



ADVERTISEMENT CALLS OF THREE LEPTODACTYLID FROGS
IN THE STATE OF BAHIA, NORTHEASTERN BRAZIL (AMPHIBIA, ANURA,
LEPTODACTYLIDAE), WITH CONSIDERATIONS ON THEIR TAXONOMIC STATUS¹
(With 9 figures)

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ABSTRACT: The advertisement call of *Proceratophrys cristiceps* and a different advertisement call of *Leptodactylus ocellatus* are described, and the advertisement call of *Leptodactylus troglodytes* is redescribed. Power spectrums, audiospectrograms, and waveforms are presented. Vocalizations were recorded in municipalities of Feira de Santana and Mangue Seco, State of Bahia, Brazil. Aspects related to taxonomy from vocalization of species are discussed.

Key words: *Proceratophrys cristiceps*. *Leptodactylus ocellatus*. *Leptodactylus troglodytes*. Vocalization. Taxonomy.

RESUMO: Canto de anúncio de três espécies da família Leptodactylidae no Estado da Bahia, Nordeste do Brasil (Amphibia, Anura, Leptodactylidae), com considerações sobre suas posições taxonômicas.

São descritos os cantos de anúncio de *Proceratophrys cristiceps* e um diferente canto de anúncio de *Leptodactylus ocellatus*, bem como é redescrito o canto de anúncio de *Leptodactylus troglodytes*. Espectrogramas, sonogramas e oscilogramas das vocalizações são apresentados. As gravações foram realizadas nos municípios de Feira de Santana e Mangue Seco, Estado da Bahia, Brasil. São discutidos aspectos taxonômicos a partir das vocalizações.

Palavras-chave: *Proceratophrys cristiceps*. *Leptodactylus ocellatus*. *Leptodactylus troglodytes*. Vocalização. Taxonomia.

INTRODUCTION

Anuran advertisement calls are generally species-specific (GERHARDT, 1988) and their specificity promotes a species isolating mechanism that characterizes it as an important taxonomic character (DUELLMAN & TRUEB, 1986). For example, the morphologies of some closely related species of frogs are indistinguishable, but their advertisement calls differ from each other (see HEYER *et al.*, 1996; HADDAD & POMBAL, 1998; HADDAD & SAZIMA, 2004).

Leptodactylidae is a large family of frogs with a geographical distribution ranging from southern USA and Antilles to southern South America (FROST, 2004). The subfamilies Leptodactylinae and Ceratophryinae have a lot of not well-delimited species, and vocalizations (mainly advertisement calls) have been used to solve the relationships among them (HEYER, 1978; HEYER *et al.*, 1996; KWET & FAIVOVICH, 2001; HEYER & JUNCÁ, 2003).

The purpose of our study is to describe the advertisement call of *Proceratophrys cristiceps* (Müller, 1883), describe a different advertisement call of *Leptodactylus ocellatus* (Linnaeus, 1758), redescribe the advertisement call of *L. troglodytes* Lutz, 1926, and discuss the contribution of call data to understanding their respective taxonomic status.

MATERIAL AND METHODS

Recordings of advertisement calls of two specimens of *Proceratophrys cristiceps* and one specimen of *Leptodactylus ocellatus* were obtained during a survey of anurans in Serra São José (semidecidual forest), Municipality of Feira de Santana, Bahia, Brazil. Recordings of advertisement calls of two specimens of *Leptodactylus troglodytes* were obtained during a survey of anurans in the Municipality of Mangue Seco (Atlantic Forest), Bahia, Brazil.

The vocalizations were recorded in the field with a

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SONY WM-D6 Digital Audio Tape (DAT) and a SONY ECM-MS907 Electret Condenser Microphone. Advertisement calls were analyzed using Canary 1.2.4 software (CHARIF *et al.*, 1995). The calls were digitized at a sample rate of 44.1 Hz, and sample size of 16 bits. Call classification and acoustic parameters terminology follows DUELLMAN & TRUEB (1986), JUNCA (1999), and LITTLEJOHN (2001). Temporal parameters were measured from the waveform. Dominant frequency was determined using the spectrum analysis in Canary with settings of spectrum analysis resolution filter band-width 174.85 Hz, frame length 1.024 points, grid resolution time 1.451ms, overlap 93.75%, grid resolution frequency 43.07 Hz, FFT size 1.024 points, window function hamming, amplitude logarithmic, clipping level-80 dB. Call amplitude modulation and frequency modulation were evaluated from visual inspection of wave form and audioespectrogram displays, respectively.

RESULTS

The summary of the acoustic parameters of the advertisement calls described below is presented in table 1.

Proceratophrys cristiceps (Figs.1-3)

The advertisement call comprises one multipulsed note ($\bar{x} = 57 \pm 6$ pulses; N = 29) (Fig.1). Call duration ranges from 0.52 to 0.79s ($\bar{x} = 0.66 \pm 0.05$ s; N = 29) and call interval ranges from 0.84 to 37.83s ($\bar{x} = 4.47 \pm 7.65$ s; N = 28). The pulse rate ranges from 87.43

to 91.85 pulses/s ($\bar{x} = 89.54 \pm 1.20$ pulses/s; N = 28). The call has not a frequency modulation (Fig.2). Because the narrow band filter analyses, figure 2 shows artifacts that could be misleading interpreted as an harmonic structure (VIELLIARD, 1993). The dominant frequency ranges from 0.90 to 0.99 kHz ($\bar{x} = 0.94 \pm 0.02$ kHz; N = 29) (Fig.3). The specimens were found at night, calling on the ground near a temporary stream.

Leptodactylus ocellatus (Figs.4-6)

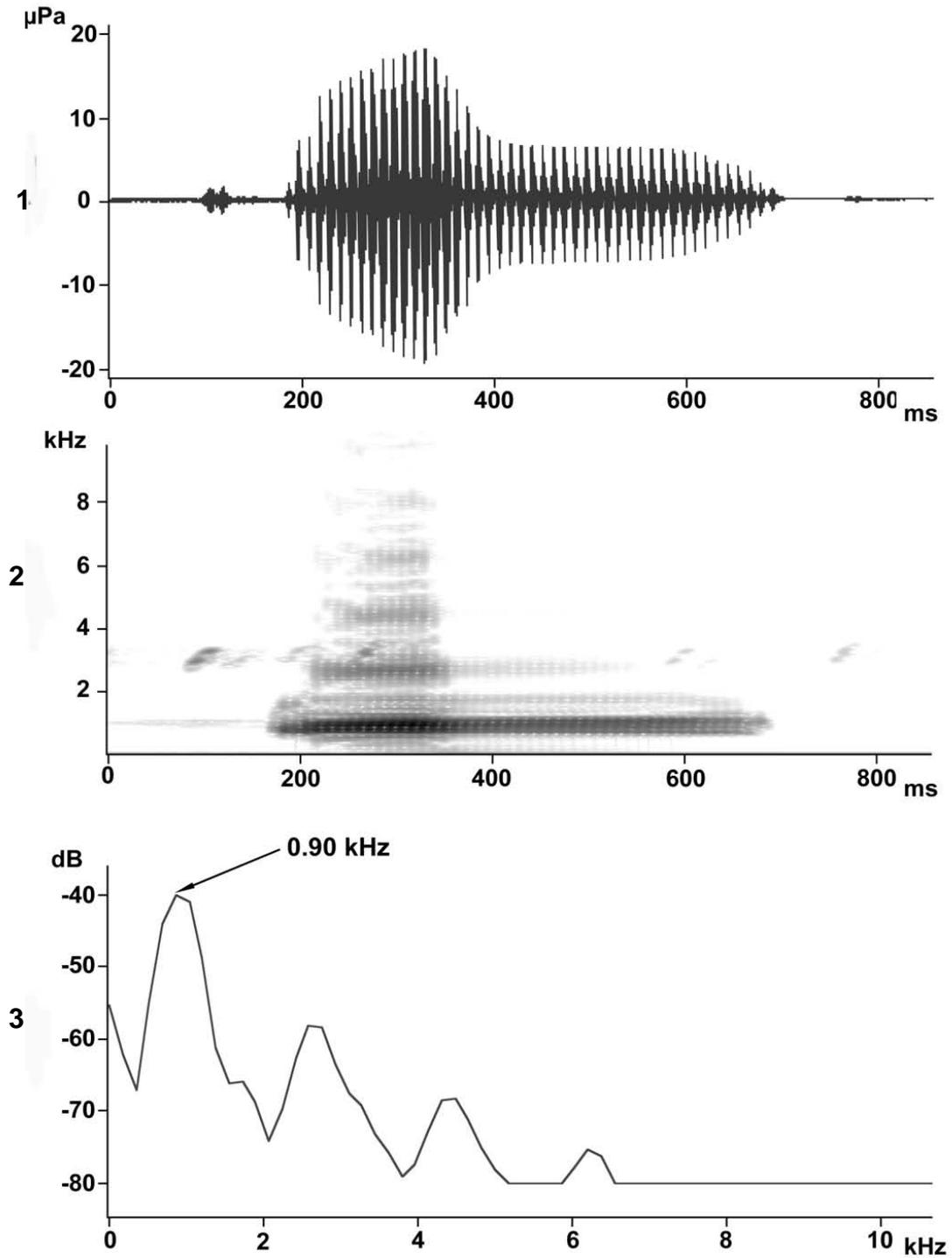
The advertisement call consists of one multipulsed note ($\bar{x} = 11 \pm 1$ pulses; N = 68) frequently repeated (Fig.4). Call duration ranges from 0.28 to 0.39s ($\bar{x} = 0.34 \pm 0.02$ s; N = 68) and call interval ranges from 0.50 to 2.82s (1.2 ± 0.52 ; N = 57). The call has an ascendant amplitude modulation (Fig.4) and do not present a frequency modulation (Fig.5). The dominant frequency ranges from 0.34 to 0.39 kHz ($\bar{x} = 0.35 \pm 0.02$ kHz; N=28) (Fig.6). The specimen was found at night, calling in the water (from a permanent pond).

Leptodactylus troglodytes (Figs.7-9)

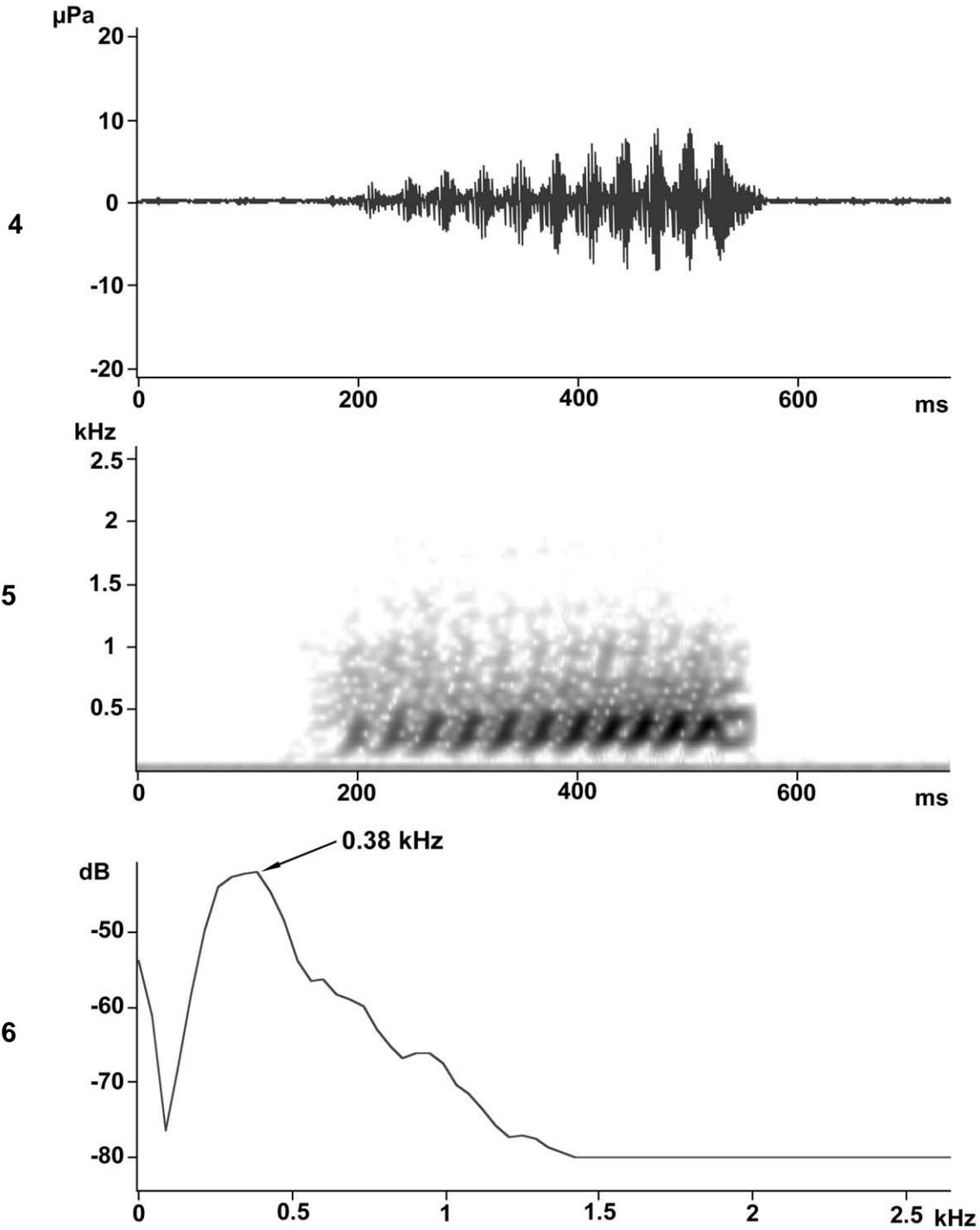
The advertisement call consists of a tonal single note (Fig.7). Call duration mean is 0.06 ± 0.01 s (N = 163) and call interval ranges from 0.18 to 1.59s ($\bar{x} = 0.48 \pm 0.18$ s; N = 162). The call has an ascendant frequency modulation (Fig.8). The dominant frequency mean is 3.28 ± 0.06 kHz (N = 163) (Fig.9). The specimens were found at night, calling hidden on rocks and dense vegetation.

Table 1. Acoustic parameters of the advertisement call of *Leptodactylus ocellatus*, *Leptodactylus troglodytes*, and *Proceratophrys cristiceps*. The results are presented as mean \pm standard deviation (amplitude).

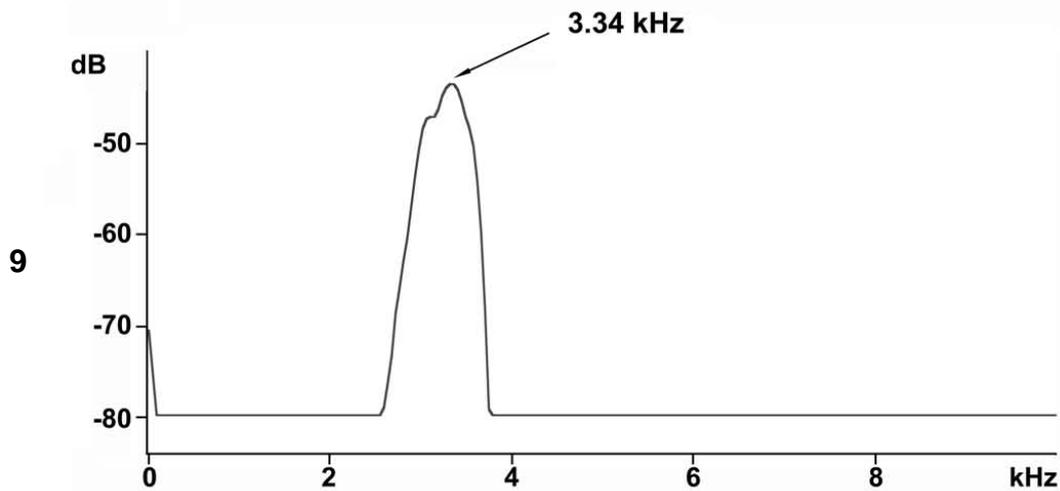
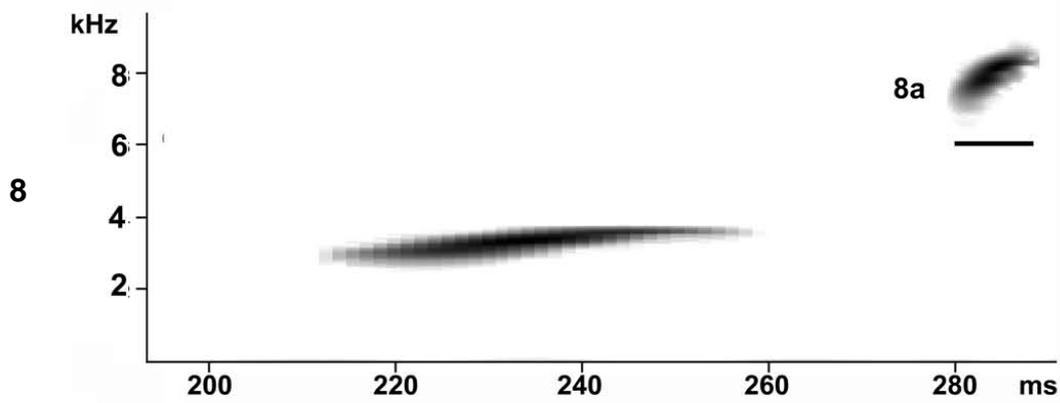
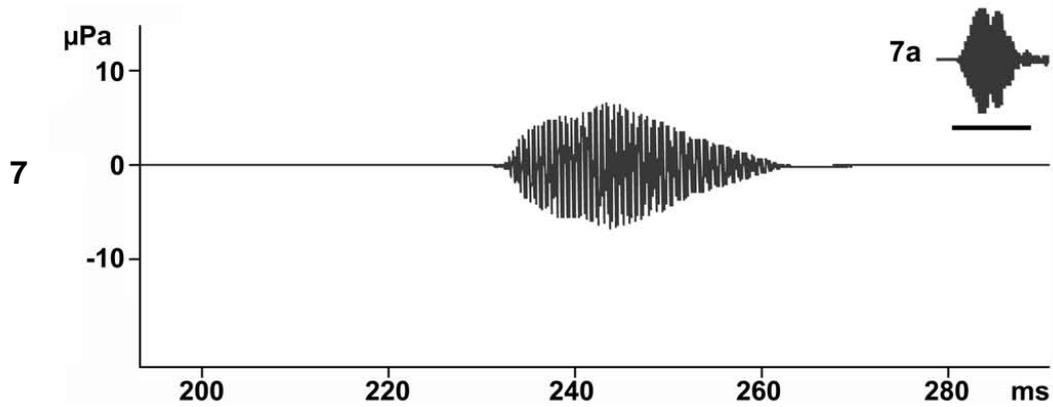
ACOUSTIC PARAMETERS	<i>Leptodactylus ocellatus</i>	<i>Leptodactylus troglodytes</i>	<i>Proceratophrys cristiceps</i>
Call duration (s)	0.34 \pm 0.02 (0.28 - 0.39)	0.06 \pm 0.01 (0.05 - 0.07)	0.66 \pm 0.05 (0.52 - 0.79)
Interval between calls (s)	1.20 \pm 0.52 (0.50 - 2.82)	0.48 \pm 0.18 (0.18 - 1.59)	4.47 \pm 7.65 (0.84 - 37.83)
Number of notes	1	1	1
Number of pulses	10.88 \pm 0.77 (9 - 12)	-	57,46 \pm 6,02 (46 - 69)
Dominant frequency (kHz)	0.35 \pm 0.02 (0.34 - 0.39)	3.28 \pm 0.06 (3.20 - 3.39)	0.94 \pm 0.02 (0.90 - 0.99)
Physical structure of call	pulsed	pulsed	pulsed
Frequency Modulation	-	ascendent	-
N (analyzed calls/ σ^2)	68 / 1	163 / 2	29 / 2



Advertisement call of *Proceratophrys cristiceps*, recorded 29/XI/2004. Air temperature 21°C and water temperature 24°C: fig.1- wave form; fig.2- audiospectrogram; fig.3- power spectrum.



Advertisement call of *Leptodactylus ocellatus*, recorded 29/XI/2004. Air temperature 21°C and water temperature 24°C: fig.4- wave form; fig.5- audiospectrogram; fig.6- power spectrum.



Advertisement call of *Leptodactylus troglodytes*, recorded 21/IV/1998. Air temperature 20°C: fig.7- wave form (7a = compacted view of amplitude structure; scale bar = 0.04s); fig.8- audiospectrogram (8a = compacted view of frequency structure; scale bar = 0.04s); fig.9- power spectrum.

DISCUSSION

The advertisement call of *Proceratophrys cristiceps* presents differences from the known vocalizations of other species of *Proceratophrys*: *P. avelinoi* (KWET & BALDO, 2003), *P. bigibbosa* (KWET & FAIVOVICH, 2001), *P. boiei* (HEYER *et al.*, 1990), *P. brauni* (KWET & FAIVOVICH, 2001), *P. cururu* (ETEROVICK & SAZIMA, 1998), and *P. moehringi* (WEYGOLDT & PEIXOTO, 1985). The number of pulses of the advertisement call of *P. cristiceps* (\bar{x} = 57) is greater than for *P. avelinoi* (\bar{x} = 38), *P. bigibbosa* (\bar{x} = 42), *P. boiei* (30-35), *P. brauni* (\bar{x} = 26), *P. cururu* (40), and less than for *P. moehringi* (140). The call duration of *P. cristiceps* (\bar{x} = 0.66 s) is longer than in *P. avelinoi* (\bar{x} = 0.54 s) and shorter than in *P. bigibbosa* (1.6-1.9s), *P. boiei* (0.7-0.8 s), *P. brauni* (0.7-0.9 s), *P. cururu* (1.2 s), and *P. moehringi* (3.5-4.0 s). The pulse rate of *P. cristiceps* (\bar{x} = 89.54 pulses/s) is faster than in *P. avelinoi* (\bar{x} = 68.7 pulses/s), *P. bigibbosa* (\bar{x} = 25.1 pulses/s), *P. boiei* (45 pulses/s), *P. brauni* (\bar{x} = 37.5 pulses/s), *P. cururu* (45 pulses/s), and *P. moehringi* (33-40 pulses/s). The dominant frequency of *P. cristiceps* (\bar{x} = 0.94 kHz) is lower than in *P. avelinoi* (\bar{x} = 1.60 kHz), *P. bigibbosa* (1.05 kHz), and *P. brauni* (1.35 kHz), and higher than in *P. boiei* (0.6 kHz), *P. cururu* (0.9 kHz), and *P. moehringi* (0.45 kHz).

The advertisement call of *Leptodactylus ocellatus* from Serra São José, Bahia, Brazil is different from the advertisement call of *L. ocellatus* from Entre Rios, Argentine, available in "Catalogue of the voices of argentine amphibians" (STRANECK *et al.*, 1993). Both calls consisted of a repeated note, but the advertisement call of Entre Rios is tonal, while from Bahia is multipulsed. The dominant frequency of the population here studied (\bar{x} = 0.35 kHz) seems similar to the argentine population (amplitude frequency of call ranges from 0.2 to 0.4 kHz). The distinct structure of the call (multipulsed x tonal) observed may indicate that called species *L. ocellatus* represents a complex of species.

The advertisement call of *Leptodactylus troglodytes* was described from one locality in the State of Bahia (Municipality of Andaraí) by HEYER (1978). The dominant frequency of the advertisement call of *Leptodactylus troglodytes* from Mangue Seco (3.20-3.39 kHz) is quite similar to that of *L. troglodytes* from Andaraí (2.60-3.20 kHz), as is the call duration (\bar{x} = 0.06s from Mangue Seco and 0.04s from Andaraí). These results lead us to conclude that the two populations of *Leptodactylus troglodytes* from Mangue Seco and Andaraí represent the same species.

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