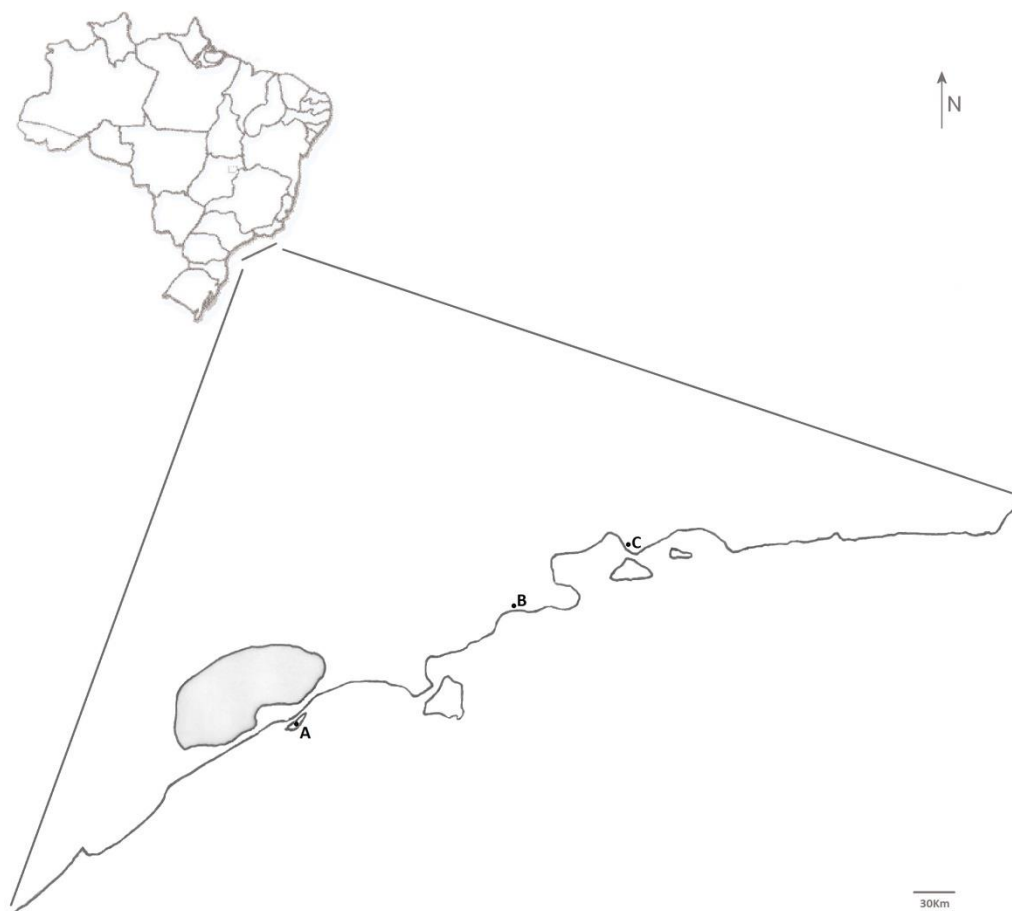


Figure 1.A. Municipality of Guarujá, SP: *Physalaemus moreirae* new population site (24°02'08.4"S, 46°17'04.4"W). B. Parque Estadual da Serra do Mar, Núcleo Picinguaba, Municipality of Ubatuba: *P. atlanticus* type locality. C. Municipality of Angra dos Reis: *P. angrensis* type locality. Grey area. Original distribution range of *Physalaemus moreirae*

All studied individuals and recordings were deposited in the collection of the Departamento de Zoologia da Universidade Estadual Paulista "Júlio de Mesquita Filho" (UNESP), Campus de Rio Claro, SP, Brasil (*P. moreirae*, CFBH 7246 – CFBH 7248).

RESULTS AND DISCUSSION

Physalaemus moreirae shares basic reproductive behavioral features with other species of its group. We observed foam nests deposited under the litter of temporary ditches on the forest floor (Figure 2) as seen in other species (see revision in Haddad; Prado 2005).

During fieldwork, the vocalization of *P. moreirae* can be easily confused with that of *P. angrensis* and even *P. atlanticus*. Fortunately, the acoustic variables of their advertisement calls can be used to help correct species identification.



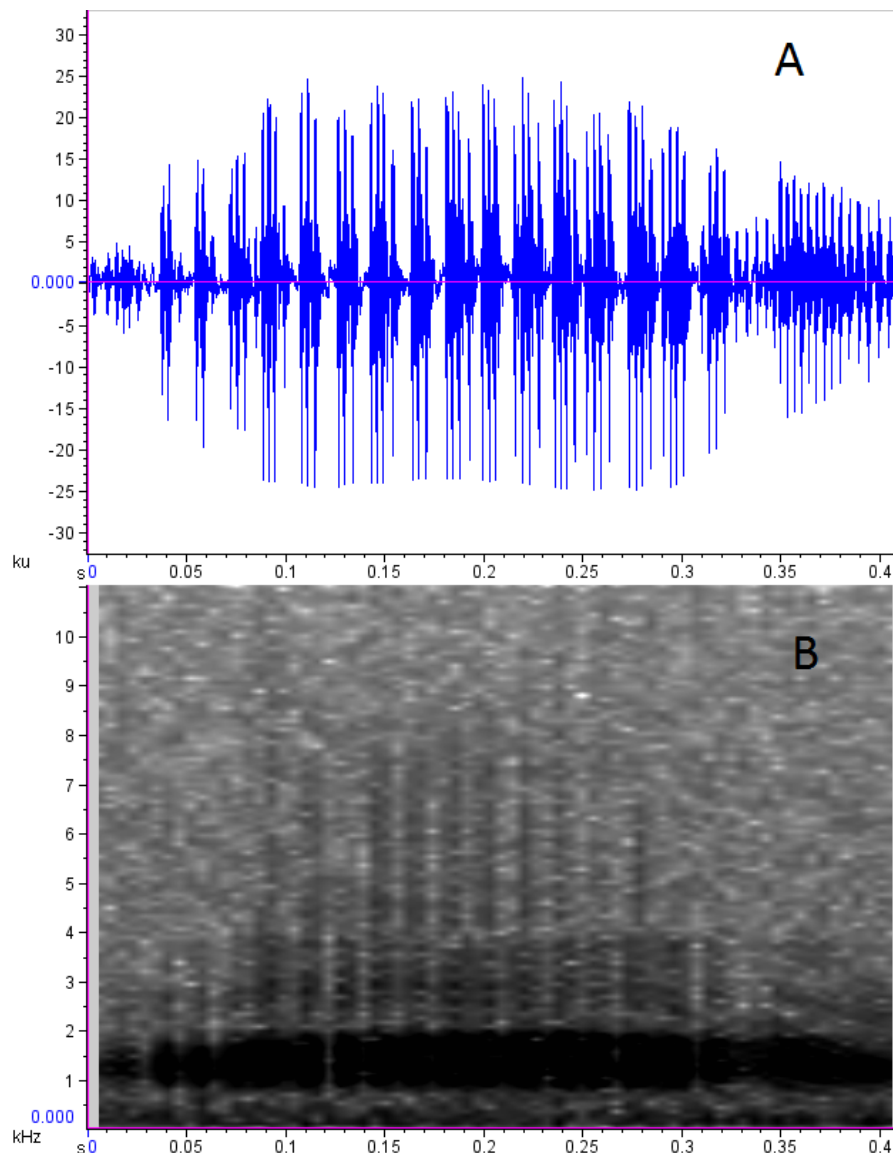
Figure 2. *Physalaemus moreirae* foam nest (A) and reproductive site (B) from Forte dos Andradas, Guarujá, SP

The advertisement call of *P. moreirae* (Figure 3) is mainly characterized by a lower dominant frequency (1177.14 ± 84.83 Hz; Table 1) in comparison to the advertisement call of *P. angrensis* (1700 ± 259 Hz; Weber et al. 2005). *Physalaemus moreirae*'s advertisement call differs from that of *P. atlanticus* (call duration: 1.281 ± 0.086 s; pulses per call: 73 ± 9.7 ; Weber et al. 2005), mainly by its shorter call duration (0.64 ± 0.15 s; Table 1) and smaller number of pulses per call (23 ± 3 ; Table 1).

Table 1. Acoustic properties of *Physalaemus moreirae* (N=12) advertisement call from Forte dos Andradas, Guarujá, SP, Brazil

	Average	Standard Deviation	Minimum value	Maximum value
Dominant Frequency (DF)	1177.14	84.83	1119.70	1378.10
Call Duration (CD)	0.64	0.15	0.42	0.93
Pulses/call (PR)	23.00	3.00	16.00	26.00
Pulses/seconds	38.00	7.30	25.00	52.00

In Brazil, use of natural resources or land occupation requires the production of environmental impact reports (EIA-RIMA). For anuran species, surveyors commonly use the transect technique and tend to identify species based solely on their advertisement calls. Rarely are acoustic analyses taken into account. For the cryptic species of the *P. signifer* group, it is quite clear that such practices can cause misleading species identification and consequently biased data sets on population size and geographic distribution.

**Figure 3.** *Physalaemus moreirae* sonogram (A) and spectrogram (B) from Forte dos Andradas, Guarujá, SP

According to Weber et al. (2005), the geographical distribution of *P. atlanticus* and *P. angrensis* is adjacent to that of *P. moreirae* (see also Caramaschi; Caramaschi 1991, Haddad; Sazima 2004). Recently, *P. atlanticus* was also observed from the Municipality of Mongaguá, state of São Paulo and Parque Nacional da Serra da Bocaina, state of Rio de Janeiro (C. F. B. Haddad pers. com.).

The IUCN Red List conservation status for *P. moreirae*, *P. angrensis* and *P. atlanticus* needs to be revised. *Physalaemus moreirae* and *P. angrensis* are considered “Data Deficient” (DD), while the conservation status of *P. atlanticus* is set as “Vulnerable” (VU). *Physalaemus moreirae* was set as DD due to the “absence of recent information on its extent of occurrence, status and ecological requirements”. Oddly, *P. angrensis* and *P. atlanticus*, which were described less than one year apart, are known only from their type localities and are set as DD and VU, respectively (IUCN, 2014; Nascimento, Verdade, 2004). The new population of *P. moreirae* is distributed within the area of the Forte dos Andradas. There is a second population in an urban forested area known as Morro da Nova Cintra (23°56'55”S, 46°21'12”W) in the municipality of Santos, about 30 km from the Army Reserve. This area is under constant human disturbance and the population still lacks acoustic analysis for species confirmation.

Both site localities are within the areas surveyed by Rossa-Feres et al. (2011) as low knowledge and sampling for the State of Sao Paulo.

This new record for the State of Sao Paulo extends the geographic distribution range of *P. moreirae* (Figure 1) south to Guarujá Municipality, *sensu* IUCN Red List (IUCN, 2014; Nascimento, Verdade, 2004).

Furthermore, according to the IUCN website, the population of *P. moreirae* is considered to be “decreasing”. These new records should help the reassessment of the conservation status of this species, as *P. moreirae* has now been found in one new protected area (Forte dos Andradas, Guarujá, SP) and its distribution range is wider than previously believed.

It is propose in this study that the conservation status of *P. moreirae* be set as “Least Concern” (LC) and that of *P. atlanticus* be set as DD, similar to *P. angrensis*. The discovery of this new population of *Physalaemus moreirae* represents one more example that the real distribution of anuran species is deficiently known in Brazil, as suggested by Thomé et al. (2007). Dozens of other species lacking published basic distributional data have had their status set as “endangered” instead of “data deficient” under IUCN criterion (see Pimenta et al. 2005, Marques et al. 2006). This may cause drawbacks in Neotropical anuran studies and conservation programs in many different countries. These data, once again, suggest the need for a full revision of the IUCN list and conservation status criteria (Stuart et al. 2004).

Currently, cytogenetic and reproductive behavior studies are being carried out on individuals from both newly discovered populations. We expect to produce valuable data for a better understanding of the biology and natural history trends in *P. moreirae*.

ACKNOWLEDGEMENTS

We thank the Brazilian Army and the Commanding Office of the Forte dos Andradas for permitting access to the reserve and supporting our research. Anne d'Heursel, Célio F. B. Haddad and Cynthia P. A. Prado for providing valuable comments on this paper. We also thank Programa Biota – FAPESP (procs. 2001/13341-3 and 2008/50928-1) for funding this research.

REFERENCES

- Caramaschi U, Caramaschi, EP. Reassessment of the type-locality and synonymy of *Physalaemus moreirae* (Miranda-Ribeiro, 1937) (Anura: Leptodactylidae). *J Herpetol.* 1991; 25(1):107-108.
- Cardoso MW. Revisão sistemática do grupo de espécies de *Physalaemus signifer* (Girard, 1853) (Amphibia, Anura, Leiuperinae). [tese] Rio de Janeiro: Universidade Federal do Rio de Janeiro; 2013.
- Haddad CFB, Prado CPA. Reproductive modes in frogs and their unexpected diversity in the Atlantic Forest of Brazil. *Bioscience.* 2005; 55(3): 207-217.
- Haddad CFB, Sazima I. A new species of *Physalaemus* (Amphibia; Leptodactylidae) from the Atlantic forest in southeastern Brazil. *Zootaxa.* 2004; 479: 1-12.
- Heyer WR. New species of frogs from Boracéia, São Paulo, Brazil. *Proc Biol Soc Wash.* 1985; 98(3):657-671.
- IUCN. Red List of Threatened Species. Version 2014.2. [Internet]. 2014 [accessed on 15 October 2014]; Available on: <http://www.iucnredlist.org>
- Marques RM, Colas-Rosas PF, Toledo LF, Haddad CFB. Amphibia, Anura, Bufonidae, *Melanophryniscus moreirae*: distribution extension. *Check List.* 2006; 2(1): 68-69.
- Miranda-Ribeiro A. "Alguns batrachios novos das colleções do Museo Nacional" *O Campo.* 1937; 8: 66-69.
- Nascimento LB, Verdade V. *Physalaemus moreirae*. The IUCN Red List of Threatened Species. Version 2014.2. [Internet]. 2014 [accessed on 15 October 2014]; Available on: <http://www.iucnredlist.org>
- Nali RC. Biologia Reprodutiva de *Bokermannohyla ibitiguara* (Anura, Hylidae) em Riachos do Sudoeste de Minas Gerais. [dissertação]. Rio Claro: Universidade Estadual Paulista; 2012.
- Nascimento LB, Caramaschi U, Cruz CG. Taxonomic review of the species groups of the genus *Physalaemus* Fitzinger, 1826 with revalidation of the genera *Engystomops* Jiménez-de-La-Espada, 1872 and *Eupemphix* Steindachner, 1863 (Amphibia, Anura, Leptodactylidae). *Arq Mus Nac.* 2005; 63(2): 297-320.
- Pimenta BVS, Cruz CAG, Silvano DL. A new species of the genus *Physalaemus* Fitzinger, 1826 (Anura, Leptodactylidae) from the Atlantic Rain Forest of southern Bahia, Brazil. *Amphibia-Reptilia.* 2005; 26: 201–210.
- Pombal Jr JP, Bastos RP. Vocalizações de *Scinax perpusillus* (A. Lutz & B. Lutz) e *S. arduous* Peixoto (Anura, Hylidae), com comentários taxonômicos. *Rev Bras Zool.* 2003; 20(4): 607-610.

Rossa-Feres, DC, Sawaya, RJ, Faivovich J, Giovanelli JGR, Brasileiro CA, Schiesari L, et al. Anfíbios do Estado de São Paulo, Brasil: conhecimento atual e perspectivas. *Biota Neotrop.* 2011; 11(1a):1-19.

Stuart SN, Chanson JS, Cox NA, Young BE, Rodrigues ASL, Fischman DL, Waller RW. Status and trends of amphibian declines and extinctions worldwide. *Science.* 2004; 306: 1783-1786.

Thomé MTC, Oyamaguchi HM, Brasileiro CA. Amphibia, Anura, Leiuperidae, *Physalaemus bokermanni*. Distribution extension. *Check List.* 2007; 3(1): 1-3.

Verdade KV, Rodrigues MT, Pavan D, Lopes MIMS, Kirizawa M, Melo MMRF. Anfíbios anuros da região da Estação Biológica do Alto da Serra de Paranapiacaba. In: Lopes MIMS,

Kirizawa M, Melo MMRF, org. Patrimônio da Reserva Biológica do Alto da Serra de Paranapiacaba: a antiga Estação Biológica do Alto da Serra. São Paulo: Instituto de Botânica; 2009. 579-604.

Weber LN, Gonzaga LP, Carvalho-e-Silva SP. A New species of *Physalaemus* Fitzinger, 1826 from the lowland Atlantic Forest of Rio de Janeiro State, Brazil (Amphibia, Anura, Leptodactylidae). *Arq Museu Nacional.* 2005; 63(4): 677-684.