

## Correspondence

## The fight call of *Bokermannohyla ibitiguara* (Anura: Hylidae): first record for the genus

RENATO C. NALI<sup>1</sup> & CYNTHIA P. A. PRADO<sup>2</sup>

<sup>1</sup>) Programa de Pós-graduação em Ciências Biológicas (Zoologia), Universidade Estadual Paulista “Júlio de Mesquita Filho”, Rio Claro, São Paulo, Brazil

<sup>2</sup>) Departamento de Morfologia e Fisiologia Animal, FCAV, Universidade Estadual Paulista “Júlio de Mesquita Filho”, Jaboticabal, São Paulo, Brazil

Corresponding author: RENATO C. NALI, e-mail: r\_nali@yahoo.com.br

Manuscript received: 26 April 2013

Accepted: 22 January 2014 by DENNIS RÖDDER

The description of different call types emitted by male frogs is very important in terms of behaviour and evolution, as mating systems and sexual selection appear to be directly associated with male calling activity (LEA et al. 2000, MURPHY & GERHARDT 2002, RYAN & RAND 2003). Calling in frogs plays several roles in social organisation, such as recruitment of individuals to the chorus, female attraction, and territory and space maintenance between males, thus individuals of the same species may emit different types of call according to the social context (WELLS 2007). The advertisement call, the most common type, is considered a pre-zygotic isolating mechanism, preventing hybridisation (HADDAD et al. 1994). Moreover, many species exhibit advertisement call plasticity in that males emit different parts of the call in the presence of predators or females (e.g., RYAN 1985) in an attempt to resolve the conflict between reproductive success (i.e., female attraction) and predation risks.

The aggressive call may also be a plastic trait, with a male being able to gradually increase the number of notes in response to an intruding male approaching his territory (e.g., MARTINS et al. 1998). In those social interactions, the intruder might either go away or engage in physical combats (e.g., MARTINS et al. 1998, TOLEDO & HADDAD 2005, GIASON & HADDAD 2006). In the latter case, fight calls are generally emitted by at least one of the males engaged in the combat (e.g., MARTINS & HADDAD 1988, BASTOS & HADDAD 2002, DAUTEL et al. 2011). Between the first sight of the intruding male and the fight itself, there might be graded aggressive calls (sensu WELLS 1988), culminating in a fight call.

*Bokermannohyla ibitiguara* (CARDOSO, 1983) is currently placed within the *B. pseudopseudis* species group (FAIVOVICH et al. 2005, FROST 2013). It is a hylid frog endemic to

the Brazilian Cerrado, occurring in the Serra da Canastra National Park and surroundings in forest fragments in Minas Gerais state, southeastern Brazil (CARDOSO 1983, HADDAD et al. 1988, NALI & PRADO 2012). Although the species is very common in its area of occurrence, its basic biology is still poorly known (see NALI & PRADO 2012), being classified as “Data Deficient” by the IUCN (CARAMASCHI & ETEROVICK 2004). Males have a well-developed prepollex spine, establish territories along streams, and engage in physical combats with other males (NALI & PRADO 2012). Their advertisement call is composed of long and short notes (CARDOSO 1983, CARVALHO et al. 2012), with the latter ones functioning as a territorial signal (NALI & PRADO 2014).

On 18 January 2011, we observed a male–male fight (NALI & PRADO 2012, Fig. 1) in a permanent stream (20°16'21.9" S, 47°04'24.5" W, 677 m altitude) in the municipality of Sacramento, Minas Gerais state, southeastern Brazil, located ca. 100 km in a straight line from the type locality (Fazenda Salto, Alpinópolis, CARDOSO 1983). During the fight, both males emitted fight calls, which were recorded with a Marantz Professional PMD-660 digital recorder with an unidirectional microphone Sennheiser ME66 at 16-bit resolution and 44100 Hz sampling rate. The analyses were performed using the software Raven Pro 1.3 (Cornell Lab of Ornithology), 512 points resolution (FFT), brightness = 80, and contrast = 80. The acoustic terminology follows MARTINS & JIM (2003). Both males (CFBH31756 and CFBH31757) were collected and deposited in the Célio F. B. Haddad Amphibian collection, Universidade Estadual Paulista, Rio Claro, São Paulo state, Brazil.

Each of the males engaged in the fight emitted only one type of note (notes A and B, respectively, Tab. 1, Fig. 2).

Both notes were commonly emitted simultaneously, without antiphony or any other recognizable pattern in the repetition rates of both notes, precluding inference of which male emitted note A and which emitted note B. Note A is to some extent similar to the long note of the advertisement call (CARVALHO et al. 2012, NALI & PRADO 2014), but note B is different from any other notes previously described for this species, as it sounds like a whine and shows no pulse structure (Fig. 2). Although the recording includes the noise of running water in the background, we managed to isolate four notes A and four notes B in a segment of 10 seconds, from which we measured the following parameters: (1) note duration (s); (2) minimum frequency (Hz); (3) maximum frequency (Hz); (4) dominant frequency (Hz); (5) note repetition rate (N notes/10s), and (6) pulse structure (Tab. 1).

Fight calls during male agonistic interactions have been reported for other frog species (see below), but ours appears to be the first description of this type of call for the genus *Bokermannohyla*. The two types of notes recorded during the fight between *B. ibitiguara* males had lower dominant frequencies compared to the advertisement call (CARVALHO et al. 2012, NALI & PRADO 2014), similar

to the *Centrolene lynchi* fight call, a centrolenid found in Colombia and Ecuador (DAUTEL et al. 2011). However, in the latter case, only one of the males emitted the fight call, whereas in *B. ibitiguara* calls were emitted by both males. Other Brazilian hylids in which fight calls are emitted by both males during the combat include *Hypsiboas faber* (MARTINS & HADDAD 1988, MARTINS et al. 1998), *Scinax fuscomarginatus* (TOLEDO & HADDAD 2005), *S. rizibilis* (BASTOS & HADDAD 2002), and *Dendropsophus elegans* (BASTOS & HADDAD 1995). *Hypsiboas faber* emitted two types of notes, similar to *B. ibitiguara*, but *S. fuscomarginatus* emitted only one type. Like *B. ibitiguara*, males of *S. fuscomarginatus* and *S. rizibilis* emitted fight call notes at irregular intervals, while in *H. faber*, such notes were emitted alternately by the males. Males of the leptodactylid frog *Physalaemus centralis* emit a fight call with a similar pattern to that of *B. ibitiguara*: each type of note is emitted by one male, one note similar to the advertisement call and the other very different (BRASILEIRO 1998). However, this fight call was not emitted when males were actually in physical combat, which was not observed, but rather when they were very close to each other (0.15 m, BRASILEIRO 1998). It is known that the emission of calls during fights



Figure 1. Males of *Bokermannohyla ibitiguara* engaging in a fight, municipality of Sacramento, state of Minas Gerais, 18 January 2011. During the fight, males emitted notes described here as a fight call.

Table 1. Bioacoustic parameters of the fight calls emitted by *Bokermannohyla ibitiguara* males, recorded on 18 January 2011, municipality of Sacramento, Minas Gerais state, Southeastern Brazil. We analysed four notes A and four notes B in a segment of 10 seconds, and results are shown as mean  $\pm$  standard deviation (min–max). Air temperature = 21°C, water temperature = 22°C, voucher specimens: CFBH31756 (SVL = 38.75 mm) and CFBH31757 (SVL = 41.6 mm); we could not determine which male emitted note A and which emitted note B.

	Note A (individual 1)	Note B (individual 2)
Note duration (s)	0.85 $\pm$ 0.18 (0.70–1.11)	0.35 $\pm$ 0.03 (0.32–0.38)
Minimum frequency (Hz)	563.0 $\pm$ 80.2 (477.1–667.9)	676.8 $\pm$ 35.9 (644.1–722.8)
Maximum frequency (Hz)	2767.0 $\pm$ 190.2 (2518.9–2957.8)	1825.8 $\pm$ 57.4 (1758.1–1888.7)
Dominant frequency (Hz)	1248.9 $\pm$ 469.2 (861.3–1808.8)	1313.5 $\pm$ 325.1 (861.3–1636.5)
Note repetition rate (N notes/10s)	6	14
Pulse structure	Groups of pulses	No pulses

might attract predators guided by sound (MARTINS et al. 1993) and represents an energy expenditure that could otherwise be used to attract females (KLUGE 1981). However, for the territorial treefrog *B. ibitiguara*, this is probably the final part of a gradually increasing aggressive behaviour (NALI & PRADO 2014) that accompanies the actual combat action. Further studies might focus on the exact function of the fight call in this species.

The description of the fight call of *B. ibitiguara* more than 30 years after the species' description is only one example of how poor our knowledge on the basic biology of Brazilian anurans is. Brazil has the richest anuran fauna (SEGALLA et al. 2012), with an endemism rate that exceeds 60% (VASCONCELOS & ROSSA-FERES 2005), and in the past

decades, species descriptions have significantly increased (ARAÚJO et al. 2009). On the other hand, information on basic biology and behaviour unfortunately does not follow at the same rate. It is urgently necessary that researchers focus on the basic biology of species, such as calling activity and behaviour, and contribute effectively to enhancing the knowledge of Brazil's huge biodiversity.

#### Acknowledgements

We thank C. F. B. HADDAD and D. RÖDDER for providing valuable suggestions on the manuscript. R. C. NALI is grateful to the CNPq (proc. 130737/2010-0) and São Paulo Research Foundation (FAPESP proc. 2010/03656-6) for the graduate fellowships.

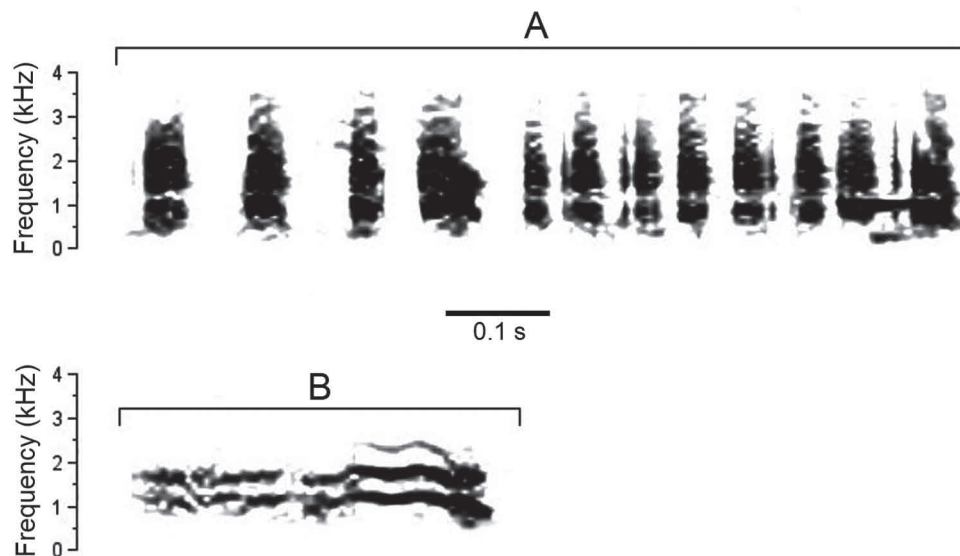


Figure 2. Spectrograms of the fight call notes of *B. ibitiguara* males. Notes A were recorded from one individual and notes B from the other engaged in the same fight. Voucher specimens: CFBH31756 (SVL = 38.75 mm) and CFBH31757 (SVL = 41.6 mm), FFT = 512, air temperature = 21°C, water temperature = 22°C.

C. P. A. PRADO acknowledges the CNPq (proc. 471106/2010-0) and São Paulo Research Foundation (FAPESP proc. 2009/12013-4) for their financial support. The authors are also grateful to the Neotropical Grassland Conservancy for field equipment donation. Capture of individuals was authorized by the Chico Mendes Institute for Biodiversity Conservation (ICMBio) under license # 23240-1.

### References

- ARAÚJO, O. G. S., L. F. TOLEDO, P. C. A. GARCIA & C. F. B. HADDAD (2009): The amphibians of São Paulo State, Brazil amphibians of São Paulo. – *Biota Neotropica*, **9**: 197–209.
- BASTOS, R. P. & C. F. B. HADDAD (1995): Vocalizações e interações acústicas de *Hyla elegans* (Anura, Hylidae) durante a atividade reprodutiva. – *Naturalia*, **20**: 165–176.
- BASTOS, R. P. & C. F. B. HADDAD (2002): Acoustic and aggressive interactions in *Scinax rizibilis* (Anura: Hylidae) during the reproductive activity in southeastern Brazil. – *Amphibia-Reptilia*, **23**: 97–104.
- BRASILEIRO, C. A. (1998): Biologia reprodutiva de *Physalaemus centralis* (Anura, Leptodactylidae) em Cachoeira das Emas, Pirassununga – SP. Unpublished Master's dissertation, Universidade Estadual de Campinas, Campinas.
- CARAMASCHI, U. & P. C. ETEROVICK (2004): *Bokermannohyla ibitiguara*. – in: IUCN (2011): IUCN Red List of Threatened Species. Version 2011.2. – <http://www.iucnredlist.org>. Downloaded on 27 February 2012.
- CARDOSO, A. J. (1983): Descrição e biologia de uma nova espécie de *Hyla* Laurenti, 1768 (Amphibia, Anura, Hylidae). – *Iheringia. Série Zoologia*, **62**: 37–45.
- CARVALHO, T. R., A. A. GIARETTA & L. MAGRINI (2012): A new species of the *Bokermannohyla circumdata* group (Anura: Hylidae) from southeastern Brazil, with bioacoustic data on seven species of the genus. – *Zootaxa*, **3321**: 37–55.
- DAUTEL, N., A. L. S. MALDONADO, R. ABUZA, H. IMBA, K. GRIFFIN & J. M. GUAYASAMIN (2011): Advertisement and combat calls of the glass frog *Centrolene lynchi* (Anura: Centrolenidae), with notes on combat and reproductive behaviors. – *Phyllomedusa*, **10**: 31–43.
- FAIVOVICH, J., C. F. B. HADDAD, P. C. A. GARCIA, D. R. FROST, J. A. CAMPBELL & W. C. WHEELER (2005): Systematic review of the frog family Hylidae, with special reference to Hyliinae: phylogenetic analysis and taxonomic revision. – *Bulletin of the American Museum of Natural History*, **294**: 1–294.
- FROST, D. R. (2013): Amphibian species of the world: an online reference. Version 5.6 (9 January 2013). – <http://research.amnh.org/vz/herpetology/amphibia>. Last accessed on 15 January 2014.
- GIASSON, L. O. M. & C. F. B. HADDAD (2006): Social interactions in *Hypsiboas albomarginatus* (Anura: Hylidae) and the significance of acoustic and visual signals. – *Journal of Herpetology*, **40**: 171–180.
- HADDAD, C. F. B., G. V. ANDRADE & A. J. CARDOSO (1988): Anfíbios anuros do Parque Nacional da Serra da Canastra, estado de Minas Gerais. – *Brasil Florestal*, **64**: 9–20.
- HADDAD, C. F. B., J. P. POMBAL-JR & R. F. BATISTIC (1994): Natural hybridization between diploid and tetraploid species of leaf-frogs, genus *Phyllomedusa* (Amphibia). – *Journal of Herpetology*, **28**: 425–430.
- KLUGE, A. G. (1981): The life history, social organization and parental behavior of *Hyla rosenbergi* Boulenger, a nest-building gladiator frog. – *Miscellaneous Publications Museum of Zoology University of Michigan*, **160**: 1–170.
- LEA, J., T. HALLIDAY & M. DYSON (2000): Reproductive stage and history affect the phonotactic preferences of female midwife toads, *Alytes muletensis*. – *Animal Behaviour*, **60**: 423–427.
- MARTINS, I. A. & J. JIM (2003): Bioacoustic analysis of advertisement call in *Hyla nana* and *Hyla sanborni* (Anura, Hylidae) in Botucatu, São Paulo Brazil. – *Brazilian Journal of Biology*, **63**: 507–516.
- MARTINS, M. & C. F. B. HADDAD (1988): Vocalizations and reproductive behavior in the smith frog, *Hyla faber* Wied (Amphibia: Hylidae). – *Amphibia-Reptilia*, **9**: 49–60.
- MARTINS, M., J. P. POMBAL-JR & C. F. B. HADDAD (1998): Escalated aggressive behaviour and facultative parental care in the nest building gladiator frog, *Hyla faber*. – *Amphibia-Reptilia*, **19**: 65–73.
- MARTINS, M., I. SAZIMA & S. G. ENGLER (1993): Predators of the nest building gladiator frog, *Hyla faber*, in southeastern Brazil. – *Amphibia-Reptilia*, **14**: 307–309.
- MURPHY, C. G. & H. C. GERHARDT (2002): Mate sampling by female barking treefrogs (*Hyla gratiosa*). – *Behavioral Ecology*, **13**: 472–480.
- NALI, R. C. & C. P. A. PRADO (2012): Habitat use, reproductive traits and social interactions in a stream-dweller treefrog endemic to the Brazilian Cerrado. – *Amphibia-Reptilia*, **33**: 337–347.
- NALI, R. C. & C. P. A. PRADO (2014): Complex call with different messages in *Bokermannohyla ibitiguara* (Anura, Hylidae), a gladiator frog of the Brazilian Cerrado. – *Journal of Herpetology*, **48**: 407–414.
- RYAN, M. J. (1985): The túngara frog: A study in sexual selection and communication. – Chicago: The University of Chicago Press.
- RYAN, M. J. & A. S. RAND (2003): Sexual selection in female perceptual space: How female túngara frogs perceive and respond to complex population variation in acoustic mating signals. – *Evolution*, **57**: 2608–2618.
- SEGALLA, M. V., U. CARAMASCHI, C. A. G. CRUZ, P. C. A. GARCIA, T. GRANT, C. F. B. HADDAD, & J. LANGONE (2012): Brazilian amphibians – List of species. – *Sociedade Brasileira de Herpetologia*. – <http://www.sbherpetologia.org.br>. Last accessed on 23 April 2012.
- TOLEDO, L. F. & C. F. B. HADDAD (2005): Acoustic repertoire and calling site of *Scinax fuscomarginatus* (Anura, Hylidae). – *Journal of Herpetology*, **39**: 455–464.
- VASCONCELOS, T. S. & D. C. ROSSA-FERES (2005): Diversidade, distribuição espacial e temporal de anfíbios anuros (Amphibia, Anura) na região noroeste do estado de São Paulo, Brasil. – *Biota Neotropica*, **5**: 137–150.
- WELLS, K. D. (1988): The effects of social interactions on anuran vocal behavior. – pp. 433–454 in: FRITZSCH, B., W. WILCZYNSKI, M. J. RYAN, T. HETHERINGTON & W. WALKOWIAK (eds): The evolution of the amphibian auditory system. – New York: Wiley.
- WELLS, K. D. (2007): The ecology and behavior of amphibians. – Chicago: The University of Chicago Press.