



A new species of *Hypsiboas* Wagler (Anura: Hylidae) closely related to *H. multifasciatus* Günther from southeastern Brazil

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Abstract

We describe a new species based on two populations, from the State of Minas Gerais, using advertisement call and morphological data as diagnostic characters. *Hypsiboas paranaíba* sp. n. is distinguished from the large-sized species of the group by the absence of a white stripe on upper (*H. lanciformis*) or upper and lower lips (*H. leucocheilus*); from *H. albopunctatus* by the absence of distinct light spots on outer thighs and inguinal region; and from *H. multifasciatus* by reaching a smaller maximum size and presenting a head as long as wide. The new species occurs in the Cerrado biome of southeastern Brazil in the State of Minas Gerais, and central Brazil in the State of Goiás, whereas *H. multifasciatus* is restricted to the Amazon Forest domain, and possibly to forest domains in northeastern Brazil.

Key words: Advertisement call, Cerrado savanna, *Hypsiboas albopunctatus* group, *Hypsiboas paranaíba* sp. n., State of Minas Gerais

Introduction

Currently, the Neotropical *Hypsiboas albopunctatus* Spix species group is just defined on molecular basis (Faivovich *et al.* 2005). It comprises nine species, one in Middle America and eight in South America (Frost 2010). *Hypsiboas multifasciatus* Günther has traditionally been considered as an Amazonian species, ranging from Venezuela to French Guiana, as well as northern and northeastern Brazil (De Sá 1996; Loebmann *et al.* 2007); its type locality is in the State of Pará (Brazil). Lutz (1973) referred to specimens of *H. multifasciatus* (= *H. daudini*, cf. De Sá 1996) from the State of Goiás (central Brazil) as “intermediate between *H. daudini* and *H. albopunctata*”. Other authors have applied the name *H. multifasciatus* to populations from the Cerrado (Guimarães *et al.* 2001; Loebmann *et al.* 2007; Vaz-Silva *et al.* 2007; Silva Jr. *et al.* 2009).

In this paper, based on adult morphology and advertisement call data we propose the recognition of populations of the group from southeastern Brazil as a new form, closely related to *H. multifasciatus*.

Material and methods

Specimens came from two municipalities of the Triângulo Mineiro region, State of Minas Gerais: Araguari and Ituiutaba. In these localities, the original vegetation was the Cerrado savanna biome (Oliveira & Marquis 2002). The study site in Araguari is located on the steep banks of the Paranaíba River valley, which has been used mainly for extensive cattle farming (Giaretta *et al.* 2008) over the last decades. In Ituiutaba, specimens were collected at the border of a forest patch, crossed by a streamlet, tributary of the Tejuco River. This forest is surrounded by urban areas, cattle farms, and agricultural fields. Natural vegetation types at both study sites include patches of forest along seasonal and perennial streams and palm grove marshes (Veredas).

The description is based on 12 adult males and 3 adult females, all deposited in the following Brazilian public collections: Museu de Zoologia da Universidade Estadual de Campinas (ZUEC), Campinas, São Paulo and collection of frogs of the Universidade Federal de Uberlândia (AAG-UFU), Minas Gerais. In order to avoid damages to the holotype, features from inside the mouth were taken from two male paratypes (AAG-UFU 2587 and ZUEC 16245). A list of examined specimens of closely related species is given in Appendix 1.

Twelve morphometric characters were taken with calipers to the nearest 0.1 mm. Seven measurements followed Duellman (1970): snout-vent length (SVL), head length (HL), head width (HW), eye diameter (ED), tympanum diameter (TD), shank length (SL), and foot length (FL); and five measurements followed Heyer *et al.* (1990): thigh length (TL), hand length (HAL), eye-nostril distance (END), fourth toe disk diameter (TDD), and third finger disk diameter (FDD). Webbing formulae as in Savage & Heyer (1997).

Morphometric data of *H. multifasciatus* were kindly made available by R. de Sá and taken from De Sá (1996). We conducted a Principal Component Analysis (PCA) applied to a correlation matrix using nine measurements (END, HL, ED, SVL, TD, SL, HAL, HW, FL) from 10 topotypic (Belém, PA) *H. multifasciatus* specimens from the unpublished thesis of R. de Sá and 12 specimens of the new form (Minas Gerais, MG) using FitopacShell software (Shepherd 2006). Differences in head shape (HW/HL ratio) between these populations were tested by Analysis of Covariance (ANCOVA), using HL as covariate (Zar 1999; Wilkinson 2000). The significance of the differences in morphometric and acoustic traits between both populations was evaluated through t-test (Zar 1999). All morphometric analyses were made considering only males to avoid influence due to sexual dimorphism and low sample size of females. A series of four males putatively attributed to *H. multifasciatus* from southern Pará (appendix 1) was not part of our morphometric analyses, as it represents a small sample size and is far (ca. 1,000 km south) from the type locality. Furthermore, the specific name *H. multifasciatus* could potentially include unrecognized species due to its wide distribution and levels of variation among populations, thereby we regarded only topotypic specimens as part of the analyses.

Calls were recorded with digital recorders (Boss BR 864 or Microtrack) set at 44,100 Hz and 16 bits resolution, coupled to directional microphones (Sennheiser K6/ME67 and K6/ME66, respectively). Calls were analyzed using Soundruler software (Gridi-Papp 2007); sound figures were generated in the Seewave R package (Sueur *et al.* 2008), using 85% overlap and “hanning” filter. Our call samples presented several note types, and we regarded note A (see call description section) as the advertisement call due to its higher intensity and frequency of emission in relation to the other (weak/rare) notes. Poorly defined (hybrid) note types were excluded from the analyses. We also analyzed five recordings of *H. multifasciatus* from the type locality (Belém, State of Pará) provided by W.E. Duellman (1970; KU tape recordings 7755–7759) and one recording from the State of Maranhão by L.F. Toledo. For comparative purposes, we present sound figures of two other species of the group (*H. albopunctatus* and *H. raniceps*) that co-occur with the new form.

Results

Hypsiboas paranaiba Carvalho & Giaretta, new species

(Figures 1–3)

Holotype: ZUEC 16244 (former AAG-UFU 4647), an adult male from the farm of Mr. Adir Lemos (Fazenda Vão) (18°39'35"S; 48°08'14"W, approximately 600 m altitude), on the margins of the MG 413 road, municipality of Araguari, State of Minas Gerais, Brazil, collected by A.A. Giaretta and T.R. de Carvalho on September 27th, 2007.

Paratopotypes: Nine adult males from Araguari: AAG-UFU 2587 on November 18th, 2003; AAG-UFU 3167 on November 20th, 2005; AAG-UFU 4582 on June 26th, 2006; AAG-UFU 4619 on October 4th, 2007; ZUEC 16243 (former AAG-UFU 4646), AAG-UFU 4648, ZUEC 16245 (former AAG-UFU 4649) on September, 2007; AAG-UFU 4687, AAG-UFU 4688 on October 31st, 2008. Three adult females: AAG-UFU 3941, AAG-UFU 3942 on September 7th, 2006; AAG-UFU 4074 on September 19th, 2006. **Paratypes:** Two

adult males from Ituiutaba (18°57'60"S; 49°29'61"W, approximately 600 m altitude): AAG-UFU 4793, AAG-UFU 4794 on October 4th, 2009. All collected by A.A. Giaretta and/or T.R. de Carvalho.

Differential Diagnosis: *Hypsiboas paranaiba* sp. n. is a long-headed, pointed snout species of the *H. albopunctatus* group, as *H. albopunctatus*, *H. raniceps* Cope, *H. lanciformis* Cope, *H. leucocheilus* Carasmachi & Niemeyer, and *H. multifasciatus* (*sensu* Lutz 1973). The head shape allied to SVL easily distinguishes this group from the other species in the genus. The new form is diagnosed by a combination of traits: (1) small size for the group (SVL 46.2–52.3 mm, mean 49.4, SD=2.1; N=15); (2) absence of white stripe on upper or upper and lower lips; (3) presence of white supra-anal dermal ridge; (4) absence of distinct light spots or black bars on posterior surface of thighs; (5) head width/length ratio.

Hypsiboas paranaiba sp. n. (Figures 1–3) is smaller than the large-sized species of the group, *H. lanciformis* (60.8–70.6 mm, mean 63.7; N=8) and *H. leucocheilus* (56.7–81.2 mm; N=13) (Caramaschi & Niemeyer 2003). Besides, the new species does not present a white stripe on upper or upper and lower lips, as in *H. lanciformis* and *H. leucocheilus* respectively. It differs from *H. raniceps* (45.5–81.6 mm, mean 63.3; N=12) by the absence of well-defined dark bars on inner and outer surfaces of thighs, and by the presence of white supra-anal dermal ridge. It differs from *H. albopunctatus* (40.3–56.7 mm, mean 48.0; N=19) by the absence of distinct light (yellow in life, white in preservative) spots on the hidden parts of thighs and inguinal region.

Although SVL overlaps, maximum SVL of *Hypsiboas paranaiba* sp. n. (mean male SVL 49.0, range 46.3–52.3 mm; SD=2.1, N=12; mean female SVL 48.9, range 46.2–51.2 mm; SD=2.5, N=3) is smaller than: (i) topotypic *H. multifasciatus* (mean male SVL 50.2 mm, range 46.3–58.6 mm; SD=3.7, N=10; mean female SVL 55.9 mm, range 49.1–65.4 mm; SD=4.8, N=9) (De Sá unpubl. data), (ii) northern Brazilian (Venezuelan border) *H. multifasciatus* populations (male SVL 50.4–57.3 mm, mean 52.9; N=9 males) (Duellman 1997) and (iii) our sample of *H. multifasciatus* from southern Pará (ZUEC specimens) males range from 46.3–55.3 mm SVL (mean 50.7, SD=4.0, N=4; mean female SVL 50.8, SD=2.9, N=2).

Additionally, we performed Principal Component Analysis (PCA) on raw measurements of topotypes of *H. multifasciatus* (R. de Sá unpublished thesis) and our new species. The first three principal components accounted for 77.8% of the overall variation and PCA factor loadings are given in Appendix 2. A plot of factor scores on the first two axes (Figure 11) showed that the new species (MG) and the topotypes of *H. multifasciatus* (PA) overlapped completely along the first PC axis, which represented overall size (Table 1). In contrast, along the second PC axis, the new species was almost completely separated from *H. multifasciatus* topotypes, reflecting its relatively narrower eye-nostril distance (END), wider head (HW), smaller eye diameter (ED), and longer foot (FL) in relation to the topotypic (Belém, State of Pará) population.

The new species have significantly wider head (homogeneous slopes ANCOVA, $F_{1,19}=18.293$; $p<0.001$) than topotypic *H. multifasciatus* (Figure 12).

Head width/head length ratio was significantly ($t=5.84$; $p<0.001$; $df=20$) larger in *H. paranaiba* sp. n. than in *H. multifasciatus*. In the former, head slightly longer than wide (N=9), sometimes wider than long (N=2) and in one case as long as wide (HW/HL = 0.91–1.05, mean 0.96, SD=0.04, N=12 males), in the latter, head always longer (on average 14%) than wide (HW/HL=0.79–0.92, mean 0.86, SD=0.04, N=10 males; De Sá unpublished thesis).

Moreover, none of the specimens of *Hypsiboas paranaiba* sp. n. presents a black mid-dorsal stripe, which may be present in *H. multifasciatus*.

Hypsiboas paranaiba sp. n. presents three types of notes (notes A, B and C; see call description section and Figs. 4–5; Table 2). In our sample of calls, Amazonian *H. multifasciatus* presents calls resembling these three, and an exclusive fourth type (note D; presented below) (Figure 6), which presents harmonic structure. Note D is temporally similar to note C of *H. paranaiba* sp. n. but similar in dominant frequency to note A. Quantitatively note A of the new species differs from that of *H. multifasciatus* by presenting a significantly ($t=3.98$, $p=0.0022$, $df=11$) longer ($\approx 50\%$) call, more pulses per call ($t=2.68$; $p=0.0215$; $df=11$), and significantly ($t=2.54$; $p=0.027$; $df=11$) lower dominant frequency (Figures 4–5; Table 2). The new species differs from *H. raniceps* (mean call duration = 162.7 ms (114–244), SD=30.8; mean dominant frequency = 0.76 kHz (0.71–0.90), SD=0.03, N=31 calls) and *H. lanciformis* (mean call duration = 390.4 ms (252–566),

SD=75.4; mean dominant frequency = 1.65 kHz (1.49–1.87), SD=0.1; N=23 calls) by presenting sharper (higher in pitch) and longer calls (Marquez *et al.* 1993; Figure 9); from *H. albopunctatus* (dominant frequency from 1.8 to 2.0 kHz in Riviera, Uruguay, and in the State of São Paulo, Brazil; from 2.0 to 2.3 kHz in the State of Rio Grande do Sul, Brazil; and from 1.9 to 2.1 kHz in Misiones, Argentina), by sharper (higher in pitch) call and absence of pulses in well-delimited groups (Kwet *et al.* 2002; Figure 10).

TABLE 1. Measurements of *H. multifasciatus* and *H. paranaiba* **sp. n.** type-series from type-localities. Mean and (SD). To holotype values, see text.

Features (mm)	<i>H. multifasciatus</i>	<i>H. paranaiba</i> sp. n.	
	Type locality (PA)	Type locality (MG)	
	Males ¹ (N=10)	Males ² (N=12)	Females (N=3)
Snout-vent length	50.2 (3.7)	49.0 (2.1)	48.9 (2.5)
Head width	15.7 (0.7)	16.7 (0.7)	16.6 (0.8)
Head length	18.3 (1.1)	17.4 (1.1)	17.4 (0.7)
Eye diameter	5.5 (0.4)	4.9 (0.4)	4.8 (0.1)
Tympanum diameter	3.5 (0.4)	3.5 (0.3)	3.1 (0.5)
Foot length	21.4 (1.4)	22.4 (1.1)	20.8 (0.7)
Hand length	14.1 (0.7)	14.2 (0.8)	12.8 (0.6)
Shank length	29.2 (2.0)	29.1 (2.0)	29.1 (0.8)
Thigh length	*	28.6 (1.4)	28.1 (0.7)
Finger III disk diameter	*	2.0 (0.2)	1.8 (0.2)
Toe IV disk diameter	*	1.7 (0.2)	1.5 (0.3)
Eye-nostril distance	5.7 (1.0)	4.7 (0.3)	4.8 (0.1)

¹ Specimens from the unpublished thesis of R. de Sá

² Including the holotype

* Measurements not provided.

Holotype description: ZUEC 16244 (Figures 1b, 2 and 3b). Body slender to robust; head slightly longer than wide; snout pointed, sub-elliptical in dorsal view, slightly protruding in lateral view; nostrils slightly protuberant, directed laterally; tympanum diameter 86% of eye diameter; canthus rostralis distinct; loreal region slightly concave; eye-nostril distance 90% of eye diameter; cranial crests absent; tympanum circular; supratympanic fold present from the proximal border of the eye to around half of the body in the flanks; vocal sac single, subgular. Forearm more robust than arm, but not hypertrophied; a discrete dermal ridge on outer forearm from the elbow articulation to outer edge of finger IV; inner metacarpal tubercle evident, elongated, the outer indistinguishable; prepollex defined, prepollical spine as a curved pointed fang, hidden under the skin; fingers slender; subarticular tubercles single, rounded; few small supernumerary tubercles present; finger disks large, circular; first finger disk remarkably smaller than those of the other fingers; finger 1<2<4<3; diameter of third finger disk 34% of eye diameter, and about 40% of tympanum diameter; fingers mostly fringed along sides, mostly free from one another; webbing formula, I none II2–3^{1/2}III3–2IV. Legs long, slender; thigh slightly shorter than shank; a discrete dermal ridge on outer tarsus, from tibiotarsal articulation to outer edge of toe V; no calcar; inner metatarsal tubercle ovoid; outer undefined; subarticular tubercles single, rounded; few discrete supernumerary tubercles on plant; toe disks less defined than those of fingers; toes extensively webbed; toe 1<2<3≈5<4; webbing formula, II–2⁺III1–2^{1/2}III1–2^{1/2}IV2–1V. Skin on dorsal surfaces smooth; gula and chest smooth, belly and under surfaces of thighs areolate; a transversal supra-anal dermal ridge.

Measurements (mm) and proportions (%) in relation to size: SVL 49.6, SL 30.4 (61.3), TL 29.8 (60.1), FL 23.8 (48.0), HAL 13.1 (26.4), HL 16.8 (33.9), HW 16.5 (33.3), END 4.5 (9.1), FDD 1.7 (3.4), TDD 1.6 (3.2), ED 5.0 (10.1), TD 4.3 (8.7).



FIGURE 1. General aspect of males *H. paranaiba* sp. n. in life. A) A paratype (AAG-UFU 4793) from Ituiutaba, B) Holotype (ZUEC 16244).

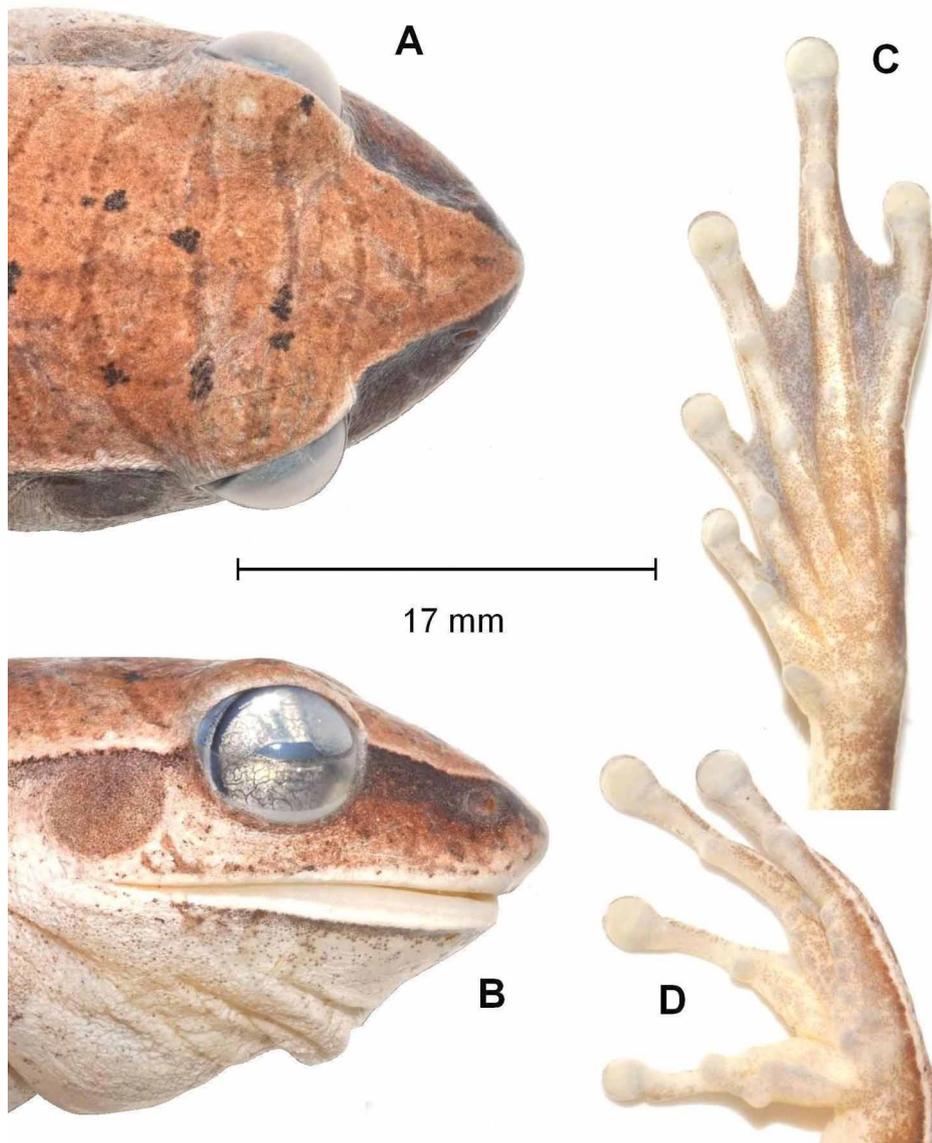


FIGURE 2. General aspect of the *H. paranaiba* sp. n. holotype. (ZUEC 16244). A) Head view from above; B) Head view from right side; C) Plantar view; D) Palmar view. Scale bar=17 mm.

Color. In preservative (ethanol 70%), dorsum reddish brown with darker brown transversal stripes, irregular black spots and few small light dots scattered on dorsal surface of body and limbs. A darker stripe on loreal region; a straight black line bordering the supratympanic fold. Lower lip bordered by a thin white stripe. Flanks essentially brownish, immaculate. Dermal ridge along outer forearms, evidenced in white. Anterior surface of thighs uniformly brownish, without dots or bars; posterior surface of thighs brownish, with very small (<1 mm) light dots; dermal ridge along outer tarsi, evidenced in white; dark brown stripe along the posterior surface of shanks; gular region cream, with a brown stripe surrounding the border of jaw; chest whitish cream, smooth; belly yellowish cream; under surface of limbs cream; outer portion of the ventral surface of tarsi, feet and hands, including the webbing, grayish.

Intra-oral features (paratypes AAG-UFU 2587 and ZUEC 16245): vocal slits present, at the inner border of jaws; tongue large, rounded, covering the entire floor of mouth, free and slightly notched behind; vomerine teeth in two arch-shaped rows nearly in medial contact, between widely separated broad choanae.

Variation: Variation in size is given in Table 1. There were specimens with color in preservative from a light gray (AAG-UFU 4687 and AAG-UFU 4688), nearly white in some parts, to a very dark brown (AAG-UFU 4619), almost the same color as the transversal stripes. There were specimens with well-delimited small

white dots on inguinal region in addition to the dorsal surface. The quantity and distribution of black spots and white dots were quite variable within the type-series. The females (AAG-UFU 3941, AAG-UFU 3942 and AAG-UFU 4074) presented a darker color (tending to grayish rather than creamish) along gular region, chest, posterior belly, and ventral surface of thighs, shanks, hands and feet.

TABLE 2. Advertisement call of *H. multifasciatus* from type locality, State of Pará (De Sá 1996; Duellman 1970) and from the State of Maranhão (Toledo 2008); advertisement call of *H. paranaíba* sp. n. from the type locality (present work, MG) and from the State of Goiás (Guimarães *et al.* 2001). Mean, SD and ranges respectively. The letter “N” represents the number of recorded specimens. The question mark represents data either not provided or unavailable for analysis.

Source	<i>H. paranaíba</i> sp. n.		<i>H. multifasciatus</i>		
	Present work (MG) N=8	Guimarães <i>et al.</i> (2001) (GO) N=5	De Sá (1996) (PA) N=5	Duellman (1970) (PA) N=5	Toledo (2008) (MA) N=1
Call duration (ms) (note A)	533 (70.7) 405–701	577 (49.8) 541–651	345 (?) 310–446	383 (57.2) 243–597	367 (67.3) 308–490
Dominant frequency (kHz)	2.63 (0.2) 2.25–2.93	2.31 (0.05) 2.27–2.38	2.7 (?) 2.5–3.0	2.92 (0.2) 2.6–3.4	2.80 (0.2) 2.6–3.1
Repetition rate (call group/min)	1.8 (0.9) 1–3	5.0 (3.0) 2–9	?	2.0 (0.6) 0–3	1.5 (0.7) 1–2
Internote interval (ms) (note A)	388 (121.3)	?	?	441 (46.5)	?
Pulses/call	129.3 (27.4) 100–168	102 (?) 87–127	60.4 (?) 46–72	92.8 (16.1) 72–110	61.5 (19.1) 48–75
Pulse duration (ms)	3.49 (0.65) 1.6–4.5	3.45 (0.49) 2.9–3.9	?	3.00 (0.30) 2.1–4.0	2.7 (0.6) 1.2–4.2
Repetition rate (pulses/sec)	246 (41.9) 192–302	?	158 (?) 124–184	200.8 (30.1) 166–235	237.5 (9.2) 231–244

Color in life: Iris bronze to light gray, mostly with a blue ring or half a ring around it. White thin stripe on lower lip; dark brown from the tip of snout until the distal border of the eye on loreal region; dark brown line just below the supra-tympanic fold; dorsum reddish to light yellow, with irregular dark spots, often present on dorsal surfaces, flanks immaculate. Throat cream and belly yellowish cream, with small dark dots surrounding the border of jaw. Small light dots on outer surfaces of thighs, and on inguinal region on a dark brown background. Broad brownish transversal stripes on dorsum, and on dorsal surface of thighs, shanks and arms, outlined by a narrow white line. White transversal supra-anal dermal ridge, and white dermal ridges from the elbow and tibiotarsal articulations to the outer tip of the fourth finger and fifth toe. Brownish stripe along outer surface of tarsi.

Color in preservative: dorsum brownish, reddish to light grayish or cream, brownish dorsal transversal stripes, ventral surface of gula and chest cream, belly yellowish cream. Blue ring around iris absent. Small dark dots surrounding the border of jaw, sometimes extending to the gula and chest regions, mainly observed in females.

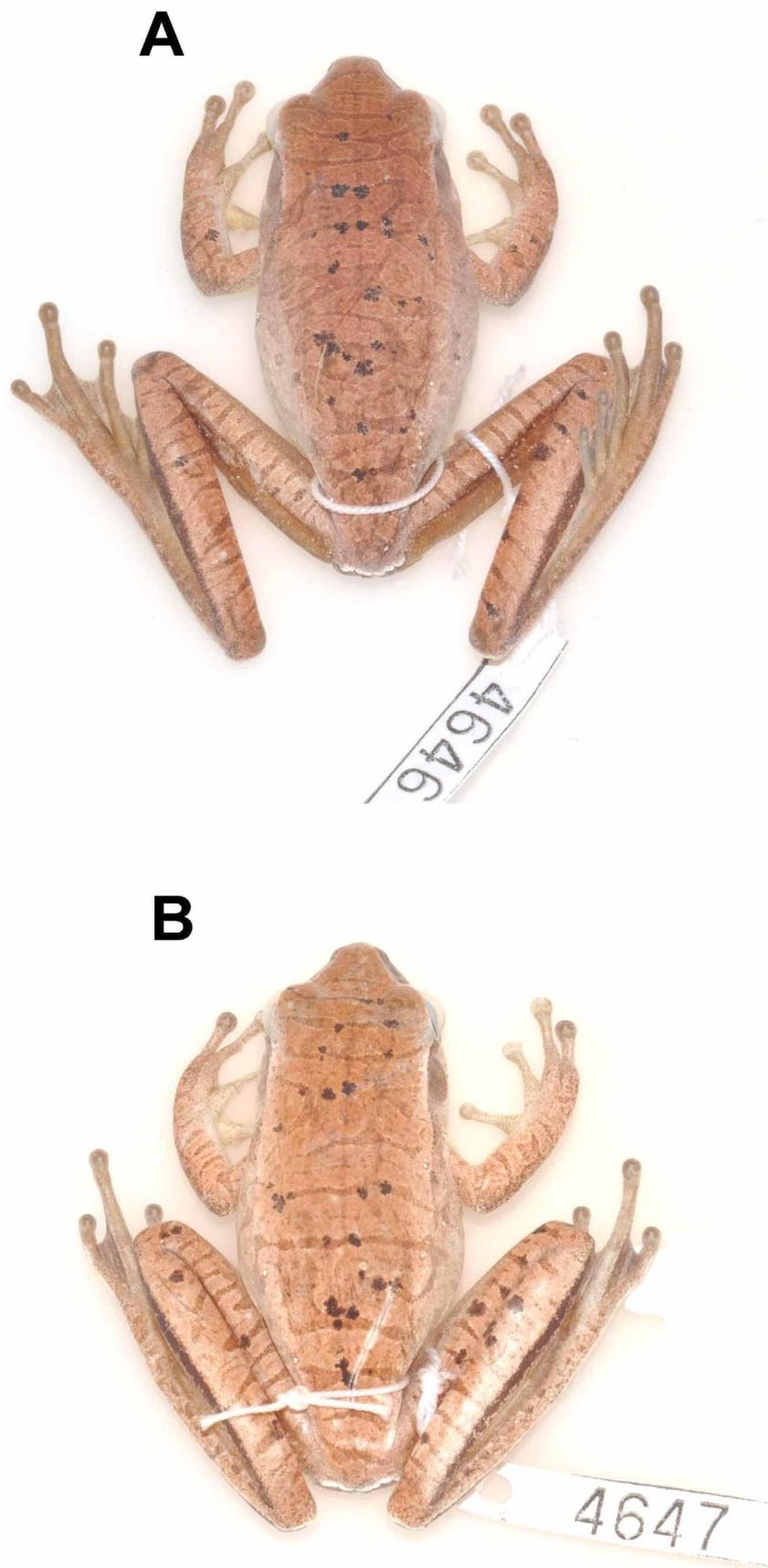


FIGURE 3. General aspect of males *H. paranaiba* sp. n. (A–B). A) Paratype ZUEC 16243 (former AAG-UFU 4646), and B) Holotype ZUEC 16244 (former AAG-UFU 4647) from Araguari, State of Minas Gerais.

Habitat and Behaviour: Males (N=15) call at forest border along streams in relatively shaded environments, such as palm grove marshes, forests, or nearby (< 50 m) open areas (N=1). Males call on the ground or perched on the vegetation up to 2 m high. In Ituiutaba, three species of the *H. albopunctatus* group were found calling at close range from each other, where *H. raniceps* and *H. albopunctatus* call in open areas, while *H. paranaiba* sp. n. calls from the forest border to inside. Other syntopic forest species include *Hypsiboas lundii* Burmeister, *Barycholos ternetzi* Miranda-Ribeiro, *Leptodactylus* aff. *leptodactyloides* Andersson, and *Dendropsophus cruzi* Pombal & Bastos. In Araguari, *H. paranaiba* sp. n. was heard all year round, except July. Some of the collected specimens had the dorsum full of superficial scars (Figure 3b), probably caused by male-male interactions.

***H. multifasciatus* calls:** Five males recorded (KU 128470–74); N=5 recordings (7755–7759): note A = 25, note D = 17). Calls with four types of notes. The advertisement call (here called note A, Figure 5) is released alone or in groups of 1–3 calls/call group. Advertisement call repetition rate ranges from 1–3 calls/min. (mean 1.8 calls/min, SD=0.4; N=5). It presents a pulsed structure and shows no significant modulation. Note duration ranges from 243–597 ms (mean 383 ms, SD=57.2; N=5), with a mean time interval of 441 ms (SD=46.5; N=5). The mean pulse repetition rate is 200.8 pulses/sec. (SD=30.1; N=5), and mean number of pulses per call is 92.8 (SD=16.1; N=5); dominant frequency ranges from 2.60–3.40 kHz (mean 2.92 kHz; SD=0.2; N=5). Call sections with note types B and C were improper for detailed analysis and graphing. Note D (Figure 6) presents between 5–6 visible harmonics (the fundamental being the weakest, around 500 Hz, sometimes not present in the sonograms, and the other five well-defined). Note D is emitted 1–3 times in a single sequence, usually just before the advertisement call (note A). Note D duration ranges from 79–180 ms (mean 119.4 ms, SD=25.6; N=5), dominant frequency ranges from 2.60–3.00 kHz (mean 2.81 kHz, SD=0.2; N=5), and corresponds to the fifth harmonic.

***H. paranaiba* sp. n. calls:** eight males recorded (AAG-UFU 4793–94, ZUEC 16243–44, one male from the paratopotypes (AAG-UFU 4648 or ZUEC 16245), and three non-collected males); N=10 recordings: note A = 25, note B = 22, note C = 9). Calls with three types of notes. The advertisement call (note A, Figure 4) is emitted alone or in groups of 1–5 calls/call group. Advertisement call repetition rate ranges from 1–3 calls/min. (mean 1.8 calls/min.; SD=0.9, N=8). It consists of a pulsed structure with no noticeable modulation. Note duration ranges from 405–701 ms (mean 533 ms; SD=70.7; N=8), with a mean time interval of 388 ms (SD=121.3; N=8); dominant frequency ranges from 2.25–2.93 kHz (mean 2.63 kHz; SD=0.2; N=8). The mean pulse repetition rate is 246.0 pulses/sec. (SD=41.9; N=8), and the mean number of pulses per call is 129.3 (SD=27.4; N=8).

The other two types of notes could be released intermingled with note A in variable sequences, such as BAAA/BAA/BA or AAAB/AA, rarely AAC/AC. Note B (Figure 7) may be executed 0–3 times per call, having a pulsed structure and showing both frequency and intensity modulation between the first and second thirds of the note (at the beginning slightly lower than 1 kHz). Note duration ranges from 513–993 ms (mean 825 ms; SD=50.7; N=3), with a mean time interval of 679 ms; dominant frequency peaked at 1.0 kHz (SD=0; N=3). The mean pulse repetition rate is 85 pulses/sec., and the mean number of pulses per call is 70. Note C (Figure 8) is seldom released (N=3 males), and it may be emitted alone or just after either a note B (usually) or A (rarely). It presents a pulsed structure, resembling a less intense and shorter note B. Note duration ranges from 219–594 ms (mean 501 ms; SD=65.1; N=2), dominant frequency ranges from 0.87–1.03 (mean 1.0 kHz; SD=0.1; N=2).

Etymology: the specific epithet “*paranaiba*” (variation “*parnaiba*”) comes from the indigenous Tupi language, and means muddy-watered or large river. It is used as a noun in apposition and refers to the Paranaíba River, which flows through most of the northern border of the Triângulo Mineiro region, and is close to the sites where the type-series of *H. paranaiba* was collected. The Tupi language word “*paraná*” by itself stands for the branch of a river, a water canal, or like the sea.

Distribution: Species known from the municipalities of Araguari and Ituiutaba in southeastern Brazil.

Additional remarks: Call duration and dominant frequency of *H. paranaiba* sp. n. coincided with those presented in Guimarães *et al.* (2001) for a population which they called *H. multifasciatus* (Table 2). Subsequently we assigned populations previously identified as *H. multifasciatus*, from which we have advertisement calls, in the Cerrado savanna biome of southeastern and central Brazil in the States of Minas

Gerais and Goiás to *H. paranaíba* **sp. n.** Thus the name *H. multifasciatus* should be probably restricted to the Amazon Forest Domain. Specimens from forest environments in northeastern Brazil, State Ceará (Loebmann *et al.* 2007), regarded as *H. multifasciatus* deserve an acoustic and morphological evaluation of its taxonomic status.

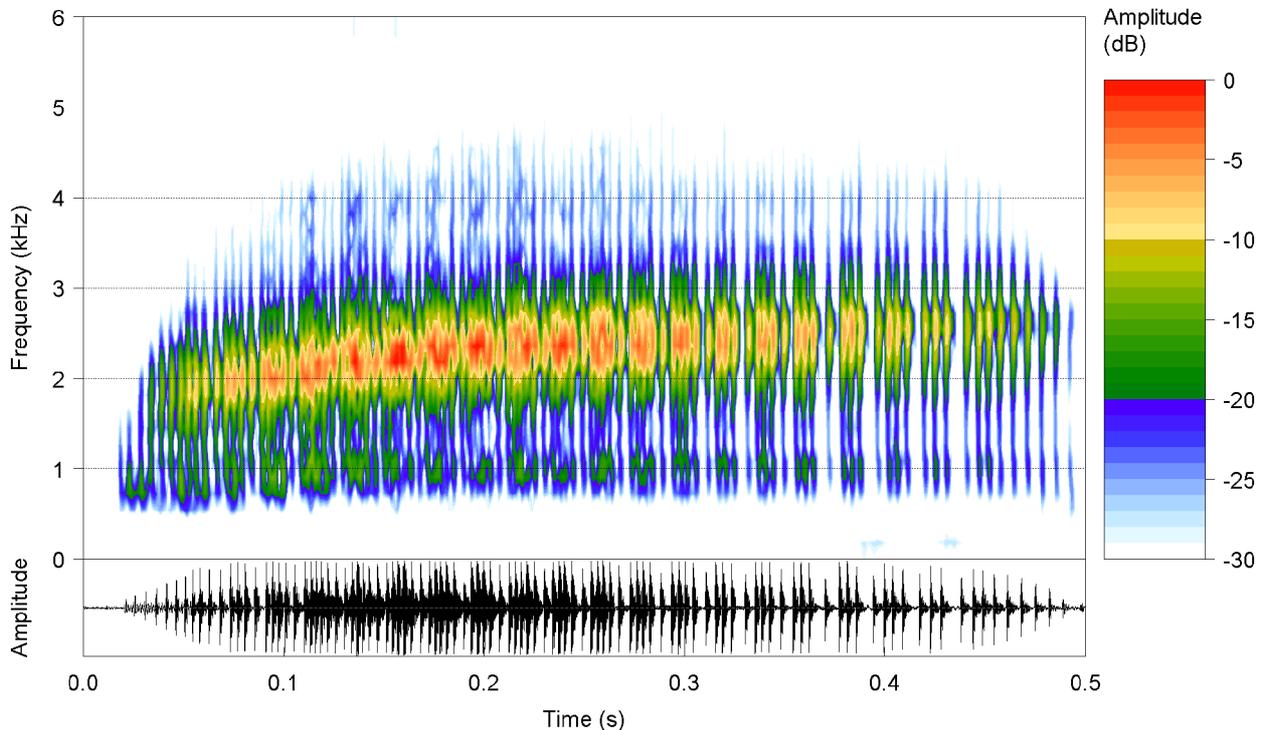


FIGURE 4. Audiospectrogram of the *H. paranaíba* **sp. n.** advertisement call. Unvouchered recording from the type locality. Record file Hypsib_paranaMG5AAGb; 1904 hs, 31 Oct 2008; air 27.0 °C, water 25.0 °C. Figure settings: FFT=256 points.

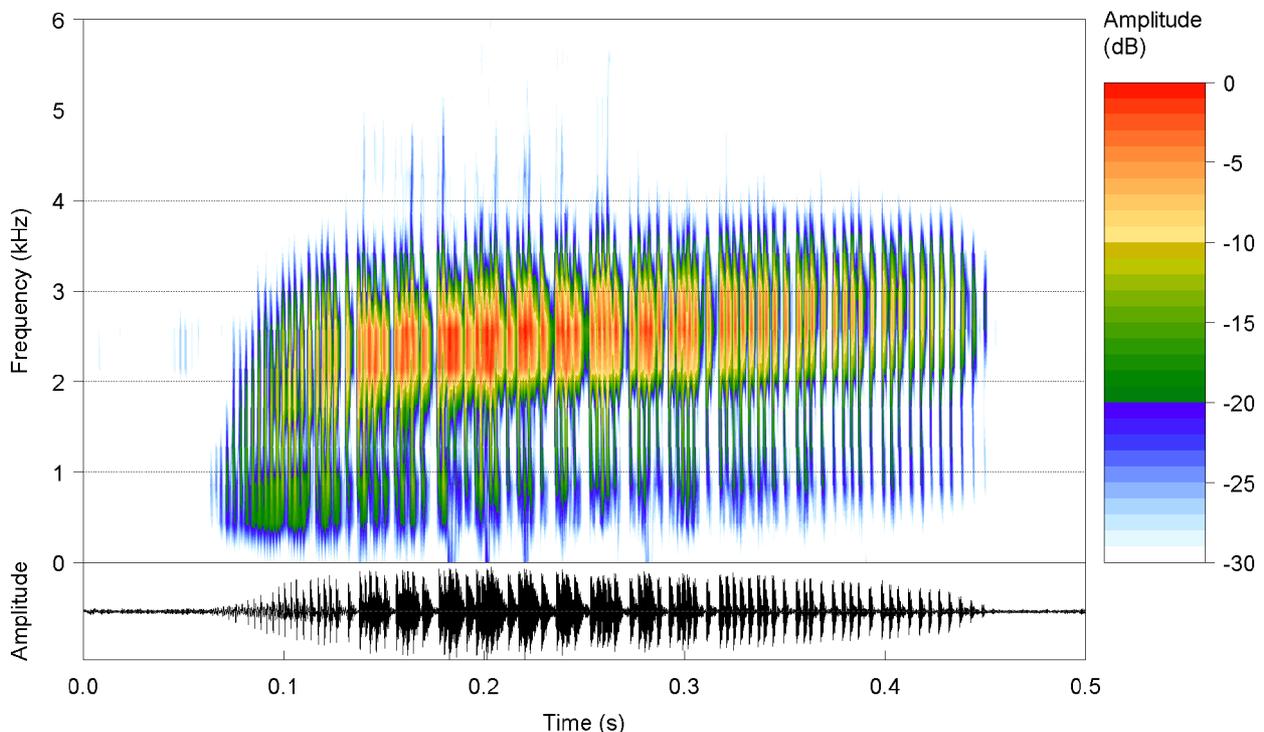


FIGURE 5. Audiospectrogram of the advertisement call of a *H. multifasciatus* specimen from the type locality (Belém, PA). Record file 7756 by W.E. Duellman; 2020 hs, 31 Mar 1970; air 27.0 °C. Figure settings: FFT=256 points.

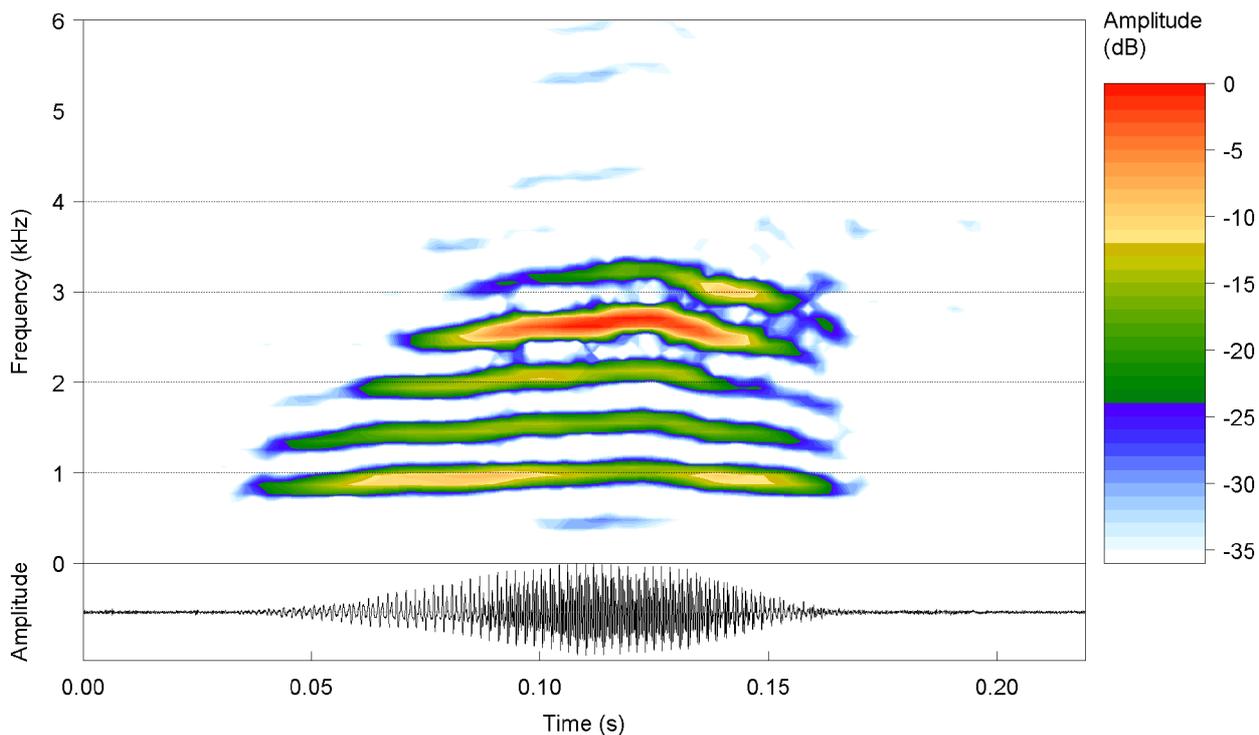


FIGURE 6. *Hypsiboas multifasciatus* note D (as detailed in text). Record file 7756 by W.E. Duellman; 2020 hs, 31 Mar 1970; air 27.0 °C. FFT=1024 points.

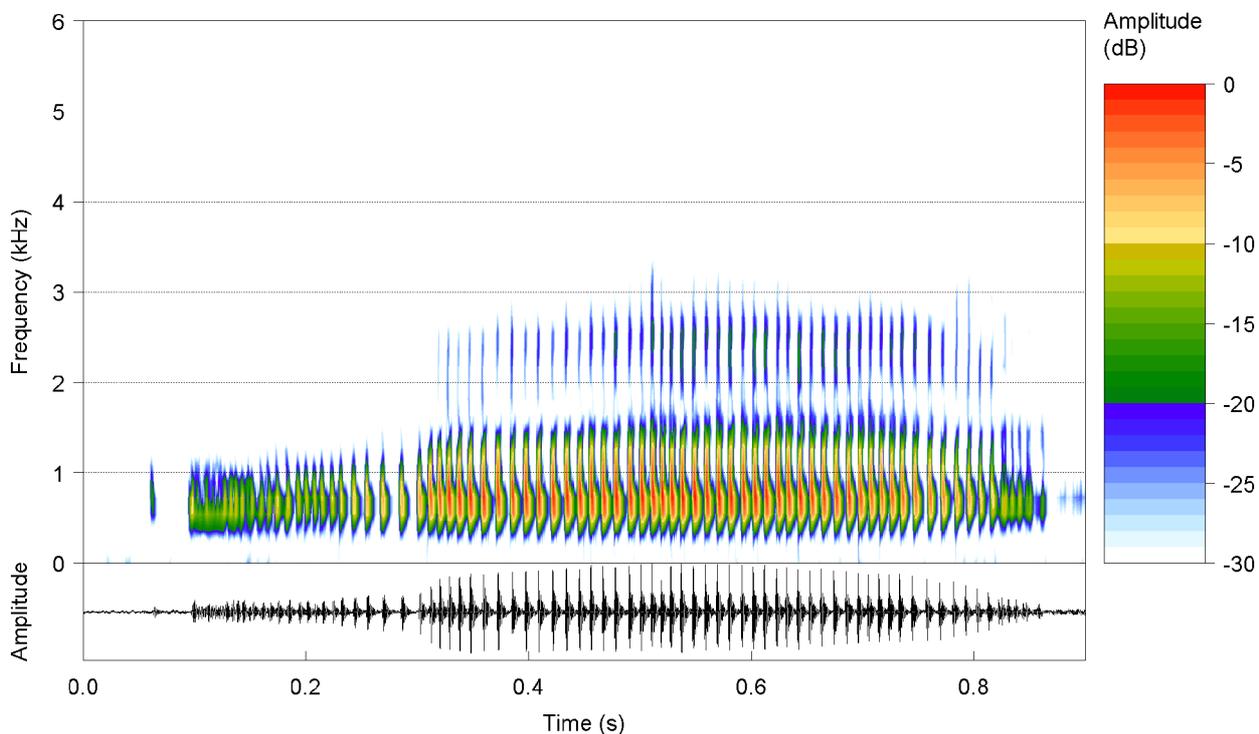


FIGURE 7. *Hypsiboas paranaiba* sp. n. note B (as detailed in text). Voucher specimen: holotype (ZUEC 16244). Record file Hypsib_paranaMG3AAGb; 2040 hs, 3 Oct 2007; air 29.0 °C, water 24.0 °C. FFT=256 points.

Field studies are necessary to clarify if notes *B* and *C* of *H. multifasciatus* and *H. paranaiba* sp. n. can be regarded as aggressive calls (*sensu* Wells 2007), as well as the precise role of *H. multifasciatus* note *D*.

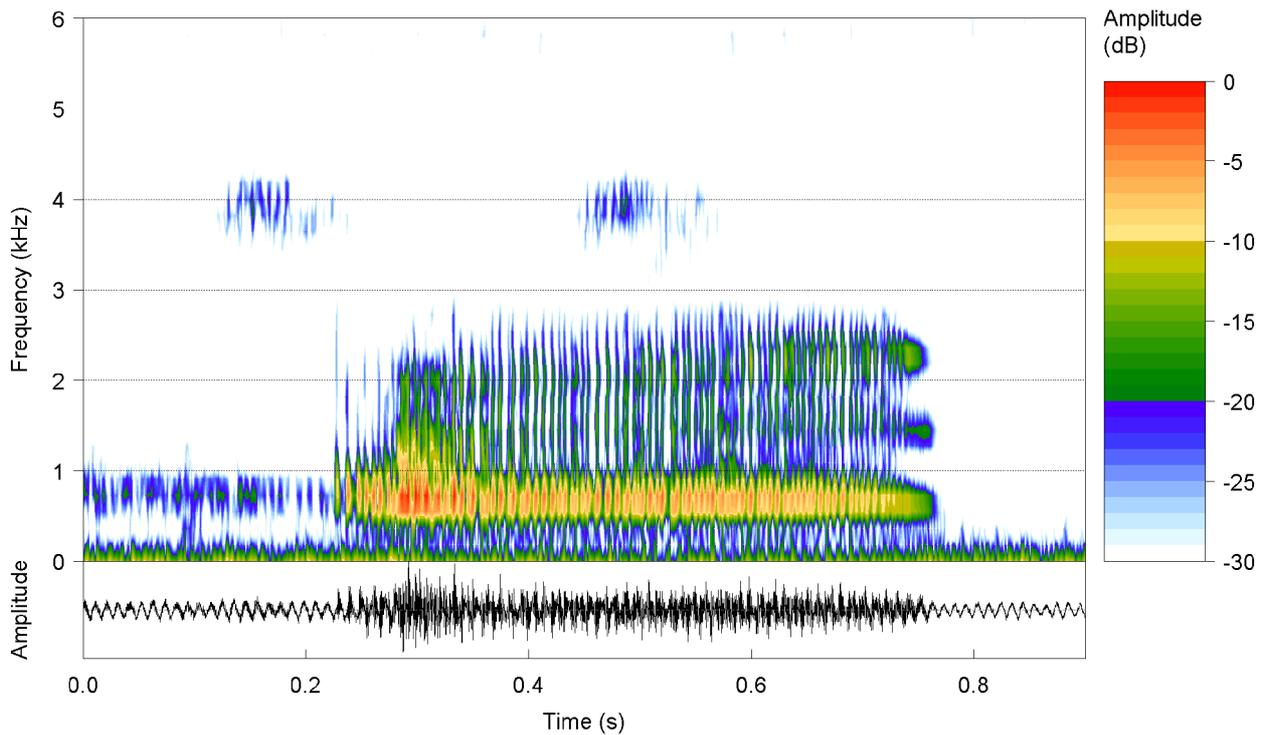


FIGURE 8. *Hypsiboas paranaiba* sp. n. note C. Voucher specimen: paratype (ZUEC 16243). Record file Hysib_paranaMG7bAAGb; 2011 hs, 31 Oct 2008; air 27.0 °C, water 25.0 °C. FFT=256 points.

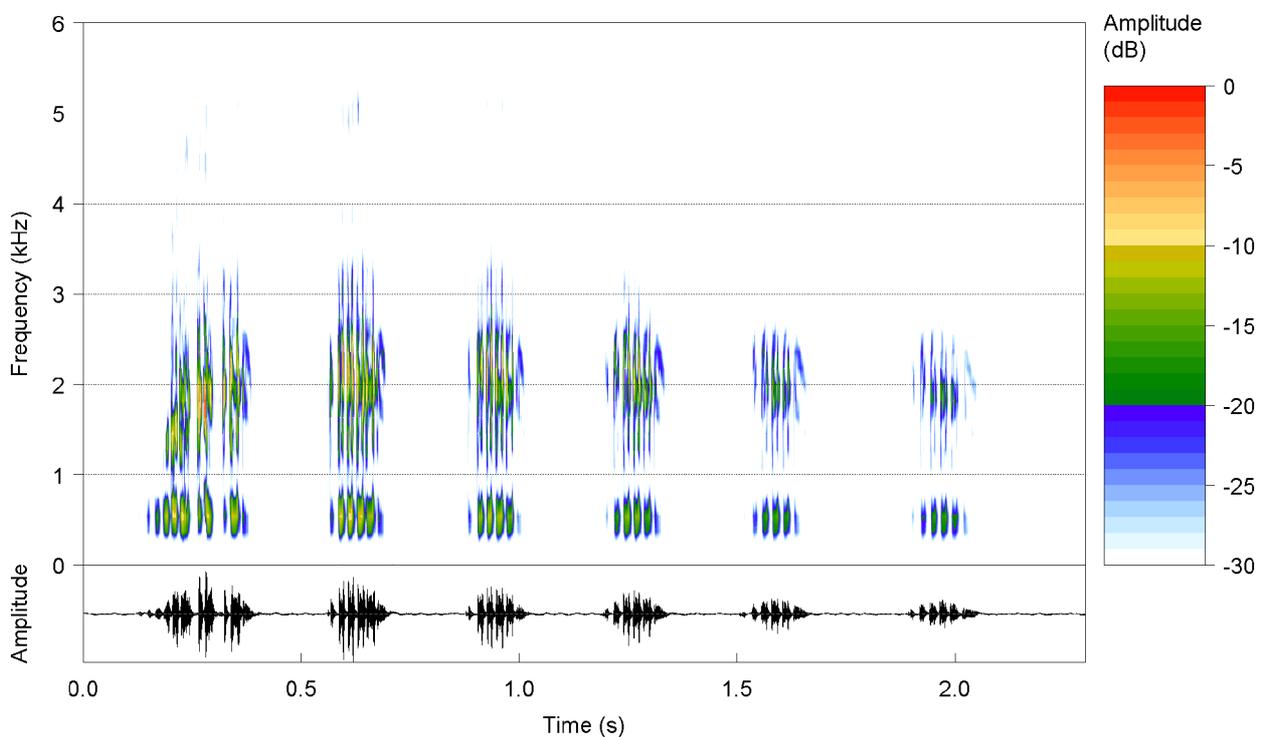


FIGURE 9. Audiospectrogram of the *H. raniceps* specimen advertisement call from Uberlândia. Record file Hysib_ranicepsMG1AAGb; 1930 hs, May/2003; air 25.0 °C, water 30.0 °C. FFT=256 points.

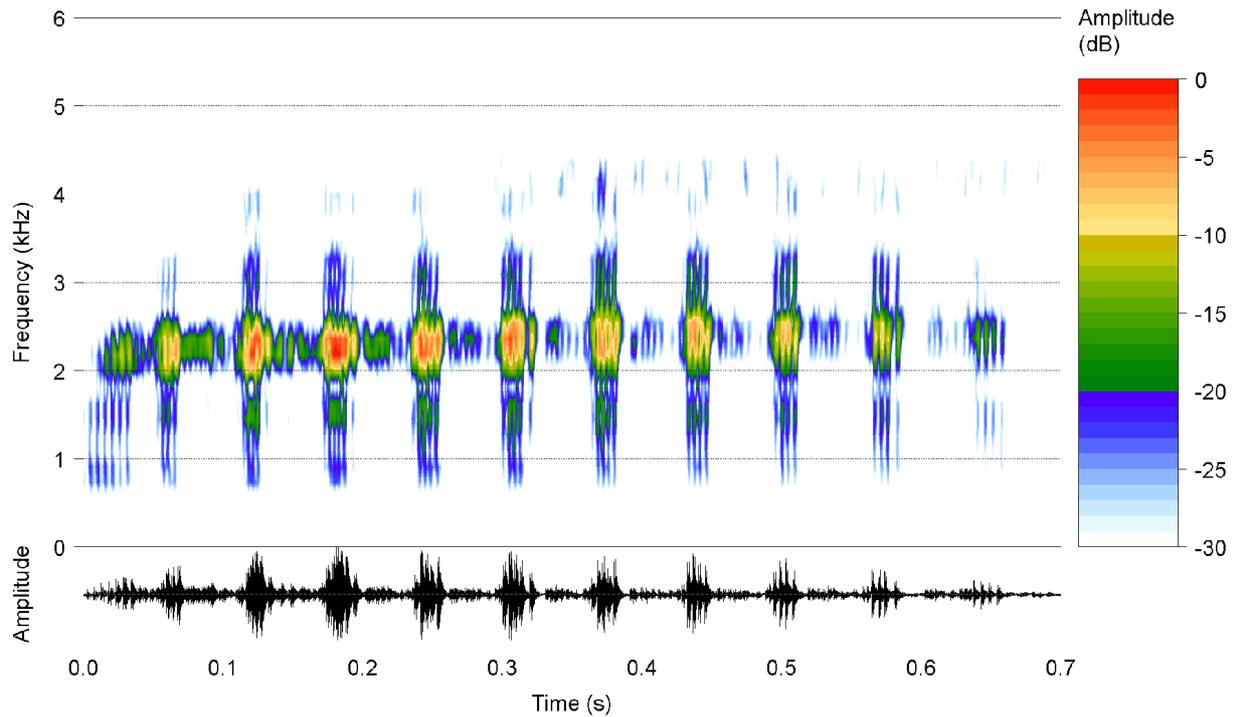


FIGURE 10. Audiospectrogram of the advertisement call of a *H. albopunctatus* specimen from Uberlândia. Record file Hysib_albopunctatusMG1AAGmt; 2045 hs, Dez/2008; air 21.6 °C, water 23.2 °C. Figure settings: FFT=256 points.

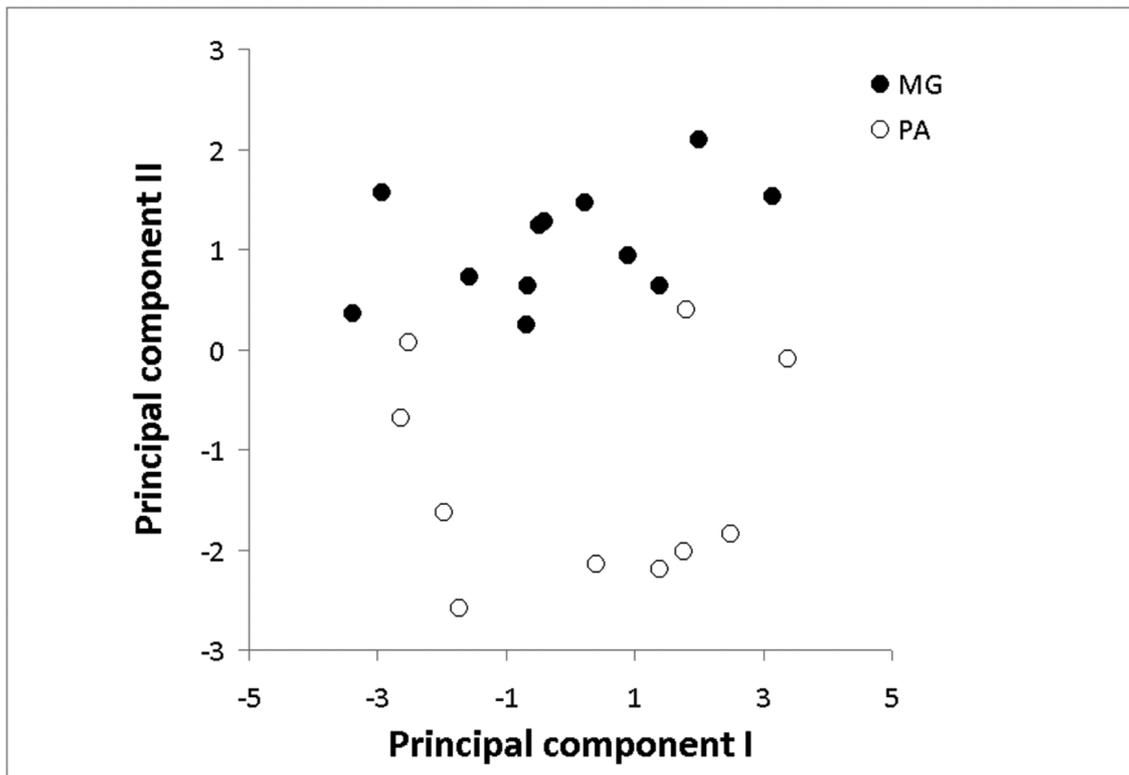


FIGURE 11. Scatterplot of factor scores from first two principal component axes for adult male specimens of *H. multifasciatus* (open circles) and *H. paranaiba* **sp. n.** (closed circles).

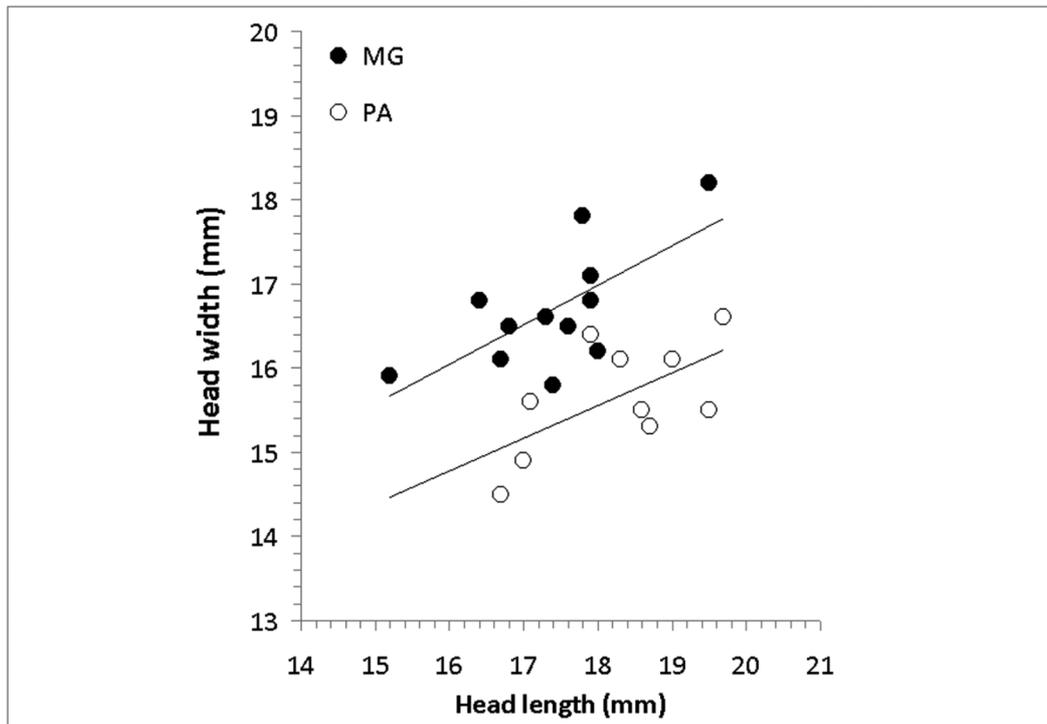


FIGURE 12. Relationship between head width (HW) and head length (HL) for adult male specimens of *H. paranaiba* sp. n. (closed circles) and *H. multifasciatus* (open circles) using head length (HL) as covariate.

Acknowledgements

Financial support by FAPEMIG and CNPq. Fellowships by CNPq (AAG) and FAPEMIG (TRC). Collection permit: IBAMA 02015.008064/02–51. Mr. Adir Lemos allowed access to his farm and provided facilities. Drs. W.E. Duellman, R. Marquez, L.F. Toledo, and Ms. D. Loebmann kindly provided sound files of *H. multifasciatus*. Dr. R. de Sá provided helpful insights on the status of some populations attributed to *H. multifasciatus*, sharing his measurement data (and discussion on the way measurements should be taken) on the species as well Dr. J. Sueur helped with the Seewave R package. Dr. L. F. Toledo and the biologist Nelson R. da Silva helped at the Museu de Zoologia da Universidade Estadual de Campinas (ZUEC). Mr. J. D. Bagnall made comments on the English version of the manuscript.

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APPENDIX 1. Other examined specimens.

Hypsiboas albopunctatus: AAG-UFU 2104, Petrópolis (RJ); AAG-UFU 2108, 2195, 2208, 2329, 2352, 3244, 4117, Uberlândia (MG); AAG-UFU 2613–14, Perdizes (MG); AAG-UFU 3199, 4568, 4684, Araguari (MG); AAG-UFU 4178–79, Monte Alegre de Minas (MG); AAG-UFU 4394, Sacramento (MG); AAG-UFU 4601–02, Itapeva (MG); AAG-UFU 4747, Capitólio (MG).

Hypsiboas lanciformis: ZUEC 9394, Barinas (Venezuela); ZUEC 14915–6, 16114–6, Paranaíta (MT); ZUEC 14974, 16071, Jacareacanga (PA); AAG-UFU 4869–74, Pontal do Araguaia (MT).

Hypsiboas multifasciatus: ZUEC 10174–6, Formoso do Araguaia (TO); ZUEC 13247–8, Palmas (TO); ZUEC 14484, 14966, 15027, 16068, 16070, 16072, 16113, Jacareacanga (PA) and Paranaíta (MT).

Hypsiboas raniceps: ZUEC 9495, Cruzeiro do Sul (AC); ZUEC 14386, São José do Bonfim (PB); ZUEC 14487, 14945, Jacareacanga (PA); ZUEC 14613, Porto Estrela (MT); AAG-UFU 2580-82, Uberlândia (MG); AAG-UFU 3195, 4125–26, 4151, Araguari (MG).

APPENDIX 2. PCA factor loadings.

Factor loadings, eigenvalues and percentage of variation explained for the first three principal components based on measurements from adult male specimens of *Hypsiboas multifasciatus* and *Hypsiboas paranaíba* **sp. n.** from the States of Pará and Minas Gerais.

Variables	PC1	PC2	PC3
SVL (mm)	0.390	-0.100	0.085
SL	0.459	0.065	0.041
FL	0.311	0.439	0.108
HAL	0.357	0.159	0.231
HW	0.249	0.497	0.113
HL	0.391	-0.215	0.021
END	0.217	-0.522	0.016
TD	0.260	0.068	-0.946
ED	0.290	-0.444	0.130
Eigenvalues	4.133	2.081	0.788
% of variance explained	45.923%	23.127%	8.751%