On the advertisement call of *Bokermannohyla oxente* Lugli and Haddad, 2006 (Anura, Hylidae)

O canto de anúncio de *Bokermannohyla oxente* Lugli and Haddad, 2006 (Anura, Hylidae)

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Considering a new sample of calls of *Bokermannohyla oxente*, we revisited its call description and acoustic diagnosis. Four males were recorded in Piatã (Bahia, Brazil). Calls were composed of a single note emitted in sequences which could be long (up to 25 s). Notes were composed by a discrete weak/short initial prefix slightly separated from a second strong/long part; besides fundamental (= dominant), 2–3 other harmonically related bands were found. No prefix or harmonic structure were previously reported to *B. oxente*. Our record extends about 50 km the distribution of the species to west. The call of *B. oxente* is particular by having the weak/short initial prefix. *Bokermannohyla juiju* and *B. oxente* share the differential feature of releasing calls at high rates and in long sequences. *Bokermannohyla itapoty* also seems to have a higher dominant frequency than *B. oxente*.

**Keywords:** vocalization; taxonomy; species diagnosis; geographical distribution; *Bokermannohyla pseudopseudis* species group

Considering-se uma nova amostra de cantos de *B. oxente*, revisitamos sua descrição de canto e diagnose acústica. Quatro machos foram gravados em Piatã (Bahia, Brasil). O canto é composto de uma única nota emitida em sequências que podem ser longas (até 25 segundos). As notas são compostas por um prefixo inicial discreto, fraco e curto, ligeiramente separado de uma segunda parte, mais longa e forte; além da fundamental (= dominante) encontramos 2–3 outras bandas harmônicas. A presença do prefixo e de harmônicos ainda não eram conhecidas para *B. oxente*. Nossa amostra também estende cerca de 50 km a distribuição da espécie para o oeste. O canto de *B. oxente* é particular por ter o prefixo fraco/curto inicial. *Bokermannohyla juiju* e *B. oxente* compartilham uma característica diferencial de cantar em taxas elevadas e em sequências longas. *Bokermannohyla itapoty* também parece ter uma maior frequência dominante do que *B. oxente*.

**Palavras chave:** vocalização; taxonomia; diagnose específica; distribuição geográfica; grupo de espécies de *Bokermannohyla pseudopseudis*

**Introduction**

Among frogs, the advertisement call is a species-specific signal involved in mating recognition with well-established applications in taxonomy.[1,2] *Bokermannohyla oxente* Lugli and Haddad, 2006 [3] was described from localities in the Chapada Diamantina (Bahia, Brazil) and presently is placed in the *B. pseudopseudis* species group (sensu Faivovich et al. [4]). Its advertisement call was described along with the species [3] based on analogical recordings of two males. Considering the availability of a new sample of calls of *B. oxente*, we revisited its call description and acoustic diagnosis and found that an improvement of both is necessary, what we intend to provide here.

**Methods**

Four males were recorded in Piatã (Chapada Diamantina, Bahia, Brazil; 80 km southwest from type locality) in 4–6 January 2013 between 19:36 and 21:10 h. Calls were recorded with a Marantz PMD 671 (Sennheiser ME67/K6 microphone) or a MicroTrack (ME66/K6 microphone), all set to 44.1 or 48 kHz sampling rate and 16-bit resolution. Call records were performed from close range (100–300 cm) from calling males. Acoustic variables were analyzed with Raven Pro 1.5, 64-bit version [5]; terminology for call features were mostly according to Raven’s manual. A 200-Hz high-pass band filter was applied for call analyses and figuring. Sound figures were obtained with Seewave 1.6.4 [6] R package, [7] v. 3.2.2, settings were Hanning window, 85% overlap, and 256 points resolution.

Lugli and Haddad [3] recognized calls of *B. oxente* as composed by longer (20–58) and shorter (17–37 ms) notes but considering the overlap which precludes objective classification and that we did not find such variability in our sample, we avoided such differentiation.
B. juiju Faivovich, Lugli, Lourenco and Haddad, 2009 (call described in [8]), we think that, to B. oxente, taking individual notes as the call is in closer accordance with the mechanistic definition of call in frogs,[9,10] Measured call (= note; = prefix + suffix + interval) features were: (1) prefix and (2) suffix durations; (3) prefix–suffix interval; (4) note interval, (5) peak frequency; (6) lower frequency; (7) higher frequency; and (8) note rate (considering sections of 5 or 10 s of active calling). Descriptive statistics was based in mean values of individual males.

Examined voucher specimens and recorded calls are in the collection of frogs of the Universidade Federal de Uberlândia (AAG-UFU) (Appendix 1). We tried to reanalyze the original records of Lugli and Haddad [3] but they are apparently lost (C.F.B. Haddad pers. comm.). A footage of a B. oxente calling male by Herpetoorg (youtube.com/user/Herpetoorg) is available in: youtube.com/watch?v=40kZ8qP2hrM.

Results

Adult male specimens from our study site (Piatã, Bahia) in Figure 1.

Advertisement call. Table 1 and Figure 2. Call composed of a single note. Notes emitted in sequences of variable length, which could be very long (up to 220 notes, 25 s). The first 2–5 (introductory) notes could be weaker (lower amplitude) than the remaining ones; after introduction, notes varied just slightly in amplitude regarding one another. Notes were composed by a discrete weak/short prefix slightly separated from a second unpulsed strong/long part, here called suffix; besides fundamental (= dominant), 2–3 other harmonically related bands could be noticed.

Discussion

Lugli and Haddad [3] found no prefix or harmonic structure in their call sample of B. oxente, in which they were followed by Taucce et al. [8]. The differences in relation to our sample can be attributed to eventualities such as background noise, large distances of males from microphones, undesired effects resulting from digitalization and/or settings for figuring. The presence of the prefix is particularly problematic because it is very weak and

| Feature (=call) duration (ms) | Present work Mean (range) | SD | Original description Range |
|-------------------------------|---------------------------|----|---------------------------|
| Note (call) duration (ms)     | 40.5 (29.8–54.5)          | 10.41 | 17.4–57.6 |
| Prefix duration (ms)          | 4.36 (4.10–4.55)          | 0.19 | – |
| Prefix-suffix interval (ms)   | 3.29 (2.35–4.55)          | 1.07 | – |
| Suffix duration (ms)          | 32.4 (20.7–47.8)          | 11.28 | – |
| Note interval (ms)            | 79.7 (58.7–94.8)          | 15.14 | 71.5–124.5 |
| Call rate (notes/min)         | 510 (438–552)             | 51.15 | 533* |
| Lower frequency (kHz)         | 0.713 (0.692–0.743)       | 0.022 | – |
| Higher frequency (kHz)        | 1.795 (1.703–1.900)       | 0.086 | – |
| Peak frequency (kHz)          | 1.327 (1.312–1.369)       | 0.028 | 1.0–1.9 |
| Longer call sequence (s)      | 25                        | 1.2–7.2 | |
| Harmonics                     | 2–3                      | 0     | |
| Temperature (ºC)              | 22–23 air – 22 water      | 22.5 air | |

*Estimated according their Figure 4A.
could quite easily be missed during recording or analyses. Despite these differences, we have no reason to doubt our attribution of calls to *B. oxente* as call duration, dominant frequencies and call rate are in agreement between samples. Accordingly, besides call, our specimens are also in agreement with *B. oxente* description (data not shown). Our sample from Piatã extends about 50 km the known distribution of the species to the west.

Comparisons of the advertisement call of several species of *Bokermannohyla* are in Carvalho et al. [11,12] and in Tauce et al. [8]. According to our data, the call of *B. oxente* is particular by having the weak prefix. Our call redefinition to *B. oxente* turns it more similar to that of *Bokermannohyla juiju* and *B. itapoty* Lugli and Haddad, 2006 [13] than previously thought. *Bokermannohyla juiju* and *B. oxente* share the differential feature of releasing calls in long sequences and at high rates, with *B. oxente* being even faster (4 times). The syntopic *B. itapoty* also seems to have a higher dominant frequency (1680–3300 Hz,[13] than *B. oxente* (peak at 1300 Hz).

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Appendix 1. Examined material

(A) Call recordings from the A. A. Giaretta record files (N = 4 males);
   BokermoxentePiataBA1a-cAAGm671.wav;
   BokermoxentePiataBA2a-bAAGm671.wav (voucher AAG-UFU 1684);
   BokermoxentePiataBA3aLBM_AAGmt.wav;
   BokermoxentePiataBA4a-bLBM_AAGmt.wav (voucher AAG-UFU 1685).