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Setting a fundament for taxonomy: advertisement calls from the type localities of three species of the *Dendropsophus rubicundulus* group (Anura: Hylidae)

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Abstract. The *Dendropsophus rubicundulus* group comprises nine species distributed in open environments in Cerrado formations. Currently, *D. jimi*, *D. tritaeniatus*, *D elianeae*, and *D. rubicundulus* have had their advertisement calls described. Herein, we describe for the first time the advertisement calls of *D. anataliasiasi* and *D. cachimbo*, and provide a redescription of the call of *D. rubicundulus*. All three descriptions refer to calls from topotypical specimens. We also provide additional data on the morphometry and colour in life of topotypical specimens of all three species.

Key words. Amphibia, *Dendropsophus anataliasiasi*, *Dendropsophus cachimbo*, bioacoustics, morphometry.

Introduction

The genus *Dendropsophus* Fitzinger, 1843 currently comprises 95 species distributed from southern Mexico to southern Argentina and Uruguay (Frost 2014). These species are essentially divided into nine species groups (Faivovich et al. 2005). The *Dendropsophus microcephalus* species group, which includes more than 30 species, was morphologically defined (Duellman & Trueb 1986) and its monophyly has been corroborated by molecular data (Faivovich et al. 2005, Pyron & Wiens 2011, Medeiros et al. 2013).

In the *D. microcephalus* group, the species of the *Dendropsophus rubicundulus* subgroup (sensu Napoli & Caramaschi 1999) share small size, immaculate thighs, and dorsum green in life and pink to violet in preservative. This species subgroup currently comprises nine species distributed in open environments in Cerrado formations: *D. anataliasiasi* (Bokermann, 1972), *D. araguaya* (Napoli & Caramaschi, 1998), *D. cachimbo* (Napoli & Caramaschi, 1999), *D. cerradensis* (Napoli & Caramaschi, 1998), *D. elianeae* (Napoli & Caramaschi, 2000), *D. jimi* (Napoli & Caramaschi, 1999), *D. rhea* (Napoli & Caramaschi, 1999), *D. rubicundulus* (Reinhardt & Lütken, 1862), and *D. tritaeniatus* (Bokermann, 1965). A preliminary molecular phylogenetic analysis demonstrated that this species grouping did not constitute a monophyletic unit, but this question deserves further attention (Medeiros et al. 2013). At present, *D. jimi* (Martins & Jim 2004) and *D. rubicundulus* (Cardoso & Vielliard 1985) have had their advertisement calls described from their type localities, whereas those of *D. tritaeniatus* (Teixeira et al. 2013) and *D. elianeae* (Martins & Jim 2004) are known only from outside their type localities.

Herein, we describe for the first time the advertisement calls of *Dendropsophus anataliasiasi* and *D. cachimbo* based on topotypical specimens and also provide additional data on morphometry and colour in life for both species. We also present a redescription of the advertisement call of topotypical *D. rubicundulus*, discussing acoustic features that facilitate distinguishing among species of the *D. rubicundulus* group.

Material and methods

Topotypical specimens and recordings were obtained from three localities: i) *D. anataliasiasi*: Brejinho de Nazaré (11°02'34" S, 48°35'24" W; 220 m a.s.l.), State of Tocantins; ii) *D. cachimbo*: Campo de Provas Brigadeiro Velloso, Cachimbo region (9°21'32" S, 54°43'26" W; 460 m a.s.l.), Municipality of Novo Progresso, Pará; and iii) *D. rubicundulus*: Municipality of Lagoa Santa (19°37'53" S, 43°53'17" W; 745 m a.s.l.), Minas Gerais. We based our de-

scription of *D. rubicundulus* calls on recordings obtained in the Serra do Cipó Mountain Range (about 40 km northeast of its type locality) (19°20'56" S, 43°47'03" W; 803 m a.s.l.).

Calls were recorded with digital equipment (M-audio Microtrack II) set at 48.0 kHz and 16-bit resolution, coupled to directional microphones (Sennheiser K6/ME66). Acoustic variables were analysed using Raven Pro 1.5 for Windows from The Cornell Lab of Ornitology (Bioacustic Research Program 2012); settings were Hann window, window size 256 samples, 3 dB filter bandwidth 244 Hz, overlap (locked) 85%, and DFT size (locked) 1,024 samples. All other settings followed the "default" of Raven. Dominant frequency was obtained using the function "Peak frequency". Note repetition rate was quantified based on the number of calls emitted within one minute of each recording. Pulse rate was quantified as the number of pulses divided by note duration. Call nomenclature follows Duellman & Trueb (1994). Sound figures were obtained in the Seewave package (version 1.5.9) (Sueur et al. 2008), R (version 2.12.1) platform (R Development Core Team 2011), using Hanning window function, 85% overlap, and 256 points resolution (FFT).

We conducted a Principal Component Analysis (PCA) on a correlation matrix, taking individual mean values from seven acoustic features (note duration, pulse duration, number of pulses, dominant frequency, number of notes in series, pulse rate, and interval of notes when in series) of the advertisement calls of *D. cachimbo* and *D. rubicundulus*. The call of *D. anataliasiasi* was not included in the PCA since it is composed of two types of notes, which precludes a comparison with those two above-mentioned calls as they are composed of only one type of note. The PCA and its respective figure were produced using the R platform with the function "rda" in the Vegan package (version 2.0-10) (Oksanen et al. 2013).

Collected specimens were euthanised in a 5% lidocaine, fixed in 10% formalin, and preserved in 70% ethanol. Adult males were measured using an ocular micrometer coupled to a stereomicroscope. Measurements larger than 10 mm were taken with callipers accurate to 0.1 mm. Nine measurements follow Duellman (1970): snout–vent length (SVL), head length (HL), head width (HW), tympanum diameter (TD), eye diameter (ED), interorbital distance (IOD), internarial distance (IND), shank length (SL) (= tibia length), and foot length (FL), while two measurements follow Heyer et al. (1990): thigh length (TL) and hand length (HAL). Eye–nostril distance (END) follows Napoli & Caramaschi (1998). Recorded vouchers, analysed specimens (Appendix 1) and call records (Supplemental material 1) are in the Collection of Frogs of the Universidade Federal de Uberlândia (AAG-UFU), municipality of Uberlândia, state of Minas Gerais. Additional examined specimens (including type and topotypical material) are deposited in the following anuran collections: Museu Nacional do Rio de Janeiro (MNRJ), Museu de Zoologia da Universidade de São Paulo (MZUSP), Museu de Zoologia da Universidade Estadual de Campinas (ZUEC), Museu de Biodiversidade do Cerrado, Universidade Federal de Uberlândia (AAG-UFU), and Coleção Herpetológica da Universidade de Brasília (Appendix 1).

Results

Species identification

The series of specimens collected in Brejinho de Nazaré, Tocantins, was assigned to *D. anataliasiasi* based on the following combination of characters: body narrow and elongate in shape, lateral limits of dorsum passing above the tympanum, presence, in some individuals, of parallel longitudinal lines from head towards sacral region, and advertisement call distinct from that described by Cardoso & Vielliard (1985) for topotypical *D. rubicundulus*.

The series of specimens collected at Campo de Provas Brigadeiro Velloso, Cachimbo region, municipality of Novo Progresso, state of Pará, was assigned to *D. cachimbo* based on the following combination of characters: absence of dorsal stripes, lateral limits of dorsum passing above the tympanum, and advertisement call distinct from that described by Cardoso & Vielliard (1985) for topotypical *D. rubicundulus*. The series of specimens collected in the municipality of Lagoa Santa and Serra do Cipó Mountain Range, Minas Gerais, was assigned to *D. rubicundulus* based on the following combination of characters: lateral limits of dorsum passing above the tympanum, presence, in some specimens, of two divergent stripes from the anterior section of the head to the sacral region and two sacral stripes, and advertisement call in accordance with the description by Cardoso & Vielliard (1985).

Advertisement call of *Dendropsophus anataliasiasi* (211 calls from 10 males)

The call of *D. anataliasiasi* (Fig. 1, Tab. 1) is composed of two types of pulsed notes, herein referred to as notes A and B, both with similar dominant frequencies. Notes are emitted in series (A + B) from 2 to 4 notes (mean 2.4; SD = 0.3; N = 139). Calls are often formed by one note A followed by 1 to 3 notes B (mean 1.3; SD = 0.3; N = 152) (e.g., AB, ABB or ABBB); note A may be emitted alone, whereas note B is not emitted alone. Note A is emitted at a rate of 15 to 30 per minute (mean 21.8; SD = 4.4; N = 9), and pulse rate ranges from 95.2 to 381.0 pulses per second (mean 135.2; SD = 8.7; N = 192). Note A duration ranges from 21.0 to 69.0 ms (mean 52.1 ms; SD = 4.6; N = 192), pulses number from 5 to 9 (mean 7.0; SD = 0.6; N = 202). Pulse duration ranges from 5.0 to 10.0 ms (mean 7.6 ms; SD = 0.2; N = 199). Dominant frequency ranges from 3,843 to 4,312 Hz (mean 4,024 Hz; SD = 113.6; N = 194). Note B is emitted at a rate of 7 to 35 per minute (mean 17.5; SD = 8.5; N = 10), and repetition rate ranges from 90.9 to 200 pulses per second (mean 142.9; SD = 6.5; N = 162). Note B duration ranges from 13.0 to 34.0 ms (mean 22.7 ms; SD = 3.1; N = 165), pulses number from 2 to 4 (mean 3.2; SD = 0.4; N = 164).

Pulse duration ranges from 5 to 13 ms (mean 6.9 ms; SD = 0.3; N = 200). Dominant frequency ranges from 3,843 to 4,312 Hz (mean 4,023 Hz; SD = 118.0; N = 160).

When in series (e.g., ABB), notes are emitted at a rate of 29 to 55 per minute (mean 39.3; SD = 8.9; N = 10). Interval of notes when in series ranges from 131 to 176 ms (mean 147.8; SD = 6.8; N = 114).

Morphometric values for adult males of *D. anataliasiasi* are summarised in Table 2. An adult female has 23.2 mm SVL. Analysed specimens have a narrow elongate body, feet proportionally small (mean FL/SVL = 0.37; range: 0.35–0.41) in relation to SVL when compared to other analysed species of the *D. rubicundulus* group (mean FL/SVL = 0.46; range 0.42–0.50 in *D. cachimbo*; mean FL/SVL = 0.43; range: 0.40–0.46 in *D. rubicundulus*; Tab. 1); tympanum barely visible. Live specimens (Figs. 2A–B) have a green to brown dorsal colouration with a white vertebral pin-stripe. Dorsum immaculate or with a few dark dots, which often tend to form parallel longitudinal lines from head towards sacral region. Lateral limits of dorsum narrow and well defined, bordered above by a lighter (yellow) stripe from the nostrils towards the inguinal region, passing above the tympanum (Fig. 3). A straight brown stripe can be present, then delimiting the inner and outer edges of the shanks.

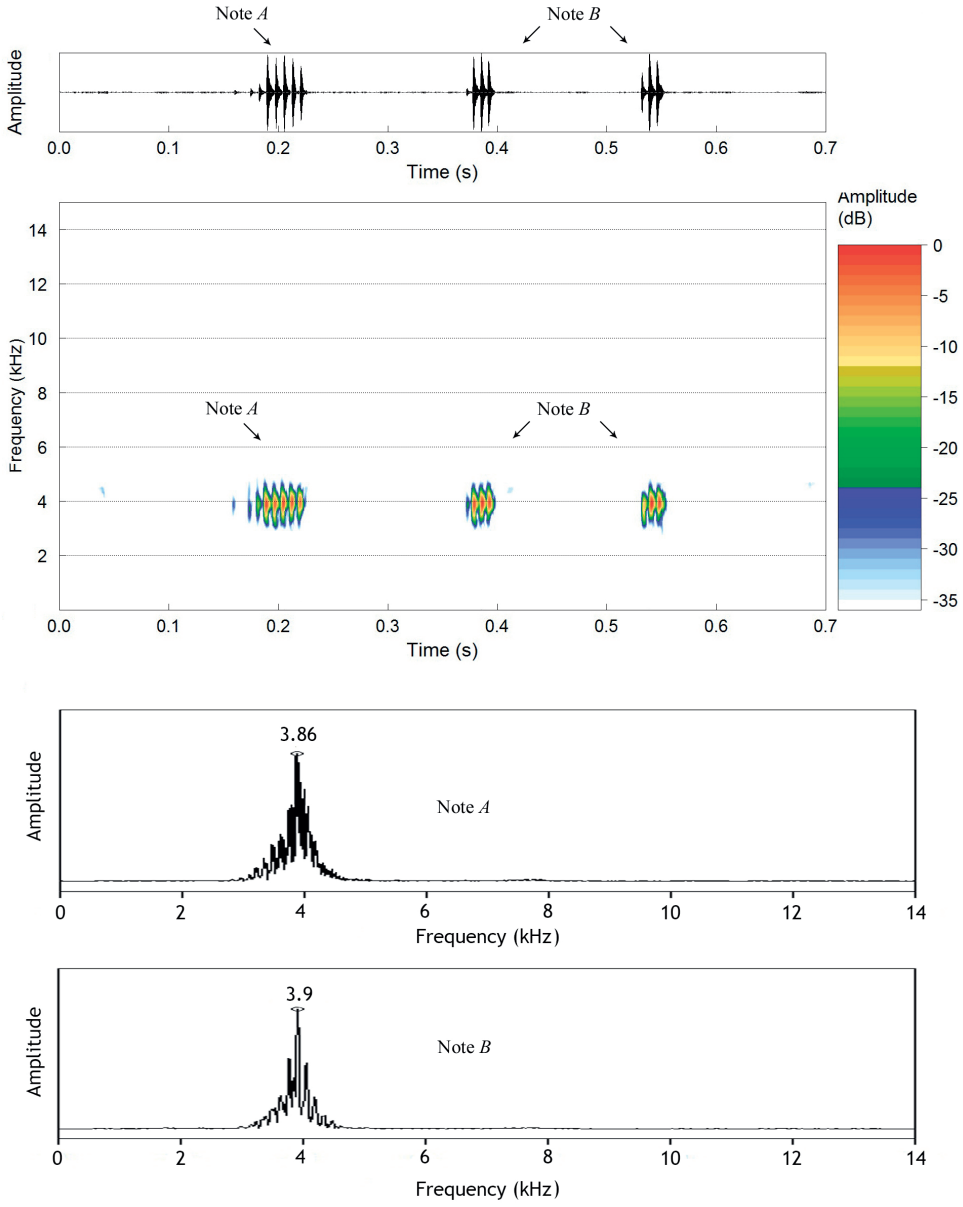

Figure 1. Advertisement call of topotypical *D. anataliasiasi* (one note A followed by two notes B). From top to bottom: waveform, respective spectrogram, power spectrum of the first note (note A) and of the second (note B). Sound file: Dendrop_anataliasiasi_BrejinhoNazare_TO_BFVT_AAG_MTc_7a 20:30h, 26 November 2011; air 28°C, water 25°C.

Table 1. Advertisement call of topotypical *Dendropsophus anataliasiasi*, *D. cachimbo*, and *D. rubicundulus*. N – number of analysed males. Mean ± SD (minimum–maximum).

Bioacoustic traits	*D. anataliasiasi* (N = 10)		*D. cachimbo*	*D. rubicundulus*
	Note A	Note B	(N = 14)	(N = 13)
Notes per call	1±0 (1–1)	1.3±0.3 (1–3)	7.1±3.1 (1–35)	7.9±0.5 (7.0–9.0)
Note duration (ms)	52.1±4.6 (21–69)	22.7±3.1 (13–34)	15.0±1.9 (5–34)	19.3±3.2 (10–32)
Pulses per note	7.0±0.6 (5–9)	3.2±0.4 (2–4)	2.1±0.2 (3–1)	3.6±0.4 (2–5)
Pulse duration (ms)	7.6±0.2 (5–10)	6.9±0.3 (5–13)	7.5±0.7 (4–17)	5.3±0.4 (2–11)
Pulse rate	135.2±8.7 (95.2–381.0)	142.9±6.5 (90.9–200.0)	148.2±18.7 (66.7–333.3)	190.4±17.7 (125–300)
Notes per minute	21.8±4.4 (15–30)	17.5±8.5 (7–35)	54.3±22.5 (19–88)	58.5±24.5 (23–110)
Dominant frequency (Hz)	4024±113.6 (3843–4312)	4023±118 (3843–4312)	4166±153.2 (3890–4406)	3730±235.8 (3093–4171)
Number of notes per series	1.3±0.3 (1–3)		8.5±3.0 (2–35)	3.1±0.8 (2–10)
Inter-note interval in series (ms)	147.8±6.8 (131–176)		288.60±18.9 (221–418)	243.6±20.9 (197–302)

Table 2. Morphometric variables (mm) of topotypes of *Dendropsophus anataliasiasi*, *D. cachimbo*, and *D. rubicundulus*. N – number of analysed specimens. Mean ± SD (minimum and maximum). * – Specimens of *D. anataliasiasi* have a barely visible tympanum.

Variables	*D. anataliasiasi* (N = 13) Brejinho de Nazaré (TO)	*D. cachimbo* (N = 25) Cachimbo (PA)	*D. rubicundulus* (N = 16) Lagoa Santa and Serra do Cipó (MG)
Snout–vent length (SVL)	21.0±0.9 (20.0–23.2)	19.0±0.7 (17.9–20.4)	20.4±0.8 (18.8–21.7)
Head width	5.2±0.2 (5.0–5.9)	6.3±0.2 (5.8–6.9)	5.8±0.4 (4.8–6.5)
Head length	5.3±0.3 (4.6–5.8)	5.9±0.3 (5.4–6.7)	4.6±0.3 (4.0–5.0)
Eye diameter	1.9±0.1 (1.8–2.1)	2.2±0.1 (2.0–2.5)	1.9±0.2 (1.7–2.5)
Tympanum diameter	– *	1.0±0.1 (0.7–1.3)	0.9±0.2 (0.5–1.0)
Foot length	7.9±0.5 (7.0–9.0)	8.7±0.4 (7.9–9.7)	7.9±0.5 (7.0–9.0)
Hand length	5.1±0.4 (4.2–5.6)	5.8±0.4 (5.1–6.8)	8.7±0.5 (7.5–9.6)
Shank length	9.2±0.5 (8.5–10.2)	10.0±0.3 (9.6–10.6)	9.8±0.4 (8.8–10.6)
Thigh length	9.3–0.4 (8.8–10.0)	10.0±0.3 (9.5–10.7)	9.9–0.4 (8.9–10.6)
Internarinal distance	1.3±0.1 (1.1–1.5)	1.6±0.1 (1.5–1.9)	1.5±0.1 (1.3–1.9)
Interorbital distance	1.5±0.1 (1.3–1.8)	2.0±0.2 (1.7–2.3)	2.0±0.2 (1.7–2.5)
Eye-nostril distance	1.4±0.1 (1.1–1.6)	1.5±0.1 (1.3–1.8)	1.6±0.1 (1.4–1.7)
Foot length/SVL	0.37±0.01 (0.35–0.41)	0.46±0.02 (0.42–0.50)	0.43±0.02 (0.40–0.46)

Specimens were found calling perched on grassy or herbaceous vegetation in a permanent pond associated with a palm grove marsh.

Advertisement call of *Dendropsophus cachimbo* (363 calls from 14 males)

The call of *Dendropsophus cachimbo* (Fig. 4, Tab. 1) is composed of one type of pulsed note emitted isolated or in series (75.7%) of 2 to 35 notes (mean 8.5; SD = 3.0; N = 109). Number of notes per call ranges from 1 to 35 (mean 7.1; SD = 3.1; N = 144). Note duration ranges from 5 to 34 ms (mean 15.0; SD = 1.9; N = 363); number of pulses from 1 to 3 (mean 2.1; SD = 0.2; N = 367). Pulse duration ranges from 4 to 17 ms (mean 7.5; SD = 0.7; N = 304). Notes are emitted at a rate of 19 to 88 per minute (mean 54.3; SD = 22.5; N = 14), and pulse rate ranges from 66.7 to 333.3 pulses per second (mean 148.2; SD = 18.7; N = 363). Interval of notes when in series ranges from 221 to 418 ms (mean 288.6; SD = 18.9; N = 202). Dominant frequency ranges from 3,890 to 4,406 Hz (mean 4,166; SD = 153.2; N = 194).

Morphometric values for adult males of *D. cachimbo* are summarised in Table 2. An adult female has 23.7 mm SVL. Analysed specimens have a slender body shape, head wider than body, non-prominent eyes, interorbital region barely defined, and hands and feet robust. Live specimens have a green to brown dorsal colouration (Figs. 2C–D). Lateral limits of dorsum defined by a narrow dark stripe, running from the nostrils towards the inguinal region and passing above the superior limits of the tympanum, bordered above by a discrete lighter (yellow) stripe. The dorsum may be immaculate, but often has some or numerous darker spots in the sacral region. Spots are also often present on the dorsal faces of the shanks and forearms (Fig. 3). Specimens were found calling perched on grassy vegetation in a swampy field with muddy soil.

Advertisement call of *Dendropsophus rubicundulus*
(250 calls from 13 males)

The call of *Dendropsophus rubicundulus* (Fig. 5, Tab. 1) is composed of one type of pulsed note emitted isolated or in series of 2 to 10 notes (mean 3.1; SD = 0.8; N = 146). Number of notes per call ranges from 1 to 10 (mean 2.3; SD = 0.6; N = 257). Note duration ranges from 10 to 32 ms (mean 19.3; SD = 3.2; N = 250); number of pulses from 2 to 5 (mean 3.6; SD = 0.4; N = 250). Pulse duration ranges from 2 to 11 ms (mean 5.3; SD = 0.4; N = 250). Notes are emitted at a rate of 23 to 110 per minute (mean 58.5; SD = 24.5; N = 13), and pulse rate ranges from 125.0 to 300.0 pulses per second (mean 190.4; SD = 17.7; N = 250). Interval of notes when in series ranges from 197 to 302 ms (mean 243.6; SD = 20.9; N = 122). Dominant frequency ranges from 3,093 to 4,171 Hz (mean 3,730; SD = 235.8; N = 247).

Morphometric values for adult males of *D. rubicundulus* are summarised in Table 2. Analysed specimens have a robust body shape, head as wide as body outline, prominent eyes, interorbital region well defined, and hands and feet robust. Live specimens have a green to brown dorsal colouration (Figs. 2E–F). Lateral limits of dorsum defined by a narrow dark stripe, running from the nostrils towards the inguinal region and passing above the superior limits of tympanum, bordered above by a discrete lighter (yel-

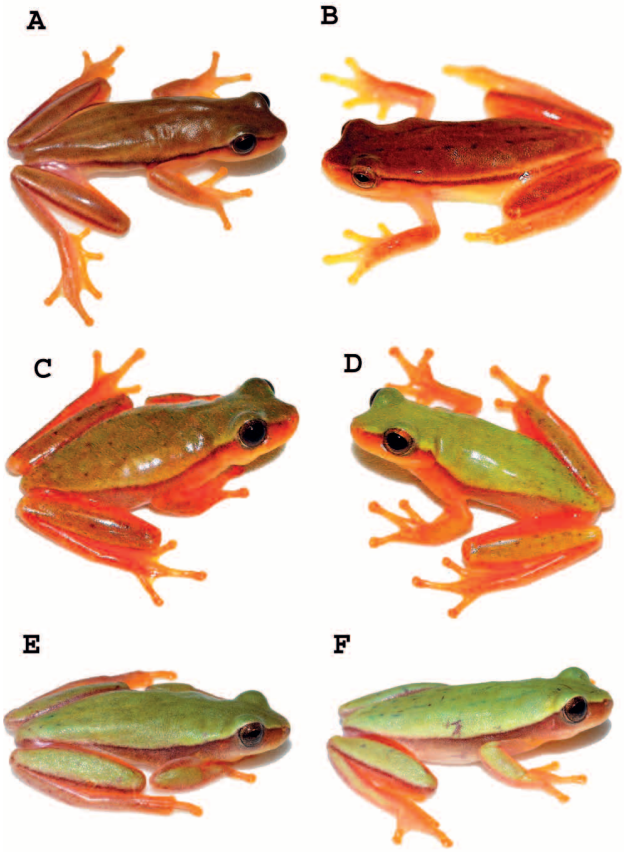

Figure 2. Adult topotypical male of *Dendropsophus anataliasiasi* (A–B); *Dendropsophus cachimbo* (C–D) (photo by Thiago R. de Carvalho); *D. rubicundulus* (E–F), in life.

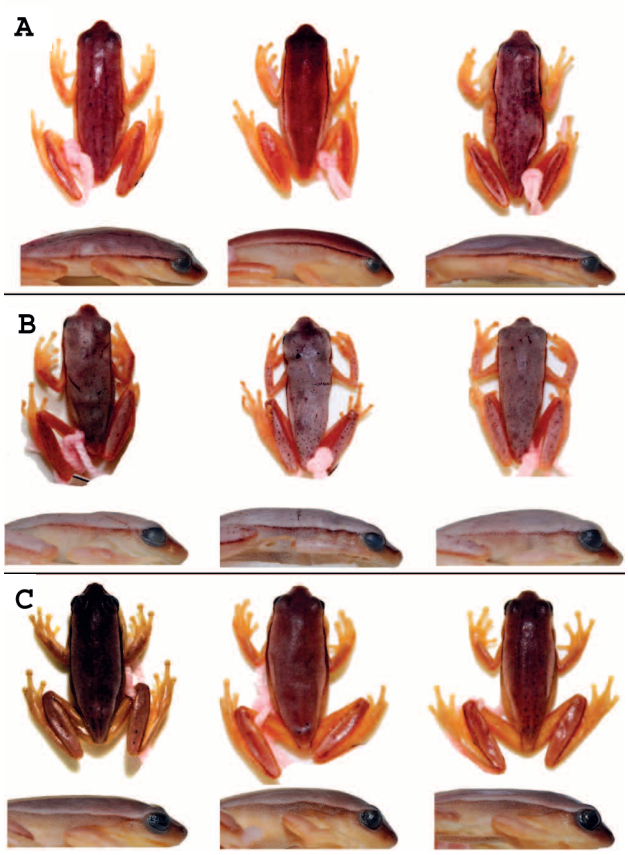

Figure 3. Dorsal and lateral views illustrating the distinctiveness in body shape, patterns of dorsal dots, and the lateral limits of dorsum of topotypes. A) *Dendropsophus anataliasiasi* (AAG-UFU 937; AAG-UFU 932; AAG-UFU 933); B) *Dendropsophus cachimbo* (AAG-UFU 1514; AAG-UFU 1506; AAG-UFU 1507); C) *Dendropsophus rubicundulus* (AAG-UFU 39, AAG-UFU 43, AAG-UFU 34).

low) stripe and below by a discrete lighter brown stripe. The dorsum may be immaculate, but often has some or numerous darker spots that tend to form two divergent dark stripes from the anterior section of the head to the sacral region, and two dark sacral stripes (Fig. 3). Dark spots are often present on the dorsal faces of the shanks. Specimens were found calling perched on grassy vegetation in temporary or permanent ponds.

Acoustic comparisons: *D. cachimbo* and *D. rubicundulus*

The Principal Component Analysis of the advertisement calls of *D. cachimbo* and *D. rubicundulus* showed a clear separation of both species along the first axis (Fig. 6; Supplemental material 2–3), whereas there is no separation along the second axis. The first two Principal Components (PCs) accounted for around 84% of the overall bioacoustic variability among the calls of *D. cachimbo* and *D. rubicundulus*. Note duration, pulse duration, and number of pulses were the acoustic features that contributed the most to their separation. Individual mean values of the seven features of the advertisement calls *D. cachimbo* and *D. rubicundulus* are presented in Figure 7.

Discussion

The advertisement call of *D. anataliasiasi* is unique among those species of the *D. rubicundulus* group whose calls are known by comprising two types of notes, a feature otherwise known from some other species of the *D. microcephalus* group, such as *D. microcephalus* (Cope, 1886) and *D. nanus* (Boulenger, 1889) (Martins & Jim 2003, Duellman 1970).

The values presented here for the advertisement call of *D. rubicundulus* are in accordance with those described by Cardoso & Vielliard (1985). At present, available data on the advertisement calls of *D. rubicundulus* and *D. elianeae* (Martins & Jim 2004, Teixeira & Giaretta unpubl. data) do not allow us to differentiate one from the other, as well as between *D. jimi* and *D. tritaeniatus* (Martins & Jim 2004, Teixeira et al. 2013), but the species in each of these pairs can be distinguished morphologically (Teixeira et al. 2013). The call of *D. rubicundulus* presents a wide

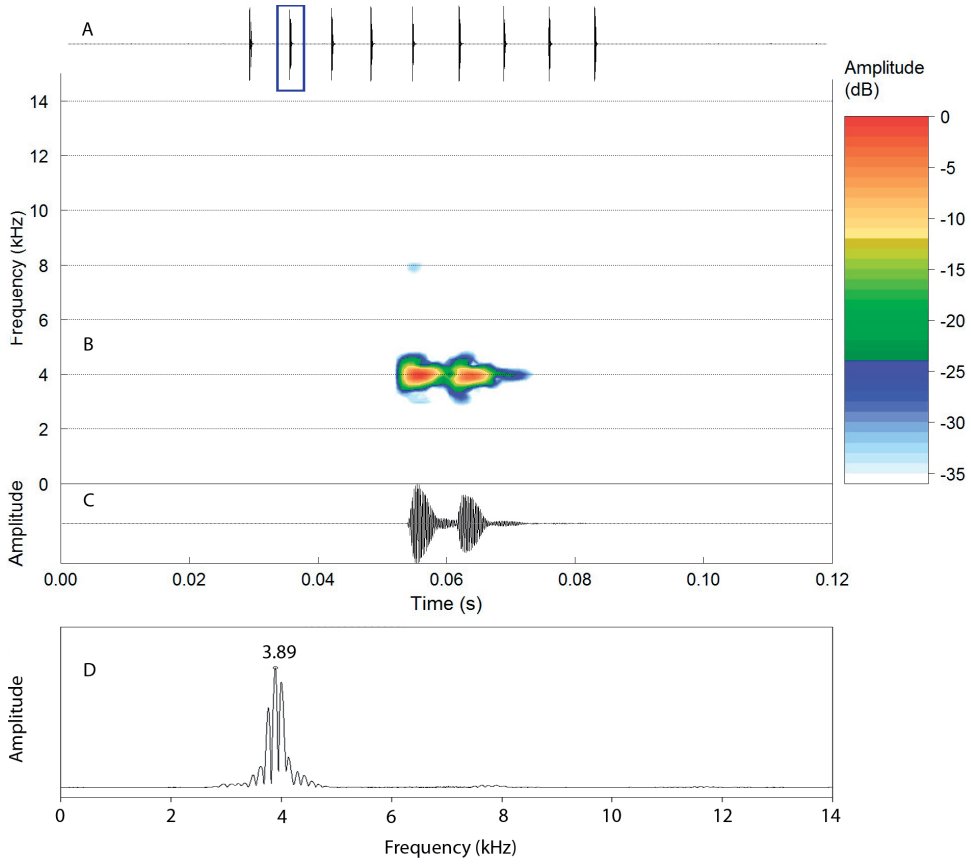

Figure 4. A) Waveform (5.6-second section) of the advertisement call of *Dendropsophus cachimbo* (Novo Progresso, Pará). The outlined note is detailed in B) spectrogram, C) waveform, and D) power spectrum. Sound file: Dendrop_cachimbo_NovoProgresso-PA_7a_BFVT_AAG_Mt 20:17h, 28 November 2012; air 26.7°C, water 26.6°C.

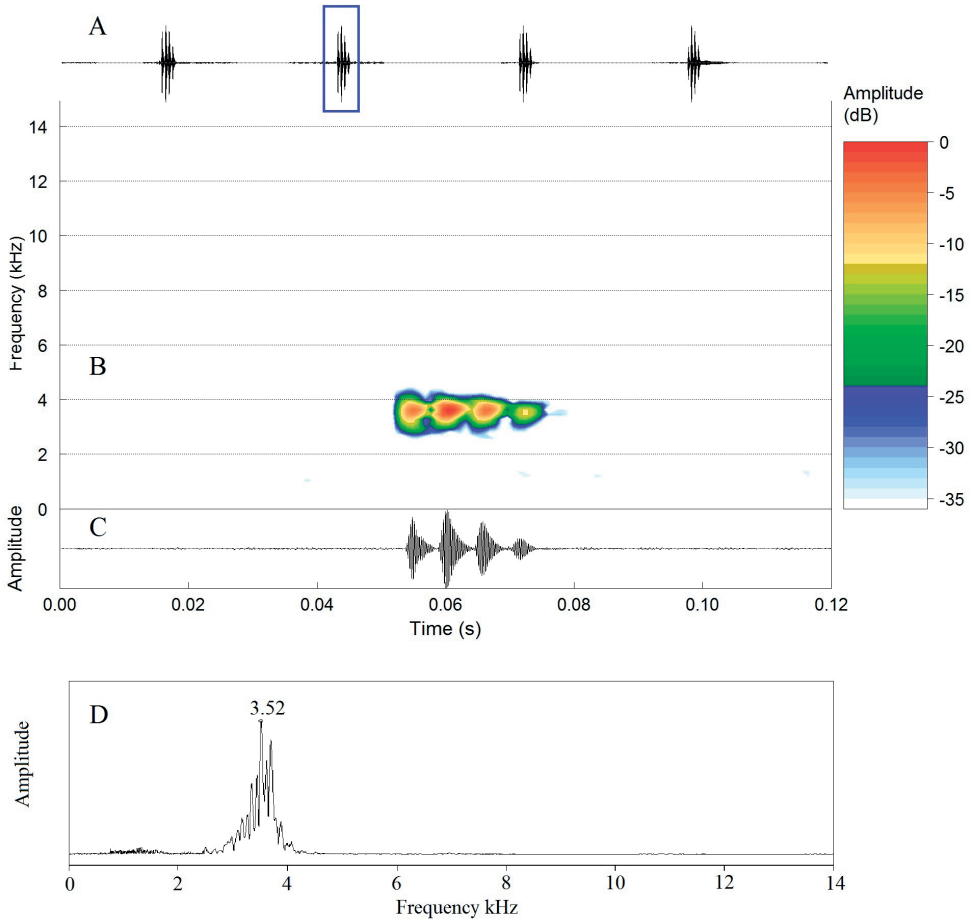

Figure 5. A) Waveform (1.2-second section) of the advertisement call of *Dendropsophus rubicundulus* (Lagoa Santa, Minas Gerais). The note outlined is detailed in B) spectrogram, C) waveform, and D) power spectrum. Sound file: DendropRubicundulus_LagoaSantaMG1cBFVT_TRCmt 19:33h, 18 November 2010; air 23.0°C, water 25.0°C.

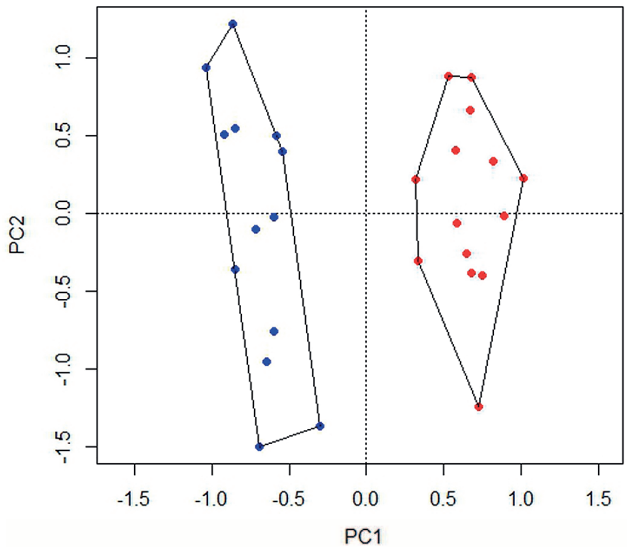

Figure 6. Principal Component Analysis of the individual mean values of seven acoustic features of the advertisement calls of *D. cachimbo* (red dots) and *D. rubicundulus* (blue dots).

overlap regarding call duration, number of pulses, and dominant frequency when compared with described calls of *D. jimi* and *D. tritaeniatus* (Martins & Jim 2004, Teixeira et al. 2013), but can be distinguished by its shorter inter-note intervals in series and not exhibiting a pattern of emitting notes in series, as is present in the two mentioned species of the *D. tritaeniatus* complex.

Although the calls of *D. cachimbo* and *D. rubicundulus* do not present unequivocal diagnostic features, we were able to separate the former from the latter by its shorter mean note duration, longer mean pulse duration, lower mean number of pulses per note, higher dominant frequency, higher number of notes per series, calls usually emitted in series, longer mean inter-note interval in series, and a lower mean pulse rate (Fig. 7), a combination of features that allows to distinguish them by ear. As we mentioned earlier, the advertisement calls of *D. rubicundulus* and *D. elianeae* are indistinguishable from each other, consequently, the call of *D. cachimbo* can also be distinguished from that of *D. elianeae* by its shorter mean note duration, longer mean pulse duration, lower mean number of pulses per note, higher dominant frequency, higher number of

notes per series, calls frequently emitted in series, longer mean inter-note interval in series, and a lower mean pulse rate. The remarkable tendency of emitting notes in sequence in the advertisement call of *D. cachimbo* is similar of those of *D. jimi* and *D. tritaeniatus* (Teixeira et al. 2013), but *D. cachimbo* can be distinguished from either by the

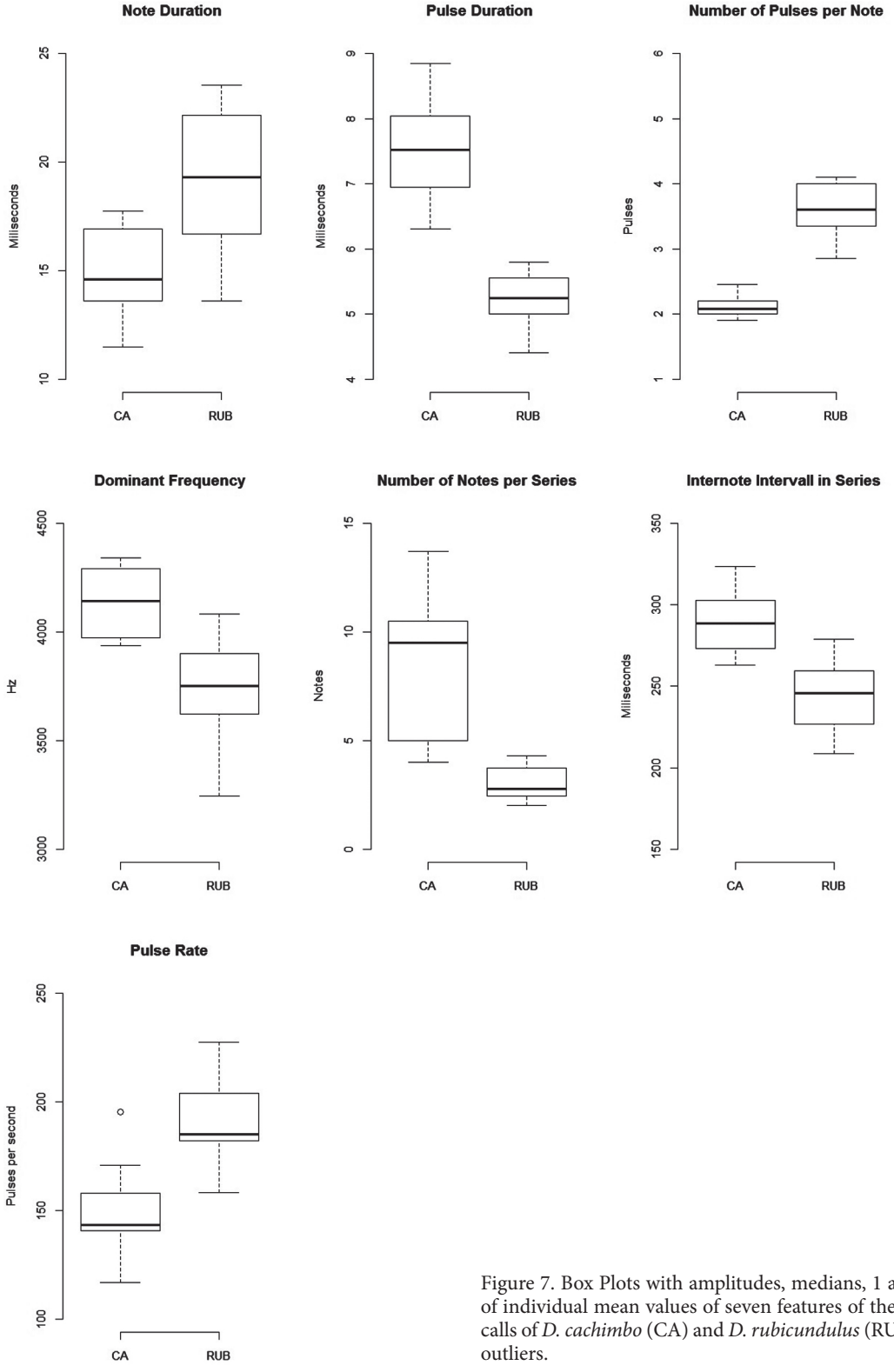

Figure 7. Box Plots with amplitudes, medians, 1 and 3° quartiles of individual mean values of seven features of the advertisement calls of *D. cachimbo* (CA) and *D. rubicundulus* (RU). Circles mark outliers.

shorter note duration (mean 15.0 ms) and lower number of pulses (mean 2.1 pulses per note), mean note duration of 32.0 ms, and mean of 3.4 pulses per note in *D. tritaeniatus* (Teixeira et al. 2013), and mean note duration of 34.0 ms and mean of 4.0 pulses per note in *D. jimi* (Martins & Jim 2004), respectively.

The type series of *D. anataliasiasi* is composed of five specimens. In the original description, Bokermann (1972) provided five morphometric variables. We here improved the characterisation of the morphological and morphometric intraspecific variation of this species. Napoli & Caramaschi (1999) reported on males of *D. anataliasiasi* from state of Mato Grosso with a smaller SVL (18.9 mm). The different measuring procedures used by Napoli & Caramaschi (1999) for foot length preclude a comparison between their population and our topotypes with respect to the proportion of foot length to SVL. In general, the morphometric values and morphological features of *D. anataliasiasi*, *D. cachimbo*, and *D. rubicundulus* are in accordance with those presented by Napoli & Caramaschi (1999).

The green dorsal colouration in live specimens is the main pattern occurring in *D. anataliasiasi*, *D. cachimbo*, and *D. rubicundulus*, and represents a useful character to recognize them, but some specimens of all three species may present both greenish brown and brownish green hues. The presence of both colouration patterns in *D. rubicundulus*, varying even in the same individual, was previously reported by Napoli & Caramaschi (1999) for a series of four live specimens from Lagoa Santa (type locality), is herein reported for *D. anataliasiasi* and *D. cachimbo* as well. Nevertheless, if one analyses a series of specimens, the green dorsal colouration is promptly recognized as the main pattern in all three species.

As is shown in Table 1 in Napoli & Caramaschi (1999) and herein, the dorsal pattern of specimens of *D. anataliasiasi* and *D. rubicundulus* can vary from immaculate to having dots arranged in lines or irregularly. It is noteworthy that with just one specimen at hand, occasionally, one cannot identify the respective nominal species by assessing morphology only. With such extent of variance, we suggest that the pattern of dorsal stripes should not be employed, at least not solely, as a diagnostic character for *D. anataliasiasi* and *D. rubicundulus*. Still, the analysed specimens of *D. anataliasiasi* and *D. rubicundulus* present the same patterns as those described by Napoli & Caramaschi (1999), i.e., as follows: i) *D. anataliasiasi*: dorsum with nearly parallel stripes, the anterior ones joining with the sacral ones; ii) *D. rubicundulus*: dorsum with two divergent stripes from the anterior section of the head to the sacral region, and two sacral stripes extending to the cloacal region. The two afore-mentioned stripe patterns, when present, are exclusive to either *D. anataliasiasi* or *D. rubicundulus*, being an additional character to help distinguish one from the other in particular. Moreover, *D. anataliasiasi* can be distinguished from *D. rubicundulus* by its narrow elongate body shape (sensu Bokermann 1972), feet proportionally small, and advertisement call consisting of two different types of pulsed notes, whereas *D. rubicundulus* has a more robust body shape, and advertisement call consisting of a single type of pulsed note. Since immaculate or loosely spotted dorsal patterns are present in *D. anataliasiasi* and *D. rubicundulus*, *D. cachimbo* can be distinguished from these two by body shape slender, spots often present on dorsal face of shanks, forearms, and sacral region, and advertisement call consisting of a single type of note, and presenting the combination of features that allows the distinction from *D. rubicundulus*, as mentioned afore.

Our efforts to obtain acoustic data of the *D. microcephalus* group are intended to create a database for comparative studies (e.g., phylogenetic signal evolution) to understand the evolution of the advertisement call in this frog group, in the manner already employed in studies of other frog groups (see Cocroft & Ryan 1995, Erdtmann & Amézquita 2009, Gingras et al. 2012, Gingras et al. 2013).

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Appendix I
Additional examined specimens

Dendropsophus anataliasiasi: type specimens: MZUSP 74204 (Ex. WCAB 45272); MZUSP-73790 (Ex. WCAB-45373); MZUSP 73788–73789 (Ex. WCAB 45257–45258); TOCANTINS: Brejinho de Nazaré (Topotypes): AAG-UFU 0926–0939; Formoso do Araguaia: ZUEC 10158; ZUEC 10170–10171; ZUEC 10177–10178; ZUEC 101201; Nova Olinda: MNRJ 73004; MNRJ 66823.

Dendropsophus cachimbo: type specimens: MNRJ 17298–17299; MZUSP 21910–21918; MZUSP 21920–21924; PARÁ: Novo Progresso (topotypes): AAG-UFU 1489–1504; AAG-UFU 1506–1514; CHUNB 13098–13108; CHUNB 34445–34469; CHUNB 40178–40195.

Dendropsophus elianeae: MATO GROSSO DO SUL: Bela Vista (topotypes): AAG-UFU 0129–0142; Ribas do Rio Pardo: AAG-UFU 0160–0164; MINAS GERAIS: Uberlândia: AAG-UFU 4947–4750; AAG-UFU 2293–2296; AAG-UFU 2303–2304; Perdizes: AAG-UFU 1030–1032; Araporã: AAG-UFU 655–656; AAG-UFU 0895–0897; MATO GROSSO: Barra do Garças: AAG-UFU 4893–4895.

Dendrospophus rubicundulus: MINAS GERAIS: Lagoa Santa (topotypes): ZUEC 10767–10786; ZUEC 4146–4149; AAG-UFU 0021–0022; Serra do Cipó: AAG-UFU 0030–0044; AAG-UFU 0647–0650; Paracatu: AAG-UFU 0647–0650; AAG-UFU 1539–1540; AAG-UFU 0647–0650; São Gotardo: AAG-UFU 1749–1754; Moema: AAG-UFU 1784; Bambuí: AAAG-UFU 0296; Curvelo: AAG-UFU 0306; Juatuba: AAG-UFU 0327; Vargem Bonita: AAG-UFU 0605; Buritis: AAG-UFU 1764–1768; Chapada Gaúcha: AAG-UFU 1985–1906; GOIÁS: Guarani de Goiás: AAG-UFU 1953–1961; TOCANTINS: Mateiros: AAG-UFU 2149; AAG-UFU 2160; AAG-UFU 2162; AAG-UFU 2250–2251; AAG-UFU 2268; AAG-UFU 2292; AAG-UFU 2300; AAG-UFU 2343; AAG-UFU 2360; Paranã: 3293–3305; MARANHÃO: Carolina: AAG-UFU 2833–2839; AAG-UFU 3264–3266.

Supplementary material
Additional information is available in the online version of this article at http://www.salamandra-journal.com

3 Supplementary tables

Table 1. AAG-UFU collection voucher numbers and their respective analysed sound archives.

Table 2. Eigenvectors, eigenvalues, and explained variation of the first three principal components of acoustic variables of topotypical *Dendropsophus cachimbo* and *D. rubicundulus.*

Table 3. Individual values of the three first Principal Components of the advertisement calls of *D. cachimbo* (CA) and *D. rubicundulus* (RUB).

Online Supplementary material

Teixeira, B. F. V. & A. A. Giaretta (2015): Casting a foundation for taxonomy: advertisement calls from the type localities of three species of the *Dendropsophus rubicundulus* group (Anura: Hylidae). – Salamandra, **51**(2): 137–146.

3 Supplementary tables

Supplementary table 1. AAG-UFU collection voucher numbers and their respective analysed sound archives.

Voucher numbers	Sound archive
0931	Dendrop_anataliasiBrejinhoNazareTO1aBFVT_AAGmt
0932	Dendrop_anataliasiBrejinhoNazareTO2aBFVT_AAGmt
0933	Dendrop_anataliasiBrejinhoNazareTO3aBFVT_AAGmt
0934	Dendrop_anataliasiBrejinhoNazareTO4aBFVT_AAGmt
0935	Dendrop_anataliasiBrejinhoNazareTO5aBFVT_AAGmt
0936	Dendrop_anataliasiBrejinhoNazareTO6aBFVT_AAGmt
0937	Dendrop_anataliasiBrejinhoNazareTO7aBFVT_AAGmt
0938	Dendrop_anataliasiBrejinhoNazareTO8aBFVT_AAGmt
0939	Dendrop_anataliasiBrejinhoNazareTO9aBFVT_AAGmt
Unvouchered	Dendrop_anataliaTO1aTRC_AAGmt
Unvouchered	Dendrop_anataliaTO2aTRC_AAGmt
Unvouchered	Dendrop_anataliaTO3aTRC_AAGmt
1489	Dendrop_cachimbo_NovoProgresso-PA_1a_BFVT_AAG_Mt
1490	Dendrop_cachimbo_NovoProgresso-PA_2a_BFVT_AAG_Mt
1491	Dendrop_cachimbo_NovoProgresso-PA_3a_BFVT_AAG_Mt
1492	Dendrop_cachimbo_NovoProgresso-PA_4a_BFVT_AAG_Mt
1493	Dendrop_cachimbo_NovoProgresso-PA_5a_BFVT_AAG_Mt
1494	Dendrop_cachimbo_NovoProgresso-PA_6a_BFVT_AAG_Mt
1495	Dendrop_cachimbo_NovoProgresso-PA_7a_BFVT_AAG_Mt
1496	Dendrop_cachimbo_NovoProgresso-PA_8a_BFVT_AAG_Mt
1497	Dendrop_cachimbo_NovoProgresso-PA_9a_BFVT_AAG_Mt
1498	Dendrop_cachimbo_NovoProgresso-PA_10a_BFVT_AAG_Mt
Unvouchered	Dendrop_cachimbo_NovoProgresso-PA_11a_BFVT_AAG_Mt
Unvouchered	Dendrop_cachimbo_NovoProgresso-PA_12a_BFVT_AAG_Mt
Unvouchered	Dendrop_cachimbo_NovoProgresso-PA_13a_BFVT_AAG_Mt
Unvouchered	Dendrop_cachimbo_NovoProgresso-PA_14a_BFVT_AAG_Mt
Unvouchered	DendropRubicundulus_LagoaSantaMG1cBFVT_TRCmt
Unvouchered	DendropRubicundulus_LagoaSantaMG2aBFVT_TRCmt
Unvouchered	DendropRubicundulus_SerraCipoMG2aBFVT_TRCmt
Unvouchered	DendropRubicundulus_SerraCipoMG3aBFVT_TRCmt
Unvouchered	DendropRubicundulus_SerraCipoMG4cBFVT_TRCmt
Unvouchered	DendropRubicundulus_SerraCipoMG5aBFVT_TRCmt
Unvouchered	DendropRubicundulus_SerraCipoMG7aBFVT_TRCmt
Unvouchered	DendropRubicundulus_SerraCipoMG8aBFVT_TRCmt
Unvouchered	Dendrop_rubicundMG1bTRC_BFVTmt
Unvouchered	Dendrop_rubicundMG2TRC_BFVTmt
Unvouchered	Dendrop_rubicundMG3TRC_BFVTmt
Unvouchered	Dendrop_rubicundMG4TRC_BFVTmt
Unvouchered	Dendrop_rubicundMG6bTRC_BFVTmt

Supplementary table 2. Eigenvectors, eigenvalues, and explained variation of the first three principal components of acoustic variables of topotypical *Dendropsophus cachimbo* and *D. rubicundulus*.

	PC1	PC2	PC3
Note Duration	-0.9840	0.9268	0.09781
Pulse duration	12.424	0.3993	0.24695
Number of pulses	-13.245	0.1727	0.07136
Dominant frequency	11.471	-0.5109	-0.31918
Number of note in series	11.389	-0.1278	0.69257
Pulse rate	-0.9577	-0.9135	0.07906
Inter-note interval in series	10.669	0.4700	-0.43394
Eigenvalues	4.6361	1.2354	0.44194
Explained variation	0.6623	0.1765	0.06313

Supplementary table 3. Individual values of the three first Principal Components of the advertisement calls of *D. cachimbo* (CA) and *D. rubicundulus* (RUB).

	PC1	PC2	PC3
RUB1	-0.8486	0.54862	-0.29491
RUB2	-10.388	0.93576	0.65364
RUB3	-0.5468	0.40084	-0.60629
RUB4	-0.8620	122.038	0.59649
RUB5	-0.6023	-0.76118	0.36827
RUB6	-0.6889	-150.122	0.07984
RUB7	-0.8503	-0.35838	-0.19289
RUB8	-0.5991	-0.02319	-0.74332
RUB9	-0.5857	0.50007	-0.80574
RUB10	-0.7122	-0.09930	0.57157
RUB11	-0.6476	-0.95552	0.26420
RUB12	-0.3045	-136.857	-0.60763
RUB13	-0.9179	0.50484	0.63764
CA1	0.7242	-124.250	122.007
CA2	0.3302	-0.30780	-0.22077
CA3	0.5753	0.40718	-0.25500
CA4	0.6765	-0.38473	-0.74835
CA5	10.125	0.22881	0.66302
CA6	0.6776	0.87676	-0.89490
CA7	0.5272	0.88841	0.65273
CA8	0.7499	-0.40212	-0.43817
CA9	0.8894	-0.01451	-0.39608
CA10	0.5853	-0.06077	-112.326
CA11	0.8222	0.34025	0.69667
CA12	0.3164	0.21982	-113.198
CA13	0.6728	0.66534	0.59059
CA14	0.6451	-0.25725	146.455