

Vocalizations and comments on the relationships of *Hypsiboas ericae* (Amphibia, Hylidae)

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ABSTRACT. The vocalizations of *Hypsiboas ericae* (Caramaschi & Cruz, 2000) are described and new information on the external morphology and osteology of the species are presented. *H. ericae* presents a bony spine in the prepolex and the individuals can present green or brown dorsal color, as other species of the *Hypsiboas pulchellus* (Duméril & Bibron, 1841) species group. The vocalizations of *H. ericae* are similar to the vocalizations of *Hypsiboas bischoffi* (Boulenger, 1887), *Hypsiboas guentheri* (Boulenger, 1886), and other species in the *H. polytaenius* (Cope, 1870 “1869”) clade of the *H. pulchellus* species group, but some osteological aspects are different to those found in the majority of the species of this group.

KEYWORDS. *Hypsiboas ericae*, vocalizations, osteology, *Hypsiboas pulchellus* group.

RESUMO. Vocalização e comentários sobre as relações de parentesco de *Hypsiboas ericae* (Amphibia; Hylidae). As vocalizações de *Hypsiboas ericae* (Caramaschi & Cruz, 2000) são descritas e novas informações sobre a morfologia externa e a osteologia da espécie são apresentadas. *H. ericae* apresenta prepólex terminando em um espinho ósseo e os indivíduos podem ter o colorido dorsal marrom ou verde, como outras espécies do grupo de *Hypsiboas pulchellus* (Duméril & Bibron, 1841). As vocalizações de *H. ericae* são similares às de *Hypsiboas bischoffi* (Boulenger, 1887), *Hypsiboas guentheri* (Boulenger, 1886) e às de outras espécies do clado de *H. polytaenius* (Cope, 1870 “1869”) do grupo de *H. pulchellus*, mas alguns aspectos de sua osteologia são muito diferentes dos encontrados na maioria das espécies do grupo de *H. pulchellus*.

PALAVRAS-CHAVE. *Hypsiboas ericae*, vocalização, osteologia, grupo *Hypsiboas pulchellus*.

Hypsiboas ericae (Caramaschi & Cruz, 2000) was described based on specimens obtained at Chapada dos Veadeiros, Alto Paraíso de Goiás, Goiás, Brazil (CARAMASCHI & CRUZ, 2000). In the original description, the species was included in the group of *Hyla pulchella* Duméril & Bibron, 1841 (now *Hypsiboas pulchellus* group *sensu* FAIVOVICH *et al.*, 2005) and related to *Hyla marginata* Boulenger, 1887, and *Hyla semiguttata* A. Lutz, 1925 (now *Hypsiboas marginatus* (Boulenger, 1887) and *H. semiguttatus* (A. Lutz, 1925)). During field studies realized at the type-locality of the species, we did new observations about *H. ericae*, including the vocalization recordings of some specimens. Some information about the diagnosis of the species were also verified by the study of part of the skeleton of some individuals. In this work, we describe the vocalization of *H. ericae* and comment on the species relationships according to the new informations obtained.

In a recent work, FAIVOVICH *et al.* (2005) transferred the *Hyla pulchella* species group to genus *Hypsiboas* and included the species of the *Hyla polytaenia* group as a clade in the *H. pulchellus* species group.

MATERIAL AND METHODS

For morphological and osteological studies some specimens from the following collections were examined: MNRJ, Museu Nacional, Rio de Janeiro, RJ, Brazil; MZUSP, Museu de Zoologia, Universidade de São Paulo, São Paulo, SP, Brazil; CFBH, Coleção Célio F. B. Haddad,

deposited in the Departamento de Zoologia, Universidade Estadual Paulista, Rio Claro, SP, Brazil.

The osteological characters were analyzed in cleared and stained specimens using the technique of TAYLOR & VAN DYKE (1985). Vocalizations of *H. ericae*, obtained from Rio dos Couros, Alto Paraíso de Goiás, central Brazil, in January 2001, were recorded using a Nagra E tape recorder and Sennheiser microphone ME-66, and analyzed using the software Canary 1.2.4 in Power Macintosh computer. The sounds were digitalized in 22.1 kHz and the spectrograms and waveforms were produced using frame length and fast Fourier transform (FFT) of 256 points, frame overlap of 50% and window function Hamming.

Material examined. BRASIL, Goiás: Alto Paraíso de Goiás, Chapada dos Veadeiros, ♀, 11♂ MZUSP 93850-93861 (93850 female), collected in 06-10 January 1974 by W.C.A. Bokermann; MNRJ 15875-15896 (15896 female), paratypes, collected in 22-25 April 1992 by U. Caramaschi; CFBH 3599-3604 (males) collected in 17 January 2001 by P.C.A. Garcia; (CFBH 6762-6765) 16 December 2003 by C. F. B. Haddad, R. P. Bastos, L. F. Toledo, L. Guimarães, and L. Lima. CFBH 3603 and 3604 cleared and stained.

RESULTS

Vocalization. Two males were recorded on 17 January 2001. Three distinct calls were observed in *H. ericae* (Fig. 1). The first of them, here denominated call “A” (Fig. 2), was the most frequent, being emitted 43 times in nine minutes of recording (\bar{x} = 4.8 calls/min). It is composed by an isolated note (“a” note), with pulsed

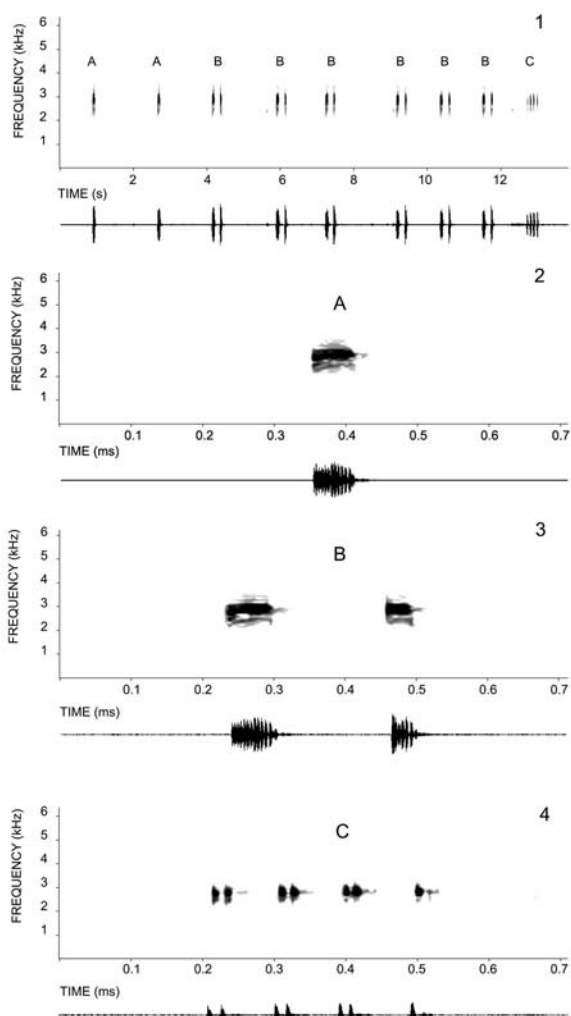
structure of 8-20 pulses/note ($\bar{x} = 14.5 \pm 2.74$), with duration of 33.6-92 ms ($\bar{x} = 67.5 \pm 13$) and frequency between 2.03 - 3.6kHz ($\bar{x} = 2.7 \pm 1$). The second call, denominated "B" call (Fig. 3), was the less frequent, being emitted 16 times in nine minutes ($\bar{x} = 1.8$ call/min), with duration of 229.8-317.9ms ($\bar{x} = 283.6 \pm 20.3$). This call is composed by two notes of pulsed structure: the first note is similar to "a" note of "A" call, with mean duration slightly larger, between 59.4 and 89.5ms ($\bar{x} = 75.5 \pm 9.1$), and frequency and number of pulses similar (Tab. 1) to those of note "a"; the second note, denominated "b" note, had smaller duration, between 40.9 e 62.5ms ($\bar{x} = 49.6 \pm 7.3$), frequency between 2.09-3.54kHz ($\bar{x} = 2.8 \pm 0.6$), and 7-10 pulses/note ($\bar{x} = 8.2 \pm 1.1$). The third call, "C" call (Fig. 4), was emitted 29 times in nine minutes ($\bar{x} = 3.2$ call/min), had a simple note, denominated "c" note, with

pulsed structure, from 2-11 pulses/note ($\bar{x} = 4.8 \pm 2.1$), duration between 103.6-560.3ms ($\bar{x} = 239.3 \pm 138.4$), and frequency between 2.12-3.54 ($\bar{x} = 2.8 \pm 0.4$). The "c" note is a trill, composed by pulses better defined than the previous notes, with duration of 6.1-49.9ms ($\bar{x} = 13.8 \pm 7.92$). The three calls are emitted independently from each other. The "C" call can be preceded by another "C" call, by an "A" call or a "B" call, occurring the same with the other calls. The calls "B" and "C" are more frequent when there are more individuals vocalizing. The function of each call is not clear, but judging for the constancy, the "A" call might correspond to the advertisement call and the "C" call to the territorial call; the function of the "B" call is unknown.

Color in life of the examined specimens. Dorsal color brown or green, with or without dark blotches. When there are blotches, these are rounded, large, and distributed irregularly along the dorsal surfaces of body and limbs. Dark brown dorsal blotches in brown specimens and dark green in green ones. A white dorsolateral stripe delimited inferiorly by a brown line, both from the superior eyelid to the inguinal region. Flanks dark brown (even in green specimens) with many small blotches, framed by a dark brown line. Some of the blotches fused, making larger and extended blotches. A whitish stripe on the upper lip, from the tip of snout to the arm insertion. Posterior surface of thigh not pigmented. Supra cloacal region with white and a dark brown stripe. Venter whitish, slightly darker in the chest and throat. Iris gold or tan, slightly lighter on the upper area.

Natural history. Specimens of *H. ericae* were found vocalizing on bushes and trees, always close to water, between 0.1 to 1m above the ground along limpid water streams inside or near gallery forest. The vocalization begins in the sunset. Males were found vocalizing in December and January. Males showed scars on the back (Fig. 5), probably a consequence of fights between males, with the use of prepollical spines. Females, clutches, and tadpoles were not found.

Comparison of osteology of *Hypsiboas ericae* and related species. Some specimens have green bones and others white. Some characteristics differentiate *H. ericae*



Figs. 1-4. Spectrogram (upper) and waveform (lower). (1) A continuous sequence of nine calls emitted by *Hypsiboas ericae* (Caramaschi & Cruz, 2000), showing A (2 calls), B (6 calls), and C calls. Recorded on 17 January 2001, 23:06 h; air temperature 20°C. Voucher specimen CFBH 3600. (2) The first call (A) of spectrogram of fig. 1, showing a simple pulsed note. (3) Third call (B call) of spectrogram of fig. 1, showing a call with two pulsed notes, the first with identical structure than note of A call. (4) Last call (C) of spectrogram of fig. 1; showing a pulsed note (trill), with seven pulses better defined.

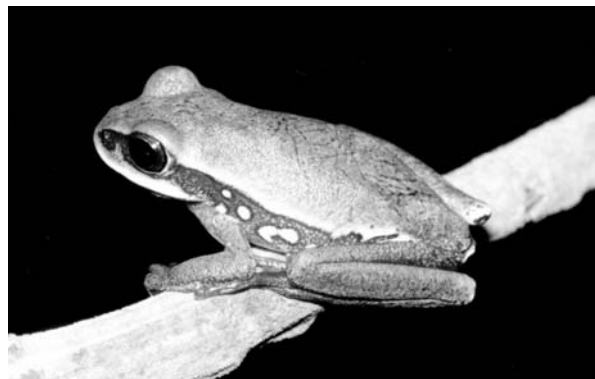
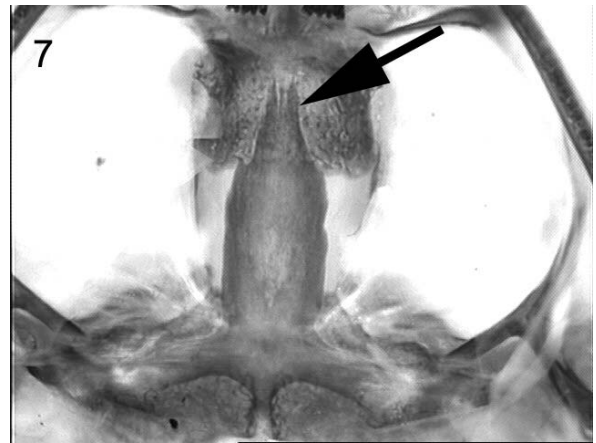
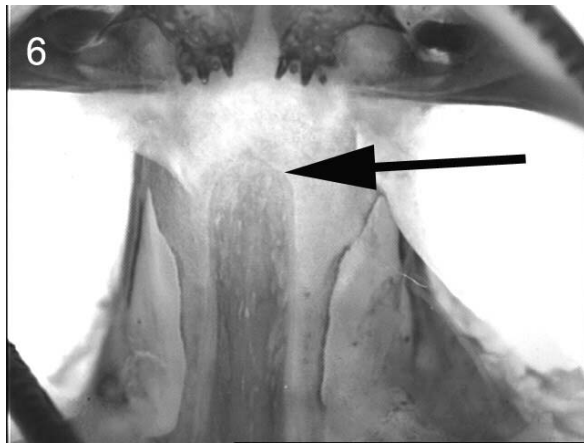


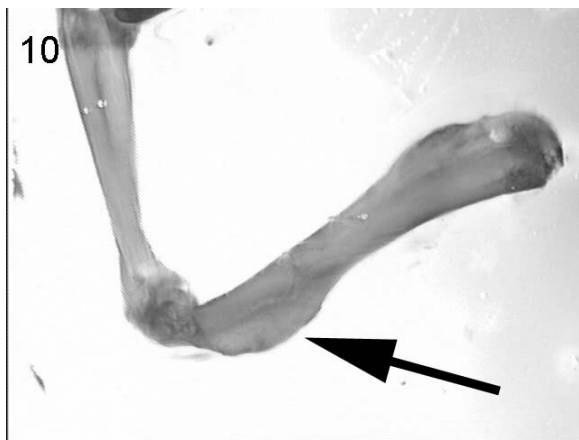
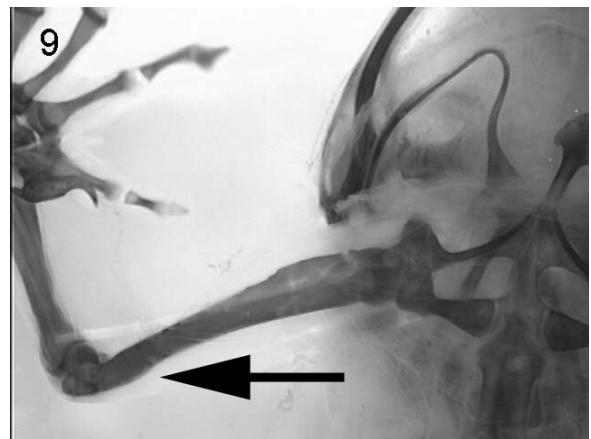
Fig. 5. Adult male of *Hypsiboas ericae* (Caramaschi & Cruz, 2000) (CFBH 3600). Note the scars on the back.

from some of the species included in the group of *H. pulchellus* (Duméril & Bibron, 1841), mainly from *H. marginatus* (Boulenger, 1887) and *H. semiguttatus* (A. Lutz, 1925). The main differences are: (1) distal tip of cultriform process of parasphenoid rounded in *H. ericae* and pointed in *H. marginatus*, *H. semiguttatus*, *H.*

prasinus (Burmeister, 1856), and *H. pulchellus* (Fig. 6 and 7); (2) humerus slender, with a rudimentary crista ventralis and medialis in *H. ericae* (Fig. 8), *H. pulchellus*, and *H. prasinus* (Fig. 9), and robust, with a crista ventralis and medialis largely developed in *H. marginatus* (Fig. 10) and *H. semiguttatus* (Fig. 11); (3) prepollex present,



Figs. 6-7. Distal part of cultriform process (arrow) of parasphenoid. 6, Rounded in *Hypsiboas ericae* (Caramaschi & Cruz, 2000) (CFBH 3604). 7, Acute and cut in *Hypsiboas marginatus* (Boulenger, 1887) (CFBH 3613).



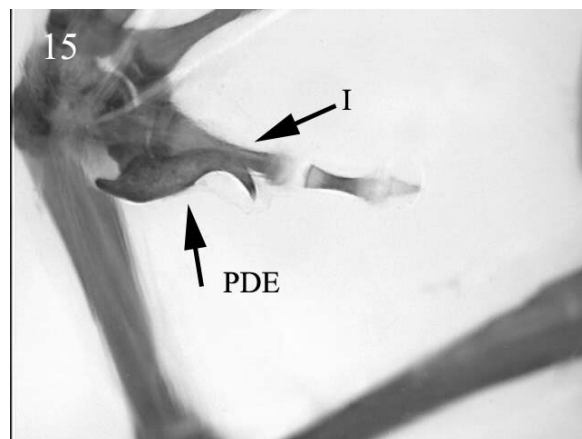
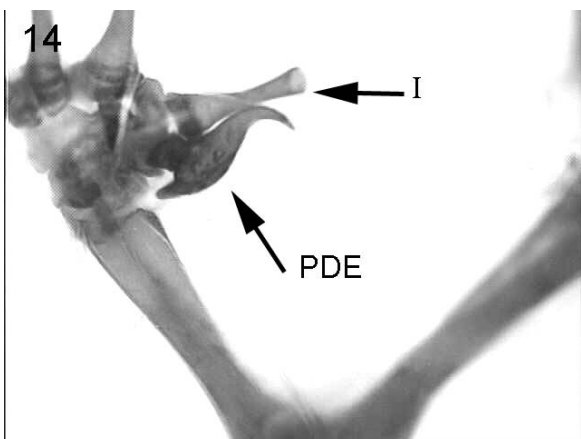
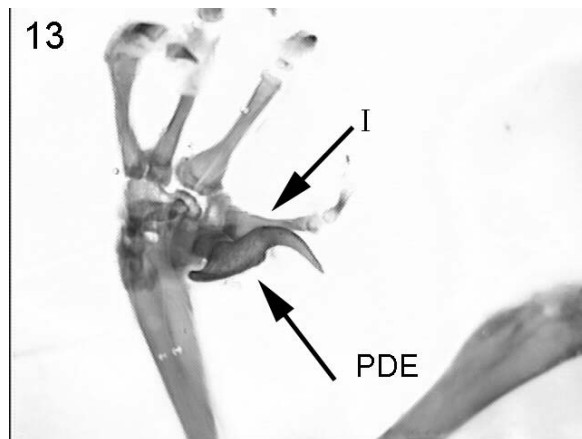
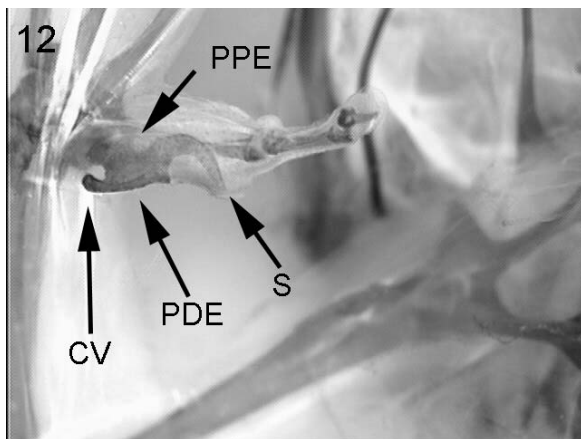
Figs. 8-11. Humerus. 8, *Hypsiboas ericae* (Caramaschi & Cruz, 2000) (CFBH 3604). See the slender bone without development of crista ventralis. 9, *Hypsiboas prasinus* (Burmeister, 1856) (CFBH 1318). Note the slender bone without development of crista ventralis. 10, *Hypsiboas marginatus* (Boulenger, 1887) (CFBH 3613). Note the strength bone and the development of crista lateralis (CL) and crista ventralis (CV). 11, *Hypsiboas semiguttatus* (A. Lutz, 1925) (CFBH 3581), showing the development of crista lateralis (CL) and crista ventralis (CV).

ending in a very robust and curved distal spine (almost 90°) (Fig. 12), while in *H. marginatus* and *H. semiguttatus* the spine is robust, but less curved (Fig. 13); in *H. prasinus* and *H. pulchellus* the spine is very curved, but less robust (Fig. 14 and 15); (4) the crista ventralis from the prepollical basis is very pronounced anteriorly in *H. ericae*, forming a second spine (Fig. 12), while the crista

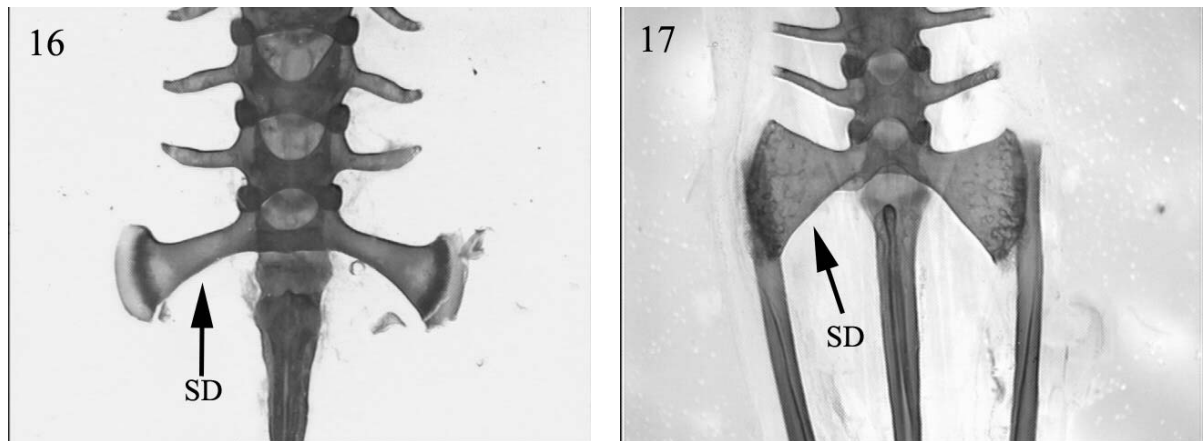
ventralis is developed in *H. semiguttatus* and *H. marginatus*, but does not form a spine anteriorly (Fig. 13), and is almost indistinct in *H. prasinus* and *H. pulchellus* (Fig. 14 and 15); (5) the sacral diapophysis is long and distally less broadened in *H. ericae* (Fig. 16), short and distally broad in *H. semiguttatus*, *H. marginatus*, *H. pulchellus*, and *H. prasinus* (Fig. 17).

Table 1. Physical parameters of vocalizations of *Hypsiboas ericae* (Caramaschi & Cruz, 2000) (two analyzed specimens). Upper line, range; lower line, mean (standard deviation). Recordings PCAG 20/1 and 20/3.

Call types	Note types	N° Sampled notes	Notes/call	Note duration (ms)	Range Frequency (kHz)	Pulses/note	Pulses duration (ms)	Call duration (ms)
A	a	43	1	33.6-92.0	2.03-3.60	8-20		33.6-92.0
				67.5 (13.0)	2.7 (1.04)	14.5 (2.74)	67.5 (13.0)	
B	a	16	1	59.4-89.5	2.01-3.60	12-18		229.8-317.9
				75.5 (9.1)	2.7 (0.6)	14.3 (1.7)	283.6 (20.3)	
	b	16	1	40.9-62.5	2.09- 3.50	7-10		
				49.6 (7.3)	2.7 (0.6)	8.2 (1.1)		
C	c	29	1	103.6-560.3	2.29- 3.54	2-11	6.1-49.9	103.6-560.3
				239.5 (138.4)	2.8 (0.4)	4.8 (2.1)	13.8 (7.92)	239.5 (138.4)



Figs. 12-15. Prepollex. 12, *Hypsiboas ericae* (Caramaschi & Cruz, 2000) (CFBH 3604). See the spine curve and the anterior development of crista ventralis (arrow), making a second spine. 13, *Hypsiboas marginatus* (Boulenger, 1887) (CFBH 3613). 14, *Hypsiboas pulchellus* (Duméril & Bibron, 1841) (CFBH 3577). Note the broadened base (arrow) and the small development of spine in relation to the first phalange of digit I (I). 15, *Hypsiboas prasinus* (Burmeister, 1856) (CFBH 3618). Note poor development of spine in relation to the first phalange of digit I. (PPE, prepollex proximal element; PDE, prepollex distal element; S, spine; CV, crista ventralis; I, first phalange of digit I).



Figs. 16-17. Sacral diapophysis (SD). 16, Small broaded SD of *Hypsiboas ericae* (Caramaschi & Cruz, 2000) (CFBH 3604). 17, Broad SD of *Hypsiboas marginatus* (Boulenger, 1887) (CFBH 3412).

DISCUSSION

CARAMASCHI & CRUZ (2000) included *Hypsiboas ericae* in the group of *Hypsiboas pulchellus*, considering it more closely related with *H. marginatus* and *H. semiguttatus*, due to the robust aspect of the body and the presence of a longitudinal white stripe situated dorsolaterally. The pointed differences between *H. ericae* and those species were: smaller size, absence of spine on the prepollex, and white bones. However, males of *H. ericae* have prepollical spine and, apparently, use it in fights in the same way as reported for other species in the group of *H. pulchellus* (GARCIA *et al.*, 2001, 2003) and in the clade *Hypsiboas polytaenius* (Cope, 1870 "1869") (MENIN *et al.*, 2004), judging by the scars on the back of some males. The presence of green bones in *H. semiguttatus* was mentioned by LUTZ (1973); LANGONE (1997) quoted this characteristic to *H. marginatus*. Even though this character is evident in live specimens, in preserved ones it disappears. Moreover, in the same population of *H. joaquina* (B. Lutz, 1968) (another species of the *H. pulchellus* species group), GARCIA *et al.* (2003) noticed the presence of some specimens with green or white bones, showing that this character can be polymorphic among specimens of the same population.

Related to the external morphology, the characteristics that indicate a close relationship between *H. ericae* and the species of *H. pulchellus* group are: (1) white stripe in the upper lip; (2) dorsolateral white stripe; (3) brown or green colored body; (4) pronounced prepollex ending in curved spine; (5) small white rounded blotches on the flanks (absent in *H. marginatus* and species of *H. polytaenius* clade); (6) absence of blotches in the concealed areas of thigh; and (7) presence of green or white bones.

The vocalization of *H. ericae* differs from all other species of the *H. pulchellus* group with known vocalization. However, some elements might be similar. The "A" and "B" calls of *H. ericae* are structurally similar to the calls of *H. pulchellus*, with the difference that in *H. pulchellus* the notes have lower duration and are not pulsed (see GARCIA *et al.* 2003). The "C" call is similar to a part of the call of *H. caingua* (Carrizo, 1990) (pers. obs.)

and of *H. prasinus* (see BARRIO, 1965) (both species included in the group of *H. pulchellus sensu* DUELLMAN *et al.*, 1997). However, the call of *H. ericae* shows more similarities with the advertisement calls of species in the clade of *H. polytaenius* (Cope, 1870), as *H. leptolineatus* (Braun & Braun, 1977) (personal observation), *Hypsiboas* sp. (*aff. polytaenius*) (Heyer *et al.*, 1990, as *H. polytaenius*), and *H. goianus* (B. Lutz, 1968) (GUIMARÃES *et al.*, 2001; MENIN *et al.*, 2004). Also shows similarities with the vocalizations of other species that were not included in formal groups, but eventually appear quoted in the groups of *H. pulchellus* or of *H. polytaenius*, as *H. guentheri* (Boulenger, 1886) (pers. obs.) and *H. bischoffi* (Boulenger, 1887) (see HEYER *et al.*, 1990, as *H. multilineatus* B. Lutz, 1939). These species have the call with one or two pulsed notes and a trill emitted in the sequence.

Although the general skeleton of *H. ericae* is relatively similar to some species of the *H. pulchellus* group (which is expected in Hylinae, since the skeletons of the majority of species are very similar; see Duellman, 2001), many differences were observed among *H. ericae*, *H. marginatus*, *H. prasinus*, *H. pulchellus*, and *H. semiguttatus*.

A recent phylogenetic study based on mitochondrial DNA showed that the group of *Hyla pulchella* was paraphyletic related to the group of *Hyla polytaenia* and also to the species *Hyla bischoffi* and *Hyla guentheri* Boulenger, 1886 (FAIVOVICH *et al.*, 2004). In this work, *Hyla ericae* appears as the sister taxon of the group, which is represented by two clades, one of which involving two species of *Hyla polytaenia* group + *Hyla semiguttata* and *H. joaquina*; and other involving the other specimens analyzed in the group of *H. pulchella* (*lato sensu*). More recently, FAIVOVICH *et al.* (2005) formalized the proposal, transferring the *Hyla pulchella* species group to the revalidated genus *Hypsiboas*, where *Hypsiboas pulchellus* group, including all species of the group of *Hyla pulchella*, plus *Hyla bischoffi*, *Hyla guentheri*, and all species of the *Hyla polytaenia* species group (*sensu* CRUZ & CARAMASCHI, 1998) as a clade of the *Hypsiboas pulchellus* group. These results corroborate the observations made here. By one side, *H. ericae*

presents morphological and biological characteristics shared with specimens considered in the group of *H. pulchellus* (GARCIA *et al.*, 2001, 2003); on the other side, presents vocalization with similar characteristics to the vocalizations of species included in the group of *H. polytaeni* (*sensu* CRUZ & CARAMASCHI, 1998). However, *H. ericae* presents exclusive osteological characteristics, which is in agreement to its position as sister group of all the other species of the *Hypsiboas pulchellus* species group.

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