

ADVERTISEMENT CALLS OF THREE ANURAN SPECIES (AMPHIBIA) FROM THE CERRADO, CENTRAL BRAZIL

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ABSTRACT. Aspects of natural history, such as the advertisement call, of many frog species from central Brazil are unknown. This kind of vocalization is important for specific recognition, thus studies describing these calls are needed. Herein we describe the advertisement calls of three anuran species from the Cerrado Biome: (a) *Allobates goianus* (Aromobatidae); (b) *Odontophrynus salvatori* (Cycloramphidae); (c) *Lysapsus caraya* (Hylidae). From October to December/2001 and March/2009, the vocalizations of individuals of these species were recorded in three municipalities in Goiás state: Alto Paraíso, Araguapaz and Silvânia. The advertisement calls emitted by *A. goianus* presented modulation of frequency and those vocalizations emitted by *O. salvatori* and *L. caraya* showed pulsed structure. In general, these species presented advertisement calls different from those emitted by other species in the same genus. This difference reinforces the importance of the advertisement calls for specific recognition and also the validity of these species.

KEYWORDS. Cycloramphidae; Aromobatidae; Hylidae; vocalization.

INTRODUCTION

Advertisement calls in anurans are commonly emitted by males to attract gravid females and to mediate aggressive interactions between males (Duellman and Trueb, 1994). Among call types, the advertisement call is the most common. The comparison of vocalization traits among different species is important to interpret ecological interactions, taxonomic position and phylogenetic relationships among species (Márquez *et al.*, 1993; Hartmann *et al.*, 2002).

Currently, the genus *Allobates* includes 44 species that occur predominantly in the Amazon region, being *A. goianus* the only species of the genus found in Goiás state (Bokermann, 1975; Bastos *et al.*, 2003; Frost, 2011). Characteristics of natural history as well as advertisement calls of some species of the genus *Allobates* have already been described (Juncá, 1998; Grant and Rodriguez, 2001; Kok *et al.*, 2006; Lima *et al.*, 2007).

The genus *Odontophrynus* Lütken and Reinhardt, 1862, is currently composed of 10 species distributed in eastern and southern South America (Frost, 2011) and only six species (*Odontophrynus americanus* (Duméril and Bibron, 1841); *O. carvalhoi* Savage and Cei, 1965; *O. cultripes* Reinhardt and Lütken, 1861; *O. lavillai* Cei, 1985; *O. maisuma* Rosset, 2008; *O. salvatori* Caramaschi, 1996) occur in the

Brazilian territory (SBH, 2010). For this genus little information about vocal repertoire is available in the literature, highlighting the studies of Martino and Sinsch (2002), Rosset *et al.* (2007) and Borteiro *et al.* (2010).

The genus *Lysapsus* is composed of three species: *Lysapsus caraya* Gallardo, 1964, *Lysapsus laevis* (Parker, 1935) and *Lysapsus limellum* Cope, 1862, being all species found in Brazil (Frost, 2011). Recently, it has been suggested that the genus *Pseudis* and *Lysapsus* should be synonymized (Aguiar *et al.* 2007; Garda and Cannatella, 2007). However, after more complete analysis of sequences of nuclear and mitochondrial genes, Wiens *et al.* (2010) recognized two genera, *Lysapsus* and *Pseudis*, the nomenclature we will adopted in this work. Thus, for the genus *Lysapsus*, only the advertisement call of *L. limellum* has already been described (Bosch *et al.*, 1996).

Contributing to the knowledge about the anuran species of the Cerrado, central Brazil, the present study describes the advertisement calls of the following species: (a) *Allobates goianus* (Bokermann, 1975), Aromobatidae, (b) *Odontophrynus salvatori* Caramaschi, 1996, Cycloramphidae, (c) *Lysapsus caraya* (Klappenbach, 1985), Hylidae. Besides, we also compare our data with the calls previously described in the literature.

MATERIALS AND METHODS

Field surveys were conducted in the municipalities of Alto Paraíso (14°07'57"S, 47°30'36"W), Araguapaz (15°05'27"S, 50°37'55"W) and Silvânia (16°39'32"S; 48°36'29"W), state of Goiás, central Brazil. In Silvânia, the observations were made in the Floresta Nacional (Flona), which is a protected area managed by the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). All study sites are located in the Cerrado Biome, where the climate is tropical (Koppen AW) with two well defined seasons: dry season (from April to September) and rainy season (between October and March).

The recordings were obtained between October and December 2001 and in March 2009, with the use of the following equipments: DAT recorder Sony TCD-D100 and microphone Sony ECM-MS907 or MARANTZ PMD 222 and Sennheiser ME66 microphone. Air temperature and relative air humidity were also registered.

The vocalizations were edited at sampling frequencies of 6 kHz (*O. salvatori*) or 22 kHz (for *Allobates goianus* and *Lysapsus caraya*), using 16 bit resolution in a PC-Pentium computer and analyzed with Avisoft-Sonagraphy light® and Cool Edit 96® softwares. Frequency information was obtained through Fast Fourier Transformation (FFT) of 1024 points width. We present a representative sonogram and oscillogram for a selected 1.08 s recording segment for each species. The sonograms and oscillograms were created in: (a) overlap (75%) and (b) Window (Flat Top) in the software Avisoft-Sonagraphy.

The following acoustic variables were measured: call duration (ms), note number (notes/calls), note duration (ms), pulse number, pulse duration (ms), dominant frequency (Hz) and repetition rate (calls/min). Call description follows Gerhardt (1998), Gerhardt and Huber (2002), and Wells (2007). Vouchers were deposited at the Coleção Zoológica da Universidade Federal de Goiás (ZUFG). Furthermore, we compared note duration and pulse number of the three note types of the calls of *L. caraya* using an analysis of variance (ANOVA), according to Zar (1996).

RESULTS

The description of the advertisement call of *Allobates goianus* (Figure 1A) was based on one calling male from Silvânia municipality. Individuals of this species were observed vocalizing amidst the leaf litter

in a gallery forest. The advertisement call showed modulation of frequency and a second frequency band could be detected in the sonogram (Figure 2). The calls were emitted at a rate of 76 calls per minute and each call was constituted by a note varying from 65 to 79 ms ($X = 73.2$; $SD = 4.6$; $N = 10$ calls). Mean dominant frequency and fundamental frequency were, respectively, 4946.3 ± 107.2 Hz (Range



FIGURE 1. Individuals of (A) *Allobates goianus*, Floresta Nacional de Silvânia, Goiás, Brazil; (B) *Odontophrynus salvatori*, Floresta Nacional de Silvânia, Goiás, Brazil; and (C) *Lysapsus caraya*, Mambá, Goiás, Brazil.

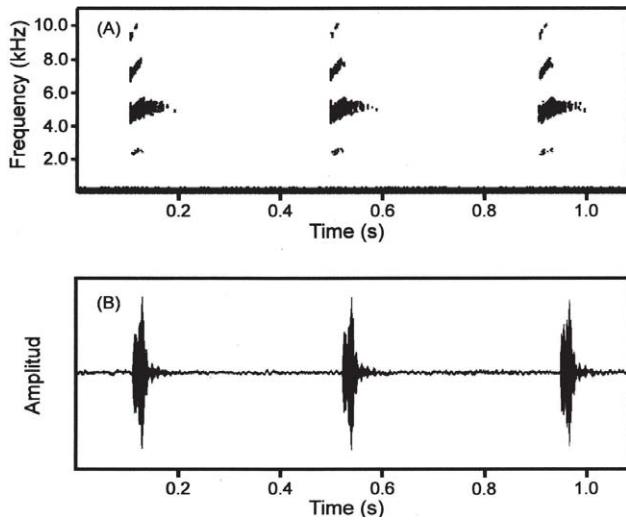


FIGURE 2. (A) Sonogram and (B) oscilogram of three advertisement calls of *Allobates goianus*, Floresta Nacional de Silvânia, Goiás, Brazil.

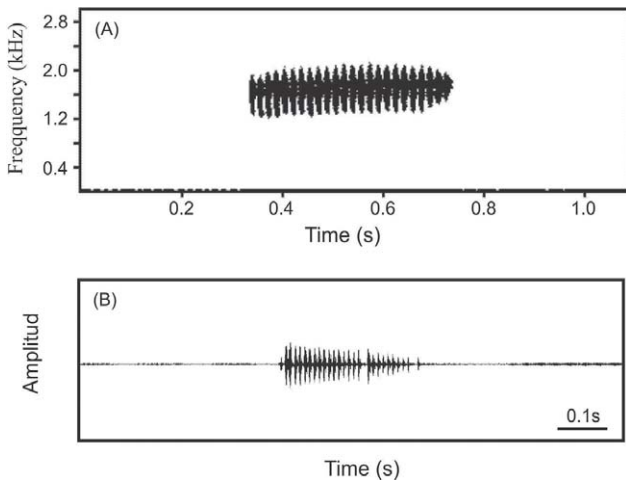


FIGURE 3. (A) Sonogram and (B) oscilogram of the advertisement call of *Odontophrynus salvatori*, Alto Paraíso, Goiás, Brazil.

= 4812.9-5049.8; N = 10 calls) and 2467.3 $\pm$ 53.5 Hz (Range = 2371-2525; N = 10 calls).

Four individuals of *Odontophrynus salvatori* (Figure 1B) were recorded in the municipality of Alto Paraíso and only one in Silvânia. Males called at the edge of streams or at the edge of permanent or temporary ponds. The advertisement call is composed of a single pulsioned note (Figure 3). On average, duration of the call was 317.2 $\pm$ 89.8 ms (Range = 198-420; N = 20 calls). The mean number of pulses per note was 20.2 $\pm$ 3.6 (Range = 15-25; N = 20 notes), with duration ranging from 8.4 to 14.2 ms (X = 10.7 ms; SD = 1.15; N = 80). Call repetition rate was 22.5 $\pm$ 10 calls per minute (N = 5 males). The frequency varied from 947 to 3445 Hz and mean dominant frequency was 1572.2 $\pm$ 225.7 Hz (N = 20 calls).

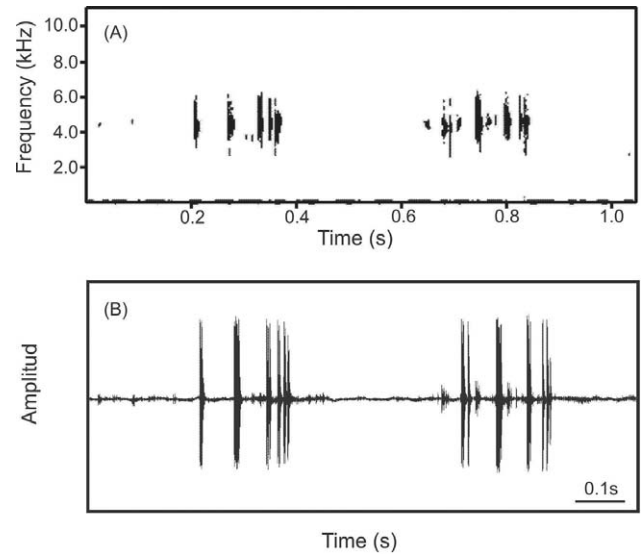


FIGURE 4. (A) Sonogram and (B) oscilogram of two advertisement calls of *Lysapsus caraya*, Araguapaz, Goiás, Brazil. (Air temperature = 25.6°C; Air humidity = 79.3%).

Vocalizations of *Lysapsus caraya* males (Figure 1C) were recorded in the municipality of Araguapaz. Calling males were observed floating on the water, anchored in the vegetation. The advertisement call is composed, on average, by 3 notes (Figure 4), each one with duration ranging from 10 to 64 ms (X = 24.1 ms; SD = 1.3; N = 10 notes) and, on average, the pulse number was 4.4 pulses/note with duration of 3.3 $\pm$ 0.3 ms (Range = 2.8-4.1; N = 50 pulses). We observed that note duration ($F_{(2,54)} = 81.729$, $p < 0.001$) and pulse number ($F_{(2,54)} = 145.32$, $p < 0.001$) were different among the three note types analyzed, being the last note longer than the others. The average duration of the call was 154.4 $\pm$ 15 ms (Range = 123-176; N = 10 calls) and the repetition rate was 57.5 calls per minute (Range = 41-74, N = 2 males). The frequency varied from 2153 to 7321 Hz and mean dominant frequency was 4499.1 $\pm$ 129 Hz (Range = 4337-4719; N = 10 calls).

DISCUSSION

Among the different communication systems observed in anurans, acoustic communication is the most common, being the advertisement call important for specific recognition (Duellman and Trueb, 1994). Therefore, the description of this kind of vocalization is important, since it can be used in studies involving taxonomy and behavioral ecology (Pombal and Haddad, 1992; Martino and Sinschi, 2002). Thus, this paper describes for the first time the advertisement

calls of three frog species from the Cerrado Biome, *A. goianus*, *O. salvatori* and *L. caraya*.

The advertisement calls of some species of the genus *Allobates* are available in the literature (Juncá, 1998; Grant and Rodriguez, 2001; Caldwell and Lima, 2003; Kok *et al.*, 2006; Lima *et al.*, 2007; Castillo-Trenn and Coloma, 2008; Barrio-Amorós and Santos, 2010). However, *A. goianus* was included in the data deficient category by IUCN (2010) and little information about its natural history is available (Bokermann, 1975; Bastos *et al.*, 2003). The advertisement call of *A. goianus* is composed of a single note, being different from those emitted by other species in the genus, such as *A. trilineatus*, *A. granti* and *A. kingsurghi*, which exhibit calls composed by a sequence of notes (Grant and Rodriguez, 2001; Kok *et al.*, 2006; Castillo-Trenn and Coloma, 2008).

In *A. goianus*, call frequency is modulated from low to high like in *A. alessandroi*, *A. femoralis*, *A. granti*, *A. melanolaemus* and *A. trilineatus* (Grant and Rodriguez, 2001; Kok *et al.*, 2006; Barrio-Amorós and Santos, 2010). Besides, we also observed a second frequency band similar to the one described for *A. brunneus* (Lima *et al.*, 2009). On average, the dominant frequency was lower than those of other species, such as *A. granti* (above 5100 Hz – Kok *et al.*, 2006) and *A. subfolionidificans* (above 5000 Hz – Lima *et al.*, 2007), but overlapped with the dominant frequency exhibited by *A. trilineatus* (4920 to 6040 Hz – Grant and Rodriguez, 2001).

Regarding the species in the genus *Odontophrynus*, some information on the advertisement calls has been published (Sala and Di Tada, 1994; Martino and Sinsch, 2002; Rosset *et al.*, 2007; Borteiro *et al.*, 2010). During our field work, besides streams, we also observed males of *O. salvatori* calling near temporary and permanent ponds, differing from *O. cultripes*, which was found only near streams (Bastos *et al.*, 2003). The advertisement call of *O. salvatori* differs from that of *O. achalensis* – 900 Hz (Sala and Di Tada, 1994), *O. occidentalis* – 820 Hz (Martino and Sinsch, 2002), *O. americanus* – 1020 Hz (Martino and Sinsch, 2002), *O. barrioi* – 641 Hz (Rosset *et al.*, 2007), and *O. maisuma* – 1170 Hz (Borteiro *et al.*, 2010) by presenting a higher dominant frequency.

Odontophrynus achalensis, *O. occidentalis* and *O. barrioi* belong to the *O. occidentalis* group. Males of species in this group commonly emit long calls composed by a group of notes (Sala and Di Tada, 1994; Martino and Sinsch, 2002; Rosset *et al.*, 2007), differing from *O. salvatori* males that emit short calls.

On the other hand, the call duration of *O. salvatori* was more similar to that emitted by *O. americanus* (Martino and Sinsch, 2002) and *O. maisuma* (Borteiro *et al.*, 2010).

The advertisement call of species of the genus *Lysapsus* has been described only for *L. limellum* (Bosch *et al.*, 1996). We observed that the structure of *L. caraya* calls is pulsioned, similar to those emitted by *L. limellum* males (Bosch *et al.*, 1996) and to those emitted by some species of the genus *Pseudis*, such as *P. minuta*, *P. bolbodactyla* and *P. paradoxa* (Vaz-Silva *et al.*, 2007; Zank *et al.*, 2008; Tárano, 2010).

Considering the dominant frequency of the advertisement call emitted by *L. limellum* (2.250–3.700 kHz – Bosch *et al.*, 1996) and by *P. minuta* (2.69 kHz – Zank *et al.*, 2008), *P. paradoxa* (2.711 kHz – Bosch *et al.*, 1996) and *P. bolbodactyla* (1.936 kHz – Vaz-Silva *et al.*, 2007), *L. caraya* exhibited the highest values for this spectral parameter. Besides, according to Zank *et al.* (2008) and Vaz-Silva *et al.* (2007), the advertisement calls emitted by *P. minuta* (7 ms and 10.67 pulse/calls) and *P. bolbodactyla* (5.4 ms and 6.6 pulse/calls) presented longer pulse duration and larger number of pulses compared to the calls emitted by *L. caraya*.

Thus, in *Allobates goianus*, *Odontophrynus salvatori* and *Lysapsus caraya*, the structure and the acoustic parameters of the advertisement calls here analyzed differed from those calls emitted by other species in the same genus. Therefore, our results reinforce the validity of these species and the importance of the advertisement call for specific recognition, helping to avoid interspecific matings (*e.g.*, Haddad *et al.*, 1994).

RESUMO

Aspectos de história natural, tais como descrições de cantos de anúncio, de muitas espécies de anuros do Cerrado ainda são escassos. Este tipo de vocalização é importante, devido ao reconhecimento específico, sendo necessários estudos que descrevam tais cantos. Desta forma, o presente trabalho tem como objetivo descrever o canto de anúncio de três espécies de anuros do Cerrado: (a) *Allobates goianus* (Aromobatidae); (b) *Odontophrynus salvatori* (Cycloramphidae); (c) *Lysapsus caraya* (Hylidae). Entre os meses de outubro a dezembro de 2001 e março de 2009, as vocalizações de indivíduos destas espécies foram gravadas em três municípios do estado de Goiás: Alto Paraíso, Araguapaz e Silvânia. Assim, observamos

que os cantos de anúncio emitidos por *A. goianus* apresentaram modulação de frequência e aqueles emitidos por *O. salvatori* e *L. caraya* tiveram estrutura pulsionada. No geral, estas espécies apresentaram vocalizações de anúncio que diferem daquelas descritas para outras espécies do mesmo gênero. Portanto, esta diferença reforça a importância do canto de anúncio para o reconhecimento específico e também a validade destas espécies.

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