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Morphological and acoustic characterization of *Proceratophrys goyana* (Lissamphibia: Anura: Odontophrynidae), with the description of a sympatric and related new species

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Abstract

Proceratophrys goyana was until recently the only species of the genus described from central Brazil. In this paper we characterize the adult morphology and advertisement call of this species, based on data collected at its type-locality (Chapada dos Veadeiros, Goiás, Brazil). These new data allowed us to recognize a new species of *Proceratophrys*, sympatric to *P. goyana*, which is described herein. *Proceratophrys goyana* is mainly characterized by the male SVL = 38.8–46.5 mm; a well-developed and continuous pair of dorsal sagittal ridges; upper eyelids triangular; developed frontoparietal crests, delimiting a shallow depression between them; overall color pattern browned, with the symmetrical dorsal ridges bordered laterally by dark brown undulations. *Proceratophrys rotundipalpebra* **sp. nov.** is characterized by the male SVL = 30.4–39.3 mm; the pair of symmetrical dorsal ridges well-developed anteriorly and somewhat interrupted in the sacral region; upper eyelids short and rounded; frontoparietal crests not well-developed; overall color pattern stained by 3–4 tonalities of gray, without a clear background color. The advertisement calls of both species are emitted in a multi-note pattern, each note pulsed, the first and last notes differing from each other and from those amidst the call in temporal features. The description of this new species is another example of the underestimated diversity of *Proceratophrys* in the Cerrado of central Brazil.

Key words: Bioacoustics, Chapada dos Veadeiros, Cerrado, *Proceratophrys*, Taxonomy

Resumo

Proceratophrys goyana era até recentemente a única espécie do gênero descrita para o Brasil central. Nesse trabalho caracterizamos a morfologia de adultos e o canto de anúncio dessa espécie, com base em dados coletados na localidade-tipo (Chapada dos Veadeiros, Goiás, Brasil). Esses novos dados nos permitiram reconhecer uma nova espécie de *Proceratophrys*, simpátrica a *P. goyana*, que é descrita aqui. *Proceratophrys goyana* caracteriza-se principalmente pelo CRC dos machos = 38,8–46,5 mm; cristas óculo-dorsais bem definidas e contínuas; pálpebras triangulares; cristas frontoparietais desenvolvidas, delimitando uma depressão rasa entre elas; coloração amarronzada, com as cristas óculo-dorsais bordeadas lateralmente por ondulações marrom-escuras. *Proceratophrys rotundipalpebra* **sp. nov.** caracteriza-se pelo CRC dos machos = 30,4–39,3 mm; cristas óculo-dorsais bem definidas na metade anterior e algo interrompidas na região sacral; pálpebras curtas e arredondadas; cristas frontoparietais não desenvolvidas; coloração variegada, com 3–4 tonalidades de cinza. Os cantos de anúncio de ambas as espécies são compostos por várias notas pulsadas, sendo que a primeira e a última nota diferem entre si e das demais em parâmetros temporais. A descrição dessa nova espécie é outro exemplo de que a diversidade de *Proceratophrys* no Cerrado do Brasil central é subestimada.

Introduction

The neotropical genus *Proceratophrys* Miranda-Ribeiro currently comprises 32 species distributed throughout Brazil, northeastern Argentina and Paraguay (Ávila *et al.* 2012; Cruz *et al.* 2012; Teixeira Jr. *et al.* 2012; Dias *et al.*

Considering the reception of advertisement calls by the female sensory system, since it is tuned to a relatively narrow range of values, and there is a tendency of selection of spectral features around species' means (reviewed in Wells 2007), we hypothesize the observed interspecific variation in mean dominant frequency ($> 20\%$) would be enough to work as a pre-zygotic barrier and prevent hybridization, if the habitat barrier is surpassed. We had already reported a similar case of sympatric, but not syntopic, pair of *Proceratophrys* species (Martins & Giaretta, 2011 – *P. vielliardi* and *P. aff. goyana*).

Besides the two species studied here, only *P. vielliardi* and *P. carranca* are known to have multi-note advertisement calls in the genus (Martins & Giaretta 2011; Godinho *et al.* 2013). The calls of *P. vielliardi* differ from both species (first and last notes longer than those amidst the call) by having the first note similar to the others amidst the call, but all other quantitative features are similar to at least one of them. The calls of *P. carranca* apparently tend to have shorter last notes (151 ms; 117–191) than both *P. goyana* (176; 87–243) and the new species (205; 45–328), but also overlap in all quantitative features. We had already reported a case of close similarity between the calls of other *Proceratophrys* species—*P. brauni* Kwet and Faivovich and *P. palustris* Giaretta and Sazima (Martins & Giaretta 2012). In these cases, probably the similar calls reflect a close phylogenetic relationship, as already shown for other anuran taxa (e.g. Cocroft & Ryan 1995; Erdtmann & Amézquita 2009).

In general, a negative correlation exists between call dominant frequency and body size, as we found for both the new species and *P. goyana* (Figure 11). This pattern is resulted from the allometric relationship between body size and the laryngeal apparatus of sound production; more specifically, as the mass and tension of vocal cords increase, the frequency at which they vibrate decreases (Martin 1972; Duellman & Trueb 1994; Wells 2007).

The environmental temperature may also affect advertisement call features, especially the temporal ones (Duellman & Trueb 1994; Wells 2007). We didn't find such relationships, probably due to the small temperature variation between our recordings (Table 3), as also reported for a species of *Scinax* (Toledo & Haddad 2005). On the other hand, this relationship was found when temperature variation was greater, e.g. for species of *Dendropsophus* (Guarnizo *et al.* 2012—temperature variation of 11.8 °C) and *Ameerega* (Magrini *et al.* 2010—temperature variation of 14.5 °C).

Finally, we are aware that much work still must be done to solve the problems regarding the taxonomy of species related to *P. goyana*. As we had already noticed (Martins & Giaretta 2011), the richness of *Proceratophrys* species in the Cerrado biome is clearly underestimated, and we believe, based on preliminary data (L.B.M. ongoing PhD thesis), that new species will still be described (see also Brandão *et al.* in press). New data is currently being gathered and analyzed, and we hope to solve as much as possible of this taxonomic confusion in the next few years.

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Appendix 1. Additional specimens examined

- Proceratophrys boiei*. Brazil, State of São Paulo: Atibaia (AAG-UFU 0950).
- Proceratophrys concavitympanum*. Brazil, State of Mato Grosso: Paranaita (ZUEC 14874–14876).
- Proceratophrys* cf. *cristiceps*. Brazil, State of Paraíba: São José do Bonfim (ZUEC 14388), Teixeira (8765–68).
- Proceratophrys cururu*. Brazil, State of Minas Gerais: Serra do Cipó (ZUEC 1649, 4113, 9556, 9559, paratypes, 9557, holotype).
- Proceratophrys moratoi*. Brazil, State of Minas Gerais: Uberlândia (AAG-UFU 1098, 1099, 4586, 4591, 4592), Ituiutaba (AAG-UFU 0843); State of São Paulo: Botucatu (ZUEC 7032, 7033).
- Proceratophrys palustris*. Brazil, State of Minas Gerais: Poços de Caldas (AAG-UFU 4819, 4820).
- Proceratophrys vielliardi*. Brazil, State of Goiás: Caldas Novas (AAG-UFU 4312, 4361, paratypes); State of Minas Gerais: Paracatu (AAG-UFU 1616–1618).

Appendix 2. Details of the recordings analyzed in the present work. For each specimen, the locality, date of recording, voucher specimen number and sound file labels are provided.

- Proceratophrys goyana*. Brazil, State of Goiás, Alto Paraíso de Goiás, 13–16 November 2012:
 AAG-UFU 1577: Procerat_goyanaVeadeirosGO1aLBM_AAGmt;
 AAG-UFU 1578: Procerat_goyanaVeadeirosGO2aLBM_AAGmt, Procerat_goyanaVeadeirosGO2bLBM_AAGmt;
 AAG-UFU 1579: Procerat_goyanaVeadeirosGO3aLBM_AAGmt, Procerat_goyanaVeadeirosGO3bLBM_AAGmt;
 AAG-UFU 1580: Procerat_goyanaVeadeirosGO4aLBM_AAGmt;
 AAG-UFU 1581: Procerat_goyanaVeadeirosGO5aLBM_AAGmt, Procerat_goyanaVeadeirosGO5bLBM_AAGmt, Procerat_goyanaVeadeirosGO5cLBM_AAGmt, Procerat_goyanaVeadeirosGO5dLBM_AAGmt;
 AAG-UFU 1582: Procerat_goyanaVeadeirosGO12aTRC_AAGmt, Procerat_goyanaVeadeirosGO12bTRC_AAGmt;
 AAG-UFU 1586: Procerat_goyanaVeadeirosGO9aTRC_AAGm671, Procerat_goyanaVeadeirosGO9bTRC_AAGm671;
 AAG-UFU 1587: Procerat_goyanaVeadeirosGO11aTRC_AAGm671, Procerat_goyanaVeadeirosGO11bTRC_AAGm671, Procerat_goyanaVeadeirosGO11cTRC_AAGm671, Procerat_goyanaVeadeirosGO11dTRC_AAGm671;
 AAG-UFU 1588: Procerat_goyanaVeadeirosGO6aBFVT_AAGmt;
 AAG-UFU 1589: Procerat_goyanaVeadeirosGO7aBFVT_AAGmt, Procerat_goyanaVeadeirosGO7bBFVT_AAGmt, Procerat_goyanaVeadeirosGO7cBFVT_AAGmt;