

Distress calls of two species of the *Bokermannohyla circumdata* group (Amphibia, Anura, Hylidae)

Elvis Almeida Pereira Silva^{1*}, Emanuel Teixeira da Silva², Renata Magalhães Pirani³ and Sarah Mângia⁴

In the behavioural repertoire of anurans, calls are used in different contexts and the same species may present different acoustic signals (Wells 1977; 2007). Distinct types of calls can be observed, such as advertisement calls, aggressive calls, distress calls and mixed calls (e.g. Bogert, 1960; Lingnau et al. 2004). The distress call is characterized by loud, explosive vocalizations emitted by males, females, and juveniles in response to disturbance of potential predators (Duellman & Trueb 1994; Toledo et al. 2005), and few data on this type of vocalization are available in literature (Toledo & Haddad 2009).

The treefrog genus *Bokermannohyla* Faivovich et al. (2005) currently comprises 33 species occurring in the Atlantic Forest, Cerrado and Caatinga domains all in Brazilian territory (Leite et al. 2011; Carvalho et al. 2012). The genus is divided in four phenetic species groups: the *B. circumdata* group; *B. pseudopseudis* group; *B. martinsi* group; and *B. claresignata* group. The *B. circumdata* group currently comprises 19 species occurring in mountain stream habitats along the Brazilian Atlantic Forest and Cerrado domains (Napoli

& Pimenta 2009; Carvalho et al. 2012), among them the two species treated in this study, *Bokermannohyla circumdata* (Cope 1871) and *Bokermannohyla nanuzae* (Bokermann & Sazima 1973).

Toledo and Haddad (2009) described the distress call of *B. circumdata*, however, only the call of females was described. No information is available about the distress call of *B. nanuzae*. This study brings description of the distress calls of *B. circumdata* and *B. nanuzae*. Additionally, we provide comparison among the known distress calls within *Bokermannohyla*.

Individuals of *B. circumdata* and *B. nanuzae* were recorded at Floresta Estadual do Uaimií (20°29'66"S, 43°57'47"W; ca. 900 to 1400m asl.) in the municipality of Ouro Preto, state of Minas Gerais, Brazil. On 22 May 2010 we observed one male of *B. circumdata* (MZUFV 10575, SLV = 57.7 mm) in marginal vegetation nearby a permanent stream at 1077m asl. When captured and handled, the male produced a strong, explosive call, understood by us as a distress call. During manipulation, it emitted 20 calls, which were recorded. On 11 Nov 2010, some individuals of *B. nanuzae* were found, calling in marginal vegetation in a forested permanent stream. At around 20:00 h, a male specimen (MZUFV 9721, SLV = 53.5 mm) was captured and produced strong explosive calls (n = 4). Both males were recorded using a Panasonic RR US 450® digital recorder, with frequency response ranging from 300 Hz to 5.000 Hz.

The recordings were analyzed with SoundRuler version 0.9.4.1 and Raven Pro 1.4 for Windows (Cornell Lab of Ornithology Research Program Bioacoustics Workstation). Audio spectrograms were made with the following parameters: FFT window width = 256, Frame = 100, Overlap = 75, and flat top filter. The voucher specimens are housed at the Collection of Amphibians of Museu de Zoologia João Moojen (MZUFV), Universidade Federal de Viçosa, Viçosa municipality, Minas Gerais state, Brazil.

¹Programa de Pós-graduação em Biologia Animal, Departamento de Biologia Animal, Universidade Federal de Viçosa, Viçosa, MG, Brazil.

²Universidade Federal de Minas Gerais, Departamento de Zoologia, Laboratório de Herpetologia, Avenida Antônio Carlos, 6627, Pampulha. 31270-901. Belo Horizonte, MG, Brazil.

³EcoaFlora Projetos e Consultoria Ambiental LTDA, Rua Ivan Lins, 828, Belo Horizonte, Minas Gerais, Brazil.

⁴Departamento de Sistemática e Ecologia, Centro de Ciências Exatas e da Natureza, Universidade Federal da Paraíba, João Pessoa, PB, Brazil.

*Corresponding author e-mail: elvisaps@hotmail.com

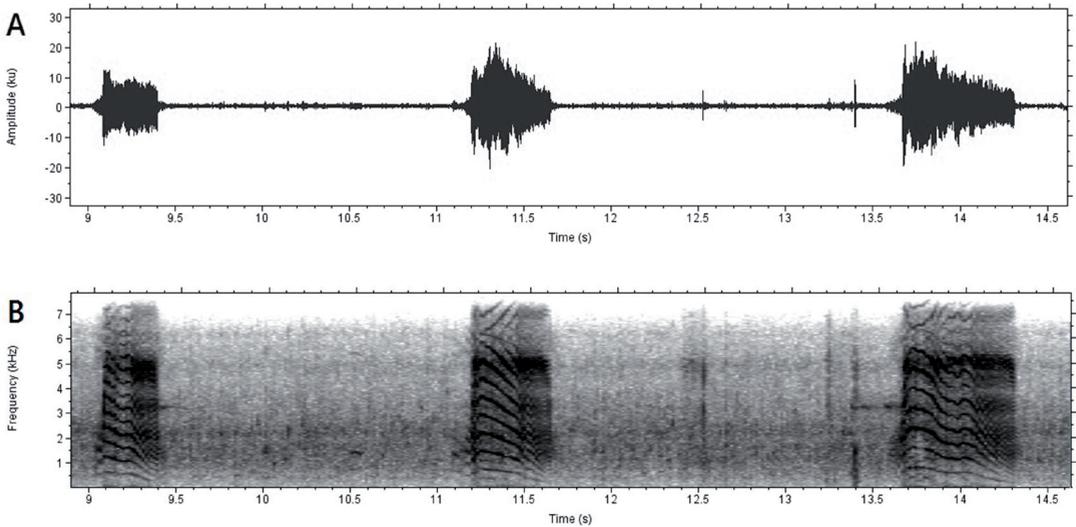


Figure 1. Distress call of a male *Bokermannohyla circumdata* from Floresta Estadual Uaimii, municipality of Ouro Preto, southeastern Brazil: (A) oscillogram and (B) audiospectrogram of three calls (air temperature = 18.6 °C).

The distress call of *Bokermannohyla circumdata* was emitted with open mouth, and consists of a single, harmonic, not pulsed note with duration of 0.36–0.76 s (mean \pm SD = 0.59 s \pm 0.12 s; n=11 calls) (Figure 1), with a descendent frequency modulation, and dominant frequency of 1.89–5.06 kHz (3.80 kHz \pm 1.31 kHz; n=11) ranging from the second to the seventh harmonic.

The distress call of *Bokermannohyla nanuzae* was emitted with open mouth and consists of a single, harmonic, not pulsed note with duration of 0.07–0.10 s (mean \pm SD = 0.09 s \pm 0.02 s; n=4 calls) (Figure 2) with a descendent frequency modulation, and dominant frequency of 2.12–2.19 kHz (2.17 kHz \pm 31.25 kHz) located on the second or third harmonic.

Among the 33 currently known species of *Bokermannohyla*, only four have the distress calls described (Table 1). In comparing our results with those of Toledo & Haddad (2009) some differences arise between distress call durations of male and female *B. circumdata*. The call of the male is shorter (mean = 0.59 s; present work) than female distress call (mean = 0.94 s; Toledo & Haddad 2009). In addition, Toledo & Haddad (2009) showed that distress calls have harmonic bands and are not too high-pitched, with a dominant frequency of 3.97 kHz, being slightly different from the dominant frequency of the male of *B. circumdata* (3.80 kHz).

Similar situation was found when we compared distress calls of *B. nanuzae*, *B. izecksohni* and *B. luctuosa*. The distress call of the male *B. nanuzae* is longer (= 53.5s) than calls of males *B. izecksohni* (= 45.0s) and *B. luctuosa* (= 49.1s) (Toledo & Haddad 2009).

The snout-vent-length is negatively correlated with dominant frequency of frog distress calls (Toledo & Haddad 2009). However, this seems not to be corroborated here for *B. circumdata*, since the male reported by us is smaller than the female reported by Toledo & Haddad (2009) (male MZUFV 10575, SVL = 57.7 mm; female, SVL = 66.5 mm; Toledo & Haddad 2009), but had a lower dominant frequency (3.80 kHz) than that of the female (3.97 kHz; Toledo & Haddad 2009). The dominant frequency of distress calls in *B. circumdata* may be an example of a sexually dimorphic trait. On the other hand, the male *B. nanuzae* reported here (MZUFV 9721, SVL = 53.5 mm) is larger than males of *B. izecksohni* and *B. luctuosa* (CRC = 45.0 mm and CRC = 49.1 mm respectively; Toledo & Haddad 2009), but its mean dominant frequency was smaller (2.17 kHz) than those of *B. izecksohni* (3.75 kHz) and *B. luctuosa* (3.35 kHz; Toledo & Haddad 2009) (Table 1), apparently confirming the findings of Toledo & Haddad (2009) about the influence of the snout vent length on anuran distress calls. Nevertheless, as we had a limited

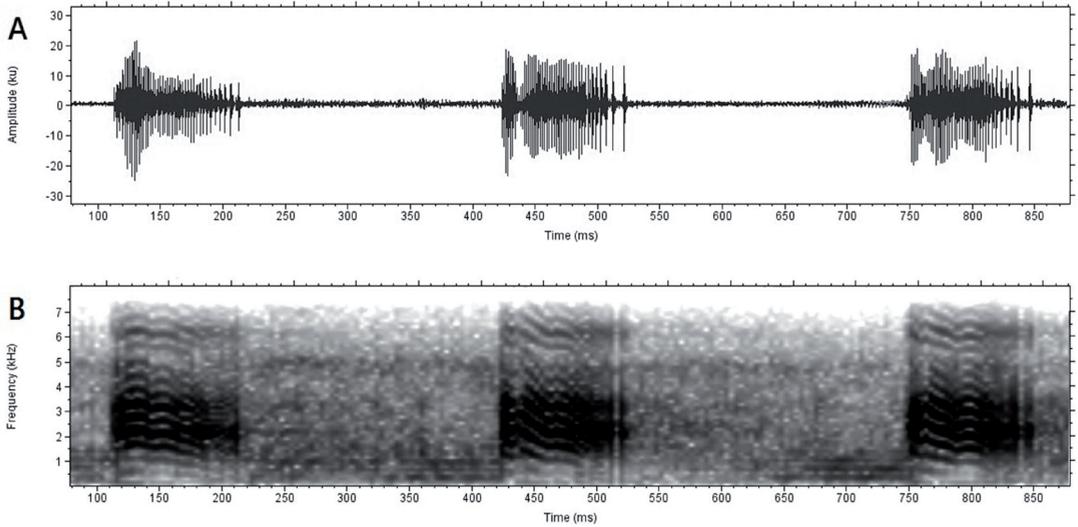


Figure 2. Distress call of a male *Bokermannohyla nanuzae* from Floresta Estadual Uaimii, municipality of Ouro Preto, southeastern Brazil: (A) oscillogram and (B) audiospectrogram of three calls (air temperature not available).

number of specimens recorded it is not possible to draw a solid conclusion about this subject.

Several anuran species still remain without any information about their defensive strategies, particularly distress call structure. Such studies are important because they generate data for further work aimed

at understanding the patterns and functions of such behaviors, as in predator-prey interactions. The data presented here, reinforce the hypothesis that distress calls can be used for taxonomic and phylogenetic inferences, as proposed by Toledo & Haddad (2009) and Figueiredo-de-Andrade et al. (2010).

Table 1. Distress calls described for *Bokermannohyla*. Values are presented as mean \pm SD (range).

Taxa	SVL (mm)	Notes/call	Call Duration (sec)	Dominant Frequency (kHz)	Dominant Harmonic	Temperature of the air (C°)	Reference
<i>B. circumdata</i> (3 females/17 calls)	66.5	1	0.94 \pm 0.32 (0.44 – 1.40)	3.97 \pm 1.22 (1.38 – 5.43)	3-8	20	Toledo and Haddad (2009)
<i>B. circumdata</i> (1 male/11 calls)	57.7	1	0.59 \pm 0.12 (0.36 – 0.76)	3.81 \pm 1.31 (1.88 – 5.06)	2-7	18.6	Present work
<i>B. hylax</i> (1 male/10 calls)	58.2	1	1.17 \pm 0.30 (0.71 – 1.64)	3.17 \pm 0.99 (1.81 – 4.48)	2-7	21	Toledo and Haddad (2009)
<i>B. izecksohni</i> (1 male/7 calls)	45.0	1	0.79 \pm 0.26 (0.55 – 1.28)	3.75 \pm 1.61 (2.76 – 7.06)	2-3	22	Toledo and Haddad (2009)
<i>B. luctuosa</i> (1 male/8 calls)	49.1	1	1.01 \pm 0.22 (0.82 – 1.36)	3.35 \pm 0.31 (3.10 – 3.96)	5-6	23.5	Toledo and Haddad (2009)
<i>B. nanuzae</i> (1 male/4 calls)	53.5	1	0.09 \pm 0.01 (0.07 – 0.10)	2.17 \pm 31.25 (2.12 – 2.19)	2-3	Not available	Present work

Acknowledgements. We thank João Vitor Lacerda for comments on the manuscript.

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