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Advertisement call and morphological variation of the poorly known and endemic *Bokermannohyla juiju* Faivovich, Lugli, Lourenço and Haddad, 2009 (Anura: Hylidae) from Central Bahia, Brazil

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Abstract

Bokermannohyla juiju is a member of the *B. martinsi* species group and it was described based on one male specimen. In order to enhance the knowledge about the species, we describe its advertisement call and morphological variation, including for the first time data on females. We also provide additional comments about its natural history, geographic distribution, and conservation. The advertisement call of *B. juiju* consists of a single note, non-pulsed, harmonic structured call emitted several times in a row. Four out of five males were found calling in bromeliads. The female, as it is common in many *Bokermannohyla* species, presents some morphological features not shared with the males, like a non-hypertrophied forearm and less developed prepollex.

Key words: Amphibia, Bioacoustics, Cophomantini, Hylinae, Taxonomy, Espinhaço Range

Introduction

The genus *Bokermannohyla* comprises 33 species (Frost, 2014) of hylid frogs occurring only in the Brazilian Atlantic Forest, Cerrado, and Caatinga domains. It includes four species groups, the *B. circumdata*, *B. claresignata*, *B. martinsi*, and *B. pseudopseudis* groups (Faivovich *et al*. 2005). Bokermann (1965), proposed the *Bokermannohyla martinsi* group based on the presence of an extensive hook-like humeral crest and a bifid distal element of prepollex, to accommodate *B. martinsi* (Bokermann, 1964) and *B. langei* (Bokermann, 1965). Because Faivovich *et al.* (2005) only had *B. martinsi* available for their phylogenetic study of hylid frogs, they could not test the monophyly of this species group. However, relying on the presence of the two morphological character states noted above, they continued to recognize the *B. martinsi* group. Faivovich *et al*. (2009) described *B. juiju* based on a single male specimen (holotype) from Chapada Diamantina, central Bahia, Brazil, with little natural history information. The species lacks a bifid distal element of prepollex, but possesses a hook-like humeral crest. Based on the presence of the latter character state, the authors decided to allocate the species in the *B. martinsi* group.

Recent fieldwork in Chapada Diamantina allowed us to collect additional specimens of *Bokermannohyla juiju*. In this paper, we describe its advertisement call and morphological variation. We also provide additional comments about its natural history, geographic distribution, and conservation.

Material and methods

We recorded six specimens of *Bokermannohyla juiju* at Cachoeira Cachoeirão, Parque Nacional da Chapada Diamantina, municipality of Mucugê, State of Bahia, distant approximately 30 km south of the type locality

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(Stream Gerais da Fumaça, municipality of Palmeiras, state of Bahia; Faivovich *et al.* 2009). We recorded the calls with a Marantz PMD 660 digital recorder coupled to a Sennheiser K6/ ME66 microphone, and carried out at 44100 Hz on 16 bit sampling size. The data were analyzed using the software Raven Pro 64 1.4 Cornell Lab of Ornithology (Bioacoustics Research Program Workstation). The spectrograms were produced with window size of 256 samples, 75% overlap, hop size of 64 samples, DFT of 1024 samples, and window type Hanning. Resolution, contrast and brightness were with default settings. We obtained oscillogram and spectrogram figure using TuneR version 1.0 (Ligges *et al.* 2013) and Seewave version 1.7.3 (Sueur *et al.* 2008) packages of the R platform version 3.0.3, 32-bit version (R Development Core Team, 2014). The spectrograms were produced with window length of 256 samples, 75% overlap, hop size of 64 samples, and window name Hanning. Voucher specimens are housed at Coleção Herpetológica da Universidade Federal de Minas Gerais (UFMG) and recordings were deposited at Coleção Bioacústica da Universidade Federal de Minas Gerais (CBUFMG; Appendix I). The following acoustic parameters were taken: number of notes, note duration (time from the beginning to the end of one note, measured on the oscillogram), dominant frequency (Cocroft & Ryan, 1995), dominant frequency range (frequency band with more energy in the note, measured on the spectrogram), interval between notes (time from the end of one note to the beginning of the adjacent note, measured on the oscillogram), and note rate, which is the total number of notes minus one divided by time from beginning of first note to beginning of last note, measured on the oscillogram (modified from the Cocroft & Ryan, 1995 call rate parameter). Note definition follows Duellman & Trueb (1986). For all parameters we analyzed 60 calls from 6 males (10 calls each). Values are presented as min–max (mean±standard deviation).

We examined one female and five male adult specimens for measurements and morphological comparisons. Measurements were taken to the nearest 0.05 mm with a Digimess digital caliper under a stereomicroscope. For the sake of comparisons, measurements were the same taken by Faivovich *et al*. (2009). The abbreviations used in the measurements are SVL (snout–vent length), HL (head length), HW (head width), TD (tympanum diameter), ED (eye diameter), EN (eye to nostril distance), IN (internarial distance), IO (interorbital distance), THL (thigh length), TL (tibia length), and FL (foot length). Sex was determined by presence of sexual characters, mainly humeral spine and vocal slits (males) and direct observation of the gonads (female).

Results

Advertisement call. The advertisement call consisted of a single note, non-pulsed, harmonic structured call emitted several times in a row (Fig. 1; Tables 1 and 2). Some of our recordings showed *Bokermannohyla juiju* calling for more than three consecutive minutes, reaching approximately 350 consecutive calls (Fig. 1A). Note duration was 47–66 ms (60±5 ms), interval between notes was 322–681 ms (423±72 ms) and dominant frequency range varied between 903–2268 Hz. Within the 60 analyzed calls, we found five values of dominant frequency, 1550.4 Hz, 1593.5 Hz, 1636.5 Hz, 1679.6 Hz, and 1722.7 Hz (each call presents only one value of dominant frequency). Fundamental frequency was the same as dominant frequency. Besides fundamental frequency, we identified three harmonics. The call was emitted at a rate of approximately 2 calls per second.

TABLE 1. Individual variation in the call of *Bokermannohyla juiju*. When there is an interval, data are presented as min–max.

Recording	CBUFMG 359	CBUFMG 361	CBUFMG 367	CBUFMG 368	CBUFMG 370	CBUFMG 371
Number of analyzed calls	10	10	10	10	10	10
Note duration (ms)	50–55	50–64	50–53	50–66	47–61	61–65
Peak frequency (Hz)	1593.5	1636.5	1550.4 and 1593.5	1593.5	1679.6 and 1722.7	1722.7
Dominant frequency range (Hz)	1134–2121	945–2247	924–2121	1029–2184	1029–2226	903–2268
Interval between notes (ms)	443–523	384–411	346–385	462–601	400–681	322–358
Note rate (notes/s)	1.93	2.20	2.39	1.76	1.95	2.49

TABLE 2. Advertisement call of *Bokermannohyla juiju* compared to the calls of *B. martinsi* and the calls of *B. pseudopseudis* group. When there is an interval, data are presented as min–max.

Species	Call characteristics	Number of notes	Note duration (ms)	Dominant frequency (Hz)	Dominant frequency range (Hz)	Interval between notes (ms)	Note rate (notes/s)
B. juiju (present work)	non-pulsed call with harmonic structure	1	47─66	1550.4─ 1722.7	903─2268	320─680	2
B. martinsi (Pinheiro *et al.* 2014) "A" note type	pulsed call with non-harmonic structure	2[a]	49–129	1312.5─ 1687.5	963.7–2077.7	1808–10895[b]	─
B. martinsi (Pinheiro *et al.* 2014) "B" note type	pulsed call with non-harmonic structure	2[a]	350–809	562.5	291.4–986.9	327–1155[c]	─
B. ibitiguara (Carvalho *et al.* 2012) "A" note type	pulsed call with non-harmonic structure	1	435–1208	─	1500–2200	91–3575	─
B. ibitiguara (Carvalho *et al.* 2012) "B" note type	pulsed call with non-harmonic structure	5–10	37–108	─	1500–2200	77–171	─
B. itapoti (Lugli and Haddad, 2006a)	non-pulsed call with non-harmonic structure	16─79	15─53	─	1680─3300	160─1580	─
B. oxente inicial notes (Lugli and Haddad, 2006b)	non-pulsed call with non-harmonic structure	10─60	20.5─57.6	─	1000─1900	101.2─547.8	─
B. oxente middle notes (Lugli and Haddad, 2006b)	non-pulsed call with non-harmonic structure	10─60	17.4─36.8	─	1000─1900	71.5─124.5	─
B. oxente final notes (Lugli and Haddad, 2006b)	non-pulsed call with non-harmonic structure	10─60	17.4─36.8	─	1000─1900	102.4─227.4	─
B. pseudopseudis (Eterovick and Brandão, 2001; Carvalho *et al.* 2013)	non-pulsed call with harmonic structure	9─18	64─122	469─656	400─2400	56.4─132	4
B. sapiranga (Brandão *et al.* 2012; Carvalho *et al.* 2013)	non-pulsed call with harmonic structure	3─8	55─146	500─797	500─797	50─138	─
B. saxicola (Eterovick and Brandão, 2001)	non-pulsed call with harmonic structure	20─25	22─441	─	900─1400	602	8

[a]The call of *Bokermannohyla martinsi* is composed of two types of notes, but sometimes only the "A" note is emitted. For details, see Pinheiro *et al.* 2014

[b]Interval between two consecutive "A" type notes

[c]Interval between one type "A" and one type "B" notes

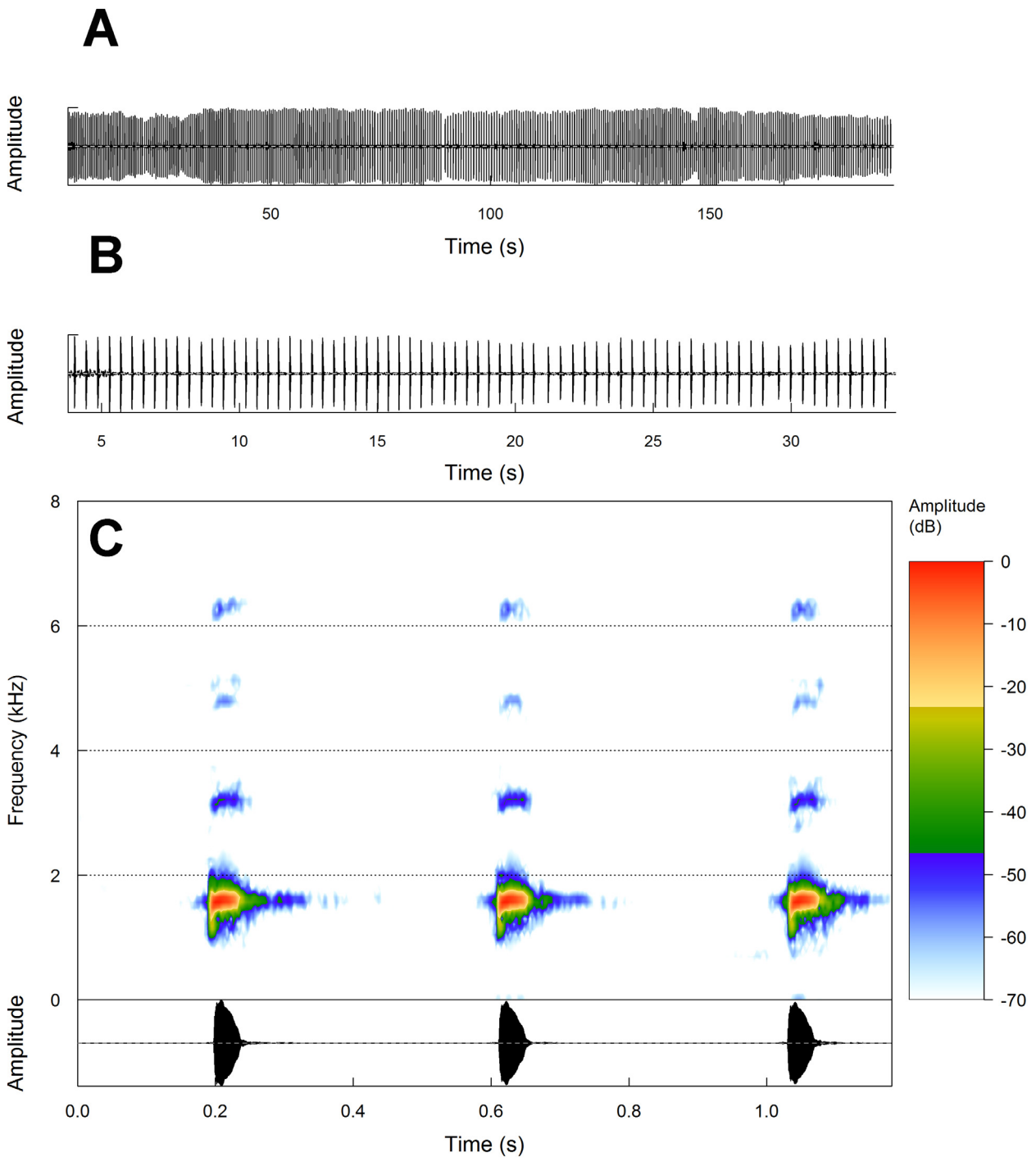

FIGURE 1. Advertisement call of *Bokermannohyla juiju.* (A) Oscillogram of entire recording showing several consecutive calls of *B. juiju*. (B) Oscillogram showing first 30 seconds of the recording. (C) Spectrogram (above) and oscillogram (below) of three consecutive calls of *B. juiju*. Recording CBUFMG 368, 1/22/2010.

Morphological variation. External morphology. Only male specimens were taken into account. Head of similar length and width (HW 84–103% HL); as wide as body to slightly wider than body; HL 34–39% SVL and HW 33–36%SVL. Eyes prominent, its diameter slightly larger than EN. TD 49–61% of ED; supratympanic fold heavily salient, starting behind the eye and extending to the anterior or the posterior margin of the insertion of the arm, covering dorsal margin of tympanic membrane. Vomerine teeth in two slightly curved series posteriorly and between the choanae, each series bears seven to ten (right) and six to ten (left) teeth. Choanae elliptical or kidney-shaped, separated by a distance that vary two to four times its maximum diameter. Tongue ovoid or cordiform, attached overall (narrowly free around margins). Macroscopically evident glandular tissue irregularly distributed

on the mental area, sometimes extending backwards up to the beginning or the middle of the gular region. Male forearms hypertrophied, with a row of tubercles along ventrolateral edge (absent in one individual; UFMG 4996). Fingers webbed basally, with a slight dermal fringe, webbing formula of outer fingers is concordant with the holotype between fingers I, II, and III and highly variable between fingers III and IV, which can be III 3^{-}–$2^{1/2}$ IV (concordant with the holotype), III 3–2 IV, III 3–3^{-} IV, or III 3^{-}–2 IV. Width of disc on Finger III equals tympanum diameter (slightly larger than tympanum diameter in one individual; UFMG 4995). Outer metacarpal tubercle barely or well differentiated, nearly heart shaped and bifid. Hind limbs slender, subtle dermic ridge along the margin of the tarsus (dermic ridge absent in one individual; UFMG 4996), tibia length 52–60% SVL, and foot length 37–44% SVL. Toe webbing formula highly variable: I $1^{1/2}$–2 II or I 2–2 II; II 1^{+}–2 III, II $1^{1/2}$–2^{+} III, II 2–3^{+} III, or II 1–2 III; III 1^{+}–2^{+} IV, III 1^{+}–2 IV, or III $1^{1/2}$–2 IV; and IV 2–1^{+} V or IV 2–1 V. The diagnostic characters for the species, such as large tympanum size with medial inclination and perpendicular bars covering only dorsal surface of the thighs were present in all exemplars. We also observed small spots in anterior and posterior surfaces of the thighs. However, the small spots were over a dark brown background (as quoted in the diagnosis of the species) in only half of the specimens, those having the "A" dorsal pattern (see dorsal pattern subsection below). Those with "B" dorsal pattern presented the small spots over a pale background. We were not able to observe any distal element of prepollex characteristics because we did not take x-ray or diaphanized any of the specimens. Characters described by Faivovich *et al*. (2009) that did not vary in our specimens are omitted.

Color in life. Dorsum and head background of UFMG 4991 light brown with irregularly shaped dark brown blotches, evenly distributed (Fig. 2A). Upper thigh surface with whitish perpendicular bars in a milky brown background. Upper tibia, tarsus, arm, and forearm surfaces light brown with perpendicular dark brown stripes. Upper hand, foot, anterior, and posterior thigh surfaces uniformly milky brown, except for Toe V, which is light brown with perpendicular dark brown stripes. Hand and foot ventral surfaces milky brown. Flanks dark brown with light brown dots. Venter and ventral surfaces of arms, thigh, tibia, and tarsus, cream. Throat cream with dark brown spots. Tympanum dark brown. Iris dark brown with black vermiculation.

Dorsal pattern. Our specimens have two dorsal patterns (Fig. 3): (A) light dorsum with irregularly spaced dark blotches (Fig. 3A) and (B) dark dorsum with irregularly spaced light blotches (Fig. 3B), the latter consistent with the holotype.

Female. Female specimen (UFMG 4992) showed some morphological differences compared to the males (Figs. 3A–D): (1) prepollex and ventral humeral crest lesser developed than in males; (2) non-hypertrophied forearm (hypertrophied in males); (3) non-pigmented gular region (pigmented in males); and (4) vocal slits, vocal sac, and glandular tissue in mental area absent (present in males). We also noted the supratympanic fold in the female is not as developed as in males. The female specimen did not show any marked morphometric difference compared to males (Table 3).

TABLE 3. Some measurements of *Bokermannohyla juiju*. Holotype measurements were taken from Faivovich *et al.* (2009). Measurements were made in millimeters (mm). Abbreviations are presented in the text.

Specimen	MZUEFS 1900 Holotype	UFMG 4992	UFMG 4991	UFMG 4993	UFMG 4994	UFMG 4995	UFMG 4996
Sex	Male	Female	Male	Male	Male	Male	Male
SVL	54.4	52.4	52.1	49.4	50.8	55.1	53.8
HL	18.6	18.8	17.6	19.4	19.0	20.8	19.2
HW	19.2	18.1	18.0	16.2	18.6	19.8	18.3
TD	4.1	3.5	3.4	3.2	3.9	3.4	3.5
ED	6.3	6.6	5.9	6.5	6.3	6.5	6.0
EN	5.5	5.5	5.3	5.8	6.0	6.1	5.9
IN	5.0	4.5	4.4	4.9	4.1	4.7	4.4
IO	3.3	6.7	6.2	6.7	7.4	7.3	6.4
THL	28.2	28.0	28.8	28.0	29.8	28.3	28.9
TL	28.2	28.7	28.8	28.8	30.3	30.6	29.8
FL	22.2	19.2	20.5	21.2	22.5	23.4	20.8

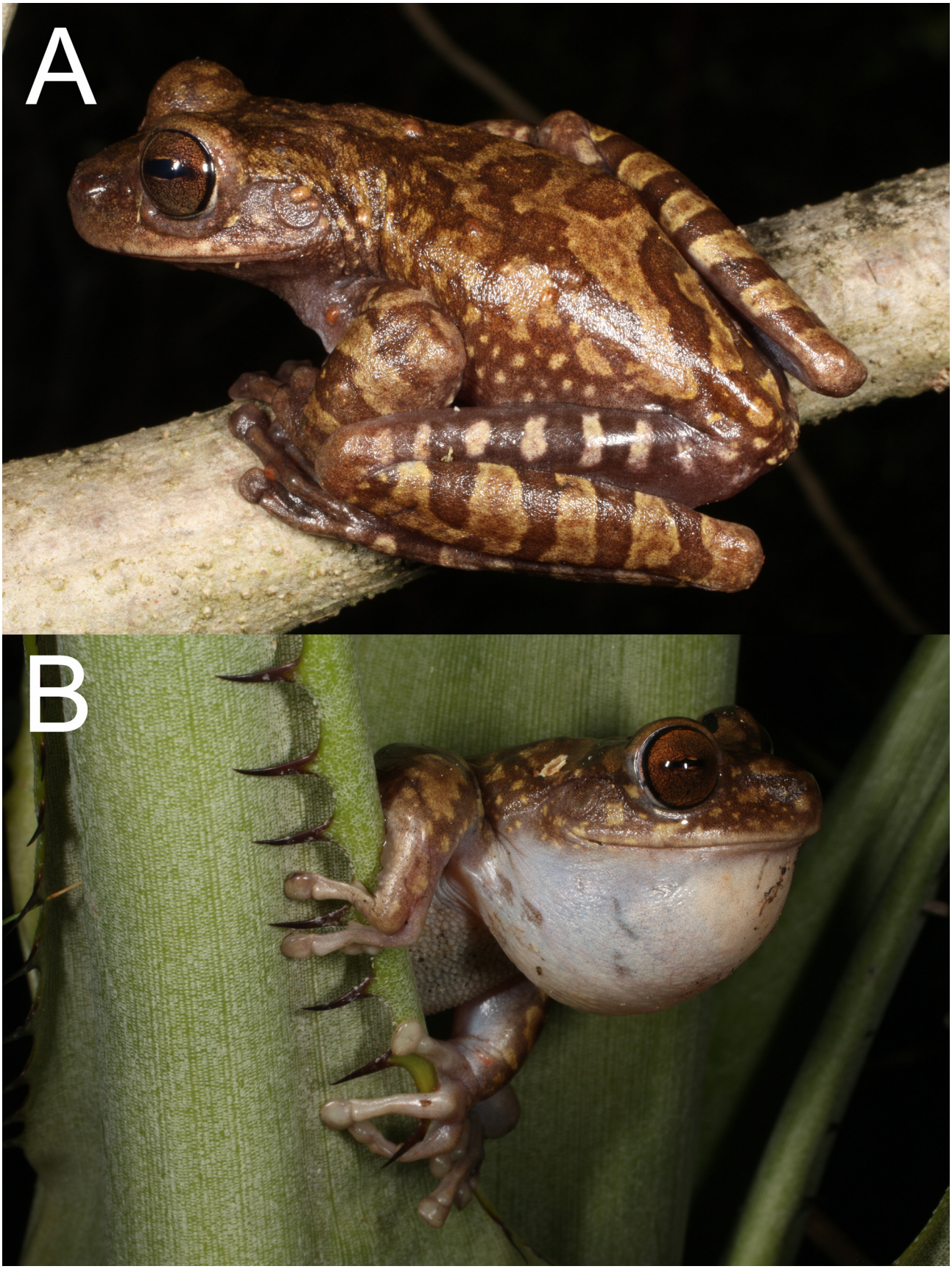

FIGURE 2. Live specimens of *Bokermannohyla juiju*. (A) Adult male (UFMG4991) showing its coloration pattern. (B) Adult male calling in a bromeliad plant. *Photos by F. S. F. Leite.*

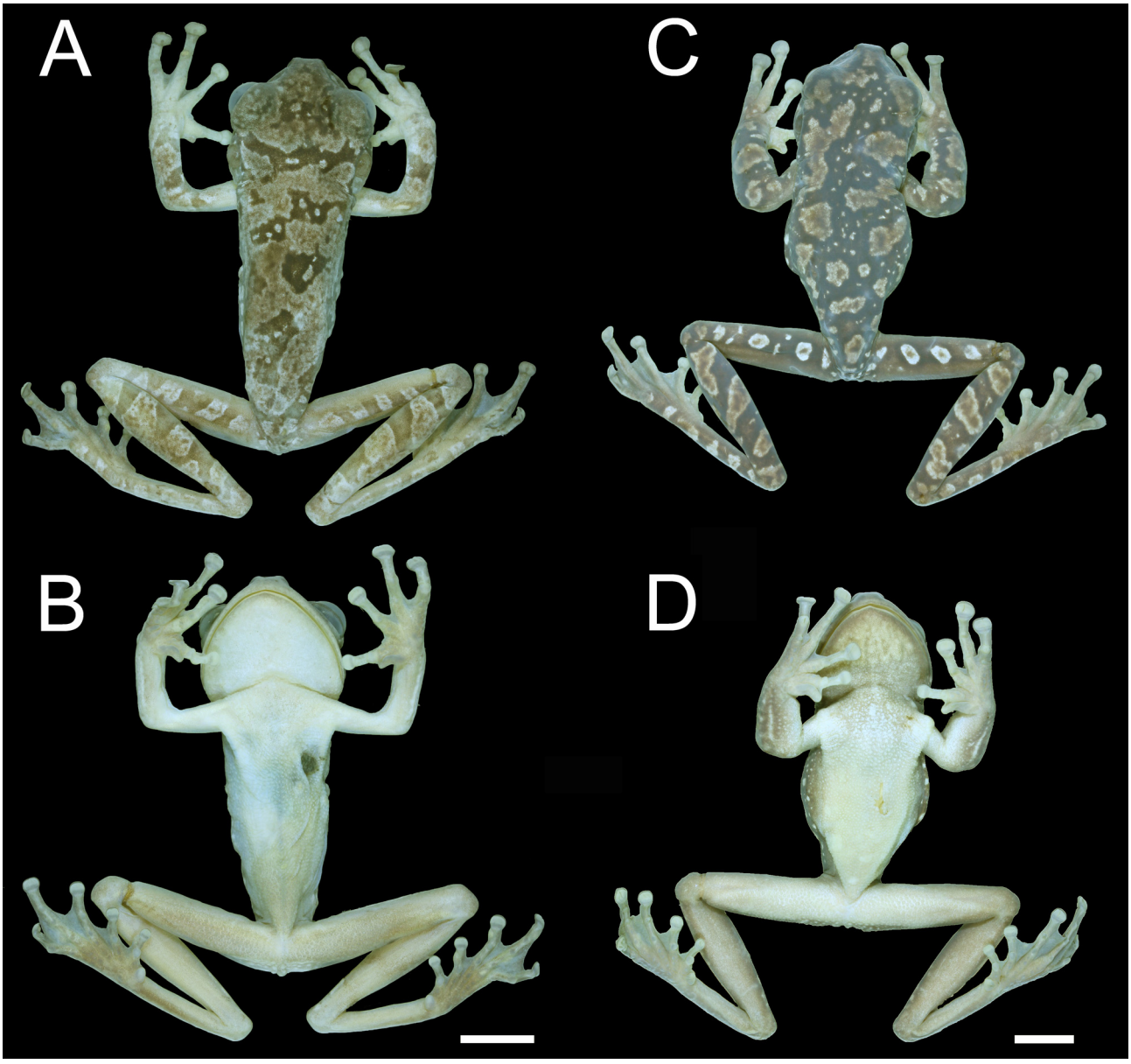

FIGURE 3. Dorsal patterns and sexual dimorphism in *Bokermannohyla juiju*. Dorsal views of (A) female UFMG4992 and (B) male UFMG4995 specimens. Ventral views of (C) female UFMG4992 and (D) male UFMG 4995 specimens, showing some of the characters granting sexual dimorphism in *B. juiju*. Horizontal scale bars equals 10 mm. *Photos by J. S. Parreiras.*

Natural history. *Bokermannohyla juiju* occurs in high-elevation (between 1215–1304 m above sea level) rocky mountain meadows called "*Campos Rupestres*", a typical phytophysiognomy of the Espinhaço Range. For a characterization of the *Campos Rupestres* flora see Stannard (1995) and Vasconcelos (2011). For a characterization of the Espinhaço Range anurofauna see Leite *et al*. (2008). Males called at night. Four out of five males called in epiphytic or rupicolous bromeliads (Fig. 2B) close to small, ephemeral streams on steep mountains slopes or rock outcrops. One male was found calling perched on vegetation 3.5 m from the ground in the gallery forest of a permanent stream. The advertisement call could be heard from a long distance. Males were found in low densities during the beginning of rainy season (December–January).

Discussion

Advertisement call. The call of *Bokermannohyla juiju* differs from the call of most species of the *B. circumdata* group by presenting non-pulsed structure. From those species that also present non-pulsed structure, *B. juiju* differs

by having just one type of note (Table 4). The call of *B. juiju* is shorter than the call of *B. circumdata* from Paranapiacaba (47–66 ms in the former and 335–544 ms in the second), which also presents one type of note and non-pulsed structure (Carvalho *et al.* 2012).

TABLE 4. Main differences between the call of *Bokermannohyla juiju* and the calls of the members of the *B. circumdata* species group.

Species	*B. juiju* (present work)	*B. astartea* (Heyer *et al.* 1990)	*B. capra* (Napoli & Pimenta, 2009)
Pulsed structure	no	yes	yes
Types of notes in advertisement call	1	2	2

Species	*B. hylax* (Heyer *et al.* 1990)	*B. ibitipoca* (Napoli & Caramaschi, 2004)	*B. lucianae* (Napoli & Pimenta, 2003)
Pulsed structure	yes	yes	yes
Types of notes in advertisement call	1	1	2

Species	*B. carvalhoi* (Carvalho *et al.* 2012)	*B. circumdata* (Carvalho *et al.* 2012)	*B. diamantina* (Napoli & Juncá, 2006)	*B. feioi* (Napoli & Caramaschi, 2004)
Pulsed structure	yes	no	yes	yes
Types of notes in advertisement call	1	2	1	2

Species	*B. luctuosa* (Carvalho *et al.* 2012)	*B. nanuzae* (Bokermann e Sazima, 1973; Carvalho *et al.* 2012; Lima *et al.* 2014)	*B. napolii* (Carvalho *et al.* 2012)	*B. sazimai* (Cardoso & Andrade, 1982; Carvalho & Giaretta, 2013)
Pulsed structure	no	yes	no	yes
Types of notes in advertisement call	2	2	2	2

The calls of the *Bokermannohyla pseudopseudis* group are the ones that most resembles the call of *B. juiju*. However, they are characterized by a set of notes, sometimes harmonic, emitted a few times in a row (5–79 times; Eterovick & Brandão, 2001; Lugli & Haddad, 2006a,b; Brandão *et al.* 2012; Carvalho *et al.* 2012; Carvalho *et al.* 2013; Table 2). On the other hand, the call of *B. juiju* is composed of a single note type, harmonic-structured, repeated indefinitely. Although we have not recorded an entire sequence of *B. juiju* calling, one of our records showed *B. juiju* emitting 378 note repetitions in a row, reaching more than three minutes (Fig. 1A). Nevertheless, given that temporal properties are highly temperature-dependent (Gerhardt & Mudry, 1980), and anurans can change their advertisement calls due to social context (Toledo *et al.* 2014), we should see the difference between the calls of *B. juiju* and the calls of the *B. pseudopseudis* species group with caution. The call of *Bokermannohyla juiju* is quite different from the call of *B. martinsi*. The call of *B. juiju* presents one type of note (two types in *B. martinsi*), it has non-pulsed structure (pulsed in *B. martinsi*), and the interval between calls is much shorter than in *B. martinsi* (320–680 ms in *B. juiju* and 1808–10895 ms in *B. martinsi*; Pinheiro *et al.* 2014).

Female. Sexual dimorphism is a common trait in *Bokermannohyla*. The non-hypertrophied forearm and less developed prepollex is also present in females of *B. ahenea* (Napoli & Caramaschi, 2004); *B. capra* Napoli & Pimenta, 2009; *B. caramaschii* (Napoli, 2005); *B. diamantina* Napoli & Juncá, 2006; *B. feioi* (Napoli & Caramaschi, 2004); *B. flavopicta* Leite, Pezzuti, & Garcia, 2012; *B. ibitiguara* (Cardoso, 1983); *B. itapoty* Lugli & Haddad, 2006; *B. izecksohni* (Jim & Caramaschi, 1979; nothing is mentioned about the forearm in the original description of the species, and the specimens we saw did not present this character dimorphic), *B. martinsi*, *B. oxente* Lugli & Haddad, 2006, *B. sagarana* Leite, Pezzuti, & Drummond, 2011, *B. saxicola* (Bokermann, 1964), and *B. pseudopseudis* (Miranda-Ribeiro, 1937; Bokermann, 1964; Jim & Caramaschi, 1979; Cardoso, 1983; Pombal & Caramaschi, 1995; Napoli & Caramaschi, 2004; Lugli & Haddad, 2006a; Lugli & Haddad, 2006b; Napoli & Juncá, 2006; Napoli & Pimenta, 2009; Leite *et al.* 2011; Leite *et al.* 2012). In *B. martinsi,* the ventral humeral crest is also well developed in males and poorly developed in females (Bokermann, 1964).

Poorly or non-pigmented gular region is also reported for *Bokermannohyla sagarana* (Leite *et al*. 2011), and *B. saxicola* (Bokermann, 1964). We also examined male and female specimens of *B. ahenea, B. caramaschi, B. carvalhoi, B. gouveai* (Peixoto & Cruz, 1992)*, B. hylax, B. ibitiguara, B. izecksohni, B. luctuosa,* and *B. martinsi* (appendix I), and pigmented and non-pigmented gular region did not appear to be a sexually dimorphic character. Regarding the absence of the mental glands in the female exemplar and its presence in all five adult males analyzed, it seems to corroborate the considerations of Brizzi *et al*. (2003) and discussed by Faivovich *et al*. (2009), the mental glands may be involved in courtship and mating behavior.

The supratympanic fold less developed in females was also reported for *Bokermannohyla caramaschii* (Napoli, 2005) and for *B. pseudopseudis* (Pombal & Caramaschi, 1995). In other species of *Bokermannohyla* we analyzed (cited above), development degree of the supratympanic fold was not a clear character, varying between and within male and female specimens. Duellman & Campbell (1992) mention the thickness of skin in *Plectrohyla* can be a result of the increase, in number and/or size, of mucous glands. Besides, the preparation of the specimens may also influence the evidence of the supratympanic fold. We think the development of the supratympanic fold could be a fixation artifact, and the sexual dimorphism in this character should be seen with caution in *Bokermannohyla* species.

Geographic Distribution and Conservation. The Espinhaço Range is characterized by high endemic anuran species richness (Leite *et al.* 2008, Carvalho *et al.* 2013), where narrowly distributed anuran species restricted to a single mountain range are usual (e.g. Leite *et al.* 2011; Leite *et al.* 2012; Barata *et al.* 2013). *Bokermannohyla juiju* is known from Serra do Sincorá (Municipalities of Palmeiras and Mucugê), Chapada Diamantina, Espinhaço Range, State of Bahia, northeastern Brazil. The species was not recorded at Serra das Almas, Serra do Itobira and Serra do Bastião (all regional designations of mountain ranges) on the southwestern Chapada Diamantina, suggesting that it is endemic to the highlands of southeastern Chapada Diamantina. The species extent of occurrence measured by a minimum convex polygon (EO, *sensu* IUCN 2001) has only 30.5 km^2. This EO is entirely within the Parque Nacional da Chapada Diamantina (PARNA Chapada Diamatina), a Federal strictly protected area (equivalent to IUCN category II, IUCN 1994) with ca. 1519 km^2, which covers most of the range of the Serra do Sincorá. The species could potentially occur in the entire Serra do Sincorá, in areas above 1000/1100 m a.s.l. The Parque Nacional da Chapada Diamantina is one of Brazilian most sought after places for ecotourism in Brazil. Despite being a protected area, the PARNA Chapada Diamatina is poorly structured and supervised. Therefore, unregulated tourism, irresponsible land use and occupation, and fire (intentional, and from agriculture or native pasture management for cattle breeding) are constant threats to *B. juiju* habitat.

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APPENDIX I. Specimens examined.

***Bokermannohyla juiju*:** BRAZIL: Bahia: Mucugê: UFMG 4991–4996.

***B. ahenea*:** BRAZIL: São Paulo: Areias: CFBH 33896, 33900, 33996, 33997. São José do Barreiro: CFBH 17517, 18111, 18112, 18122, 18123, 19261, 21953, 28796–28799.

***B. caramaschi*:** BRAZIL: Espírito Santo: Alegre: CFBH 25103, 25137. Cariacica: CFBH 22497. Domingos Martins: CFBH 10843, 22845, 22846, 30485, 30486, 32550. Santa Teresa: CFBH 22482–22484, 30685. Vargem Alta: CFBH 25088, 25581–25583.

***B. carvalhoi*:** BRAZIL: Rio de Janeiro: Teresópolis: CFBH 22010, 22011, 24775, 30925–30927, 30936, 30939, 32571.

***B. gouveai*:** BRAZIL: Minas Gerais: Itamonte: 10126, 16677–16680, 16690, 16691, 35016.

***B. hylax*:** BRAZIL: PARANÁ: Morretes: CFBH 21924. SANTA CATARINA: Anitápolis: CFBH 18191–18193. Blumenau: CFBH 27517. Siderópolis: CFBH 25722. Urussanga: CFBH 11255. SÃO PAULO: Cubatão: CFBH 11545. Eldorado: CFBH 12345, 12347, 12349. Ilhabela: CFBH 7756, 10674, 15260–15262, 15265, 15266, 17402. Itatins: CFBH 23695. Peruíbe: CFBH 13795. Piedade: CFBH 23260. Pilar do Sul: CFBH 8625, 8627, 8629. Santo André: CFBH 28953. São Luiz do Paraitinga: CFBH 13886, 14788, 14789, 14792, 14794, 14796. São Paulo: 12170.

***B. ibitiguara*:** BRAZIL: MINAS GERAIS: Alpinópolis: CFBH 0020. Furnas: CFBH 17317, 17320, 17321, 17324, 17343, 17344. Sacramento: CFBH 31743, 31744, 31746–31752, 31754–31771. São Roque: CFBH 8009–8012.

***B. izecksohni*:** BRAZIL: SÃO PAULO: Cotia: CFBH 11652–11654.

***B. luctuosa*:** BRAZIL: MINAS GERAIS: Camanducaia: CFBH 11239–11241, 11243–11247, 17559–17561, 17563–17566, 17583, 17585–17595. SÃO PAULO: Campinas: CFBH 30085. Cruzeiro: CFBH 8300–8305. Itapecerica da Serra: 36175. Jundiaí: CFBH 7709. Mauá: CFBH 22633. Ribeirão Branco: CFBH 30908, 30909. São Carlos: CFBH 26857–26860, 26863.

***B. martinsi*:** BRAZIL: MINAS GERAIS: Barão de Cocais: UFMG 5784, 10677, 10678. Brumadinho: UFMG 827. Catas Altas: UFMG 752, 5567, 5571, 12546. Congonhas: UFMG 5116. Itabirito: UFMG 762. Mariana: UFMG 3549. Moeda: 3940–3942. Nova Lima: UFMG 6511, 10486. Ouro Preto: UFMG 14975, 14981.

Analyzed recordings

CBUFMG 359—*Bokermannohyla juiju*: Vale do Paty, Chapada Diamantina National Park, municipality of Mucugê, state of Bahia. Felipe S. F. Leite recording, unvouchered, 20 January 2010.

CBUFMG 361—*Bokermannohyla juiju*: Vale do Paty, Chapada Diamantina National Park, municipality of Mucugê, state of Bahia. Felipe S. F. Leite recording, call voucher UFMG 4991, 20 January 2010.

CBUFMG 367, 368, 370, 371—*Bokermannohyla juiju*: Cachoeira Cachoeirão, Chapada Diamantina National Park, municipality of Mucugê, state of Bahia. Felipe S. F. Leite recording, unvouchered, 22 January 2010.