

# A New Species of *Hylodes* (Anura: Hylodidae) from the Brazilian Atlantic Forest

Rodrigo Lingnau<sup>1</sup>, Clarissa Canedo<sup>2</sup>, and José P. Pombal, Jr.<sup>2</sup>

**We describe a new species of Torrent Frog, genus *Hylodes*, from southern and southeastern Brazil. The new species is assigned to the *Hylodes nasus* species group and is characterized by large size, robust body, distinctly granular dorsolateral surfaces, absence of light dorsolateral stripes, moderate-sized fringe on the outer margin of toe V, and distinct advertisement call with long note duration. The new species is morphologically similar to *Hylodes asper* but is readily separated from that species by its distinct vocalization and by the shorter fringe on the outer side of toe V. Description of advertisement call and behavioral notes are provided.**

**F**ROGS of the genus *Hylodes* are restricted to fast-moving streams in the Atlantic Forest of eastern Brazil (Nascimento et al., 2001; Pombal et al., 2002), except for *H. otavioi*, which occurs in riparian forests in rocky fields on Serra do Cipó (Sazima and Bokermann, 1982; Nascimento et al., 2001). The 22 currently recognized species are partitioned into four species groups (Heyer, 1982): the *H. lateristrigatus* species group is currently composed of 17 species (*H. amnicola*, *H. babax*, *H. charadranaetes*, *H. fredii*, *H. heyeri*, *H. lateristrigatus*, *H. magalhaesi*, *H. meridionalis*, *H. ornatus*, *H. otavioi*, *H. perplicatus*, *H. phyllodes*, *H. pipilans*, *H. regius*, *H. sazimai*, *H. uai*, and *H. vanzolinii*); the monotypic *H. glaber* and *H. mertensi* species groups; and the *H. nasus* group (*H. asper*, *H. dactylocinus*, and *H. nasus*; Pombal et al., 2002; Canedo and Pombal, 2007).

Heyer (1982) characterized the *H. nasus* species group by moderate to large size, robust body form, granular dorsal surfaces, and absence of light dorsolateral stripes. Herein, we describe a new species of this group from mountains in the Serra do Mar of the southern portion of State of São Paulo and in State of Paraná, Brazil.

## MATERIALS AND METHODS

Institutional abbreviations follow Leviton et al. (1985), except for CFBH (Célio F. B. Haddad collection, Departamento de Zoologia, I.B., Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil), DZSJRP (Coleção do Departamento de Zoologia e Botânica, Universidade Estadual Paulista, São José do Rio Preto, São Paulo, Brazil), MCNAM (Museu de Ciências Naturais, Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil), MZUFV (Museu de Zoologia “João Moojen de Oliveira,” Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil), and ZUEC (Museu de História Natural, Universidade Estadual de Campinas, Campinas, São Paulo, Brazil).

Drawings of the holotype were made using a stereomicroscope and camera lucida. The following measurements (in mm) were employed for descriptions and statistical analysis: SVL (snout–vent length), HL (head length), HW (head width), TD (tympanum diameter), ED (eye diameter), IOD

(interorbital distance), END (eye–nostril distance), IND (internostril distance), SND (snout to nostril distance), THL (thigh length), TBL (tibia length), FL (foot length), and TFL (fringe length on the outer margin of toe V). Measurements were taken with calipers to the nearest 0.1 mm, except TD, ED, IOD, END, IOD, IND, and TFL, which were taken with stereomicroscope. Measurements follow Cei (1980) and Duellman (2001) except for TFL, which was measured from the middle of proximal sub-articular tubercle of toe V to the end of the fringe. We verified occurrence of TFL differences between the new species and *H. asper* performing a Mann–Whitney U test (Zar, 1999).

Vocalizations were recorded with DAT TCD-D100 recorder coupled to Sony ECM-MS 907 microphone. Calls were digitized with sampling frequency of 22 kHz and 16 bits resolution. Spectrograms were made with the software Avisoft-SASLab Light with Fast Fourier Transformation of 256 points, 75% Overlap, and Window Hamming. Dominant frequencies, power spectrums and oscillograms were obtained with Cool Edit 96 with Fast Fourier Transformation of 1024 points.

## *Hylodes cardosoi*, new species

Figures 1–2

**Holotype.**—MNRJ 29751, adult male, Brazil, State of Paraná, Municipality of Morretes, Porto de Cima, 25°23'S, 48°52'W, 8 January 2002, R. Lingnau.

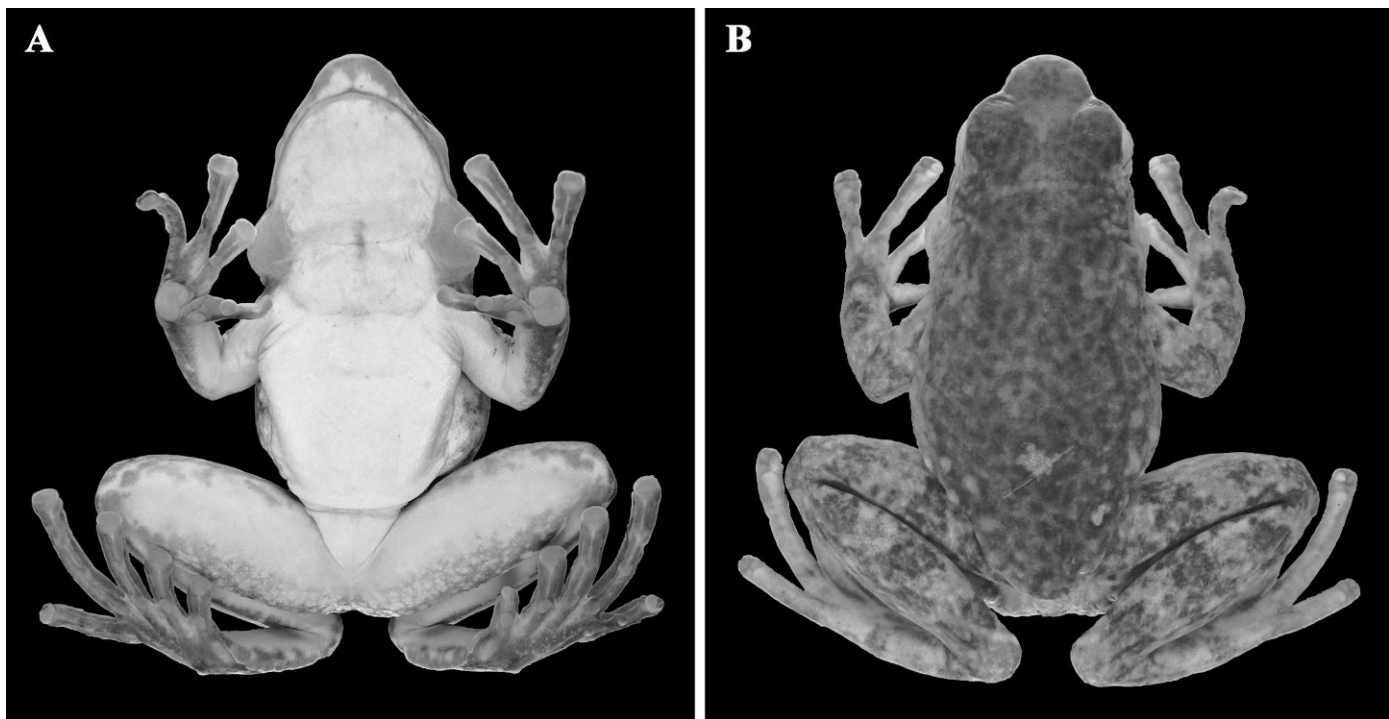
**Paratypes.**—MNRJ 28533, adult male, MNRJ 28534, female, respectively, 10 February 2002, R. Lingnau and C. M. Lingnau; MNRJ 29752, 29755, adult males, 12 February and 19 March 2002, respectively; MNRJ 29753, juvenile, 4 February 2002; MNRJ 29754, adult female, 5 February 2002, R. Lingnau; same locality as holotype. MNRJ 38061–62, 38065, adult females, MNRJ 38063–64, adult males, 16 October 2004, R. Lingnau and D. E. A. Sanchez; MNRJ 39250, adult female, MNRJ 39251, juvenile, 26 February 2005, R. Lingnau; MNRJ 40264–65, adult females, 11 November 2005, R. Lingnau and C. Canedo; MZUSP

<sup>1</sup>Universidade do Oeste de Santa Catarina, Área de Ciências Biológicas e da Saúde, Avenida Getúlio Vargas 2125, Flor da Serra, 89600-00, Joaçaba, SC, Brazil; and Programa de Pós-Graduação em Zoologia, Faculdade de Biociências, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil; E-mail: rodrigolingnau@yahoo.com.br.

<sup>2</sup>Departamento de Vertebrados, Museu Nacional, Universidade Federal do Rio de Janeiro, Quinta da Boa Vista, 20940-040 Rio de Janeiro, RJ, Brazil; E-mail: (CC) clarissa.canedo@gmail.com; and (JPP) pombal@acd.ufrj.br. Send reprint requests to JPP.

Submitted: 21 March 2007. Accepted: 3 December 2007. Associate Editor: D. Kizirian.

© 2008 by the American Society of Ichthyologists and Herpetologists DOI: 10.1643/CH-07-091



**Fig. 1.** Holotype of *Hylodes cardosoi*, MNRJ 29751 (SVL 41.5 mm) in ventral (A) and dorsal (B) views.

112585, 112587, adult males, MZUSP 112586, 112588, adult females, 28 August 1965, R. Lange; all from Brazil, State of Paraná, Municipality of Morretes, Marumbi, Taquaral river, 25°26'S, 48°55'W. DZSJRP 5200–10, 5212–13, 5215–16, 5218–20, 5223, 5226–32, 5235, juveniles, DZSJRP 5211, 5214, 5217, adult males, DZSJRP 5221–22, 5224–25, 5233–34, adult females, Brazil, State of Paraná, Municipality of Morretes, Marumbi, 12 April 1987, A. Cais, E. Leonel, and J. Jim. DZSJRP 5289–90, 5292, 5294–95, 5308–11, 5314–15, adult males, DZSJRP 5288, 5291, 5296–5298, 5304–07, 5312–13, 5316, adult females, Brazil, State of Paraná, Municipality of Morretes, 16 December 1987, A. Cais and E. Leonel. MZUSP 60689, 60693–94, juveniles, MZUSP 60685, 60688, 60692, adult females, MZUSP 60686–87, 60690–91, 60695–96, adult males, Brazil, State of Paraná, Municipality of Morretes, São João da Graciosa, 25°18'S, 48°51'W, 25–27 December 1978, W. R. Heyer, K. Kanno, and F. C. do Val.

**Diagnosis.**—Densely granular dorsolateral surfaces; large size (adult male SVL 35.6–44.1 mm); robust body; light dorso-lateral stripes absent; moderate-sized fringe on outer side of toe V; advertisement call with 4–8 notes, each note with 3–6 pulses in rapid raise and decay frequency modulation.

*Hylodes cardosoi* differs from all species of the *H. lateristrigatus* species group by absence of light dorsolateral stripes (present in all species of *H. lateristrigatus* group) and by densely granular dorsal skin (smooth to weakly granular in species of *H. lateristrigatus* species group). The new species differs from *H. nasus* by absence of light dorsolateral stripes (series of light dorsolateral spots forming discontinuous stripes in *H. nasus*) and by more granular dorsal skin than in *H. nasus*. *Hylodes cardosoi* differs from *H. mertensi* by its smaller size (*H. cardosoi* male SVL 35.6–44.1, female SVL 36.7–46.5, Table 1; *H. mertensi* female SVL 51.5 mm and 54.5 mm,  $n = 2$ ) and by granular dorsolateral skin with large white tubercles (dorsolateral skin weakly granular, lacking

large white tubercles in *H. mertensi*). The new species differs from *H. glaber* by the presence of external vocal sacs in adult males (absent in *H. glaber*). *Hylodes cardosoi* is easily distinguished from *H. glaber* by absence of contrasting color pattern in life. Most individuals of *H. glaber* (as *Hylodes pulcher*; Heyer, 1982) have bright blue and/or yellow dorsal spotting. The new species differs from *H. dactylocinus* by its larger size (*H. dactylocinus* male SVL  $24.9 \pm 1.2$ ,  $n = 6$ ; female SVL  $28.8 \pm 1.5$ ,  $n = 3$ ). *Hylodes cardosoi* is distinguished from *H. asper* by its advertisement call, as well as from all other species of the genus with known advertisement call, primarily by distinct temporal pattern of individual notes. Note duration of *H. cardosoi* is longer than those of *H. asper* and *H. nasus*. Although there are no explicit data for note duration of *H. dactylocinus*, vocalization data presented in Pavan et al. (2001) indicates that the call of *H. cardosoi* has longer note duration than that of *H. dactylocinus*. Furthermore, the advertisement call of *H. cardosoi* has fewer notes per call and shorter duration than those of *H. asper* and *H. dactylocinus* (Table 2).

*Hylodes cardosoi* and *H. asper* are morphologically similar, but some polymorphic characters occur in different frequencies. Both species have weak fringes on the outer margin of finger III and inner margin of finger IV, between proximal and distal subarticular tubercles, particularly in males. However, these parts of fringes are frequently complete or nearly complete in *H. asper* males (74.5% complete or nearly complete on outer margin of finger III and 90.2% complete or nearly complete on inner margin of finger IV;  $n = 51$ ) and generally vestigial or absent in *H. cardosoi* males (95.8% vestigial or absent on outer margin of finger III and 83.3% vestigial or absent on inner margin of finger IV;  $n = 24$ ). Both species may have a pair of cloacal tubercles, dorsally, on each side of vent, but these tubercles are more frequently present and evident in *H. cardosoi* (89.2% with distinct tubercles, 8.1% with weakly evident tubercles, and 2.7% without tubercles;  $n = 37$ ) than in *H.*

**Table 1.** Measurements in Millimeters (Mean  $\pm$  Standard Deviation, and Range) of Adult Males and Females of *Hylodes cardosoi*. Abbreviations are defined in the text.

	Males ( <i>n</i> = 32)	Females ( <i>n</i> = 31)
SVL	40.4 $\pm$ 2.0 (35.6–44.1)	42.4 $\pm$ 2.6 (36.7–46.5)
HL	15.3 $\pm$ 0.5 (14.1–15.9)	15.8 $\pm$ 0.9 (14.4–19.1)
HW	13.5 $\pm$ 0.5 (12.5–14.3)	14.0 $\pm$ 0.7 (12.7–15.1)
TD	2.5 $\pm$ 0.2 (2.2–2.8)	2.5 $\pm$ 0.2 (2.2–3.0)
ED	5.6 $\pm$ 0.3 (5.1–6.0)	5.7 $\pm$ 0.4 (4.6–6.4)
IOD	3.9 $\pm$ 0.2 (3.5–4.5)	3.9 $\pm$ 0.2 (3.5–4.4)
END	3.1 $\pm$ 0.2 (2.8–3.4)	3.2 $\pm$ 0.1 (2.8–3.6)
IND	4.8 $\pm$ 0.3 (4.2–5.4)	5.0 $\pm$ 0.3 (4.4–5.6)
SND	2.0 $\pm$ 0.2 (1.6–2.5)	2.0 $\pm$ 0.3 (1.6–2.6)
THL	21.9 $\pm$ 0.8 (20.2–23.4)	22.7 $\pm$ 1.0 (20.5–24.6)
TBL	22.1 $\pm$ 0.9 (20.3–23.5)	23.2 $\pm$ 1.0 (20.6–25.6)
FL	19.9 $\pm$ 1.0 (17.4–21.3)	21.0 $\pm$ 1.2 (18.4–23.1)
TFL	1.7 $\pm$ 0.4 (0.7–2.5)	1.7 $\pm$ 0.4 (0.9–2.6)

*asper* (7.9% with distinct tubercles, 67.3% with weakly evident tubercles, and 24.8% with no tubercles, *n* = 101). Generally, the posterior surface of thigh is marbled with brown and cream in both species, but *H. asper* more frequently has a brown area with scattered light blotches (98.0%), and anastomosed light blotches are uncommon (2.0%, *n* = 99). In contrast, in *Hylodes cardosoi* the posterior surface of the thigh is brown with anastomosed light blotches (56%) and less frequently has scattered light blotches (22.0%) or equally distributed brown and cream blotches (18.0%); thighs with brown blotches over a cream background were also observed (4.0%, *n* = 50). The fringe on the outer side of toe V in *H. cardosoi* is significantly shorter than in *H. asper* (male *U* = 424.50, *P* < 0.01, *n* = 30, 56; female *U* = 237.50, *P* < 0.01, *n* = 31, 54; *H. cardosoi* TFL in Table 1; *H. asper* male TFL  $2.2 \pm 0.6$ , *n* = 56; female TFL  $2.5 \pm 0.7$ , *n* = 54).

**Description of holotype.**—Body robust; head longer than wide; snout protruding in lateral view, round in dorsal view (Figs. 1, 2A–B); nostrils not protuberant, directed laterally; canthus rostralis distinct, almost straight; loreal region concave; tympanum distinct, nearly round, its diameter slightly smaller than half of eye diameter; supratympanic fold starting at posterior corner of eye, not reaching shoulder; vocal sacs lateral, well developed; tongue nearly ovoid, large, free posteriorly; vomerine teeth in two series between choanae; choanae round; maxillary and premaxillary teeth present; a row of unpigmented and small tubercles on margin of upper lip. Arms moderately robust; thumb without nuptial asperities or spines; outer metacarpal tubercle very large, nearly round; inner metacarpal tubercle

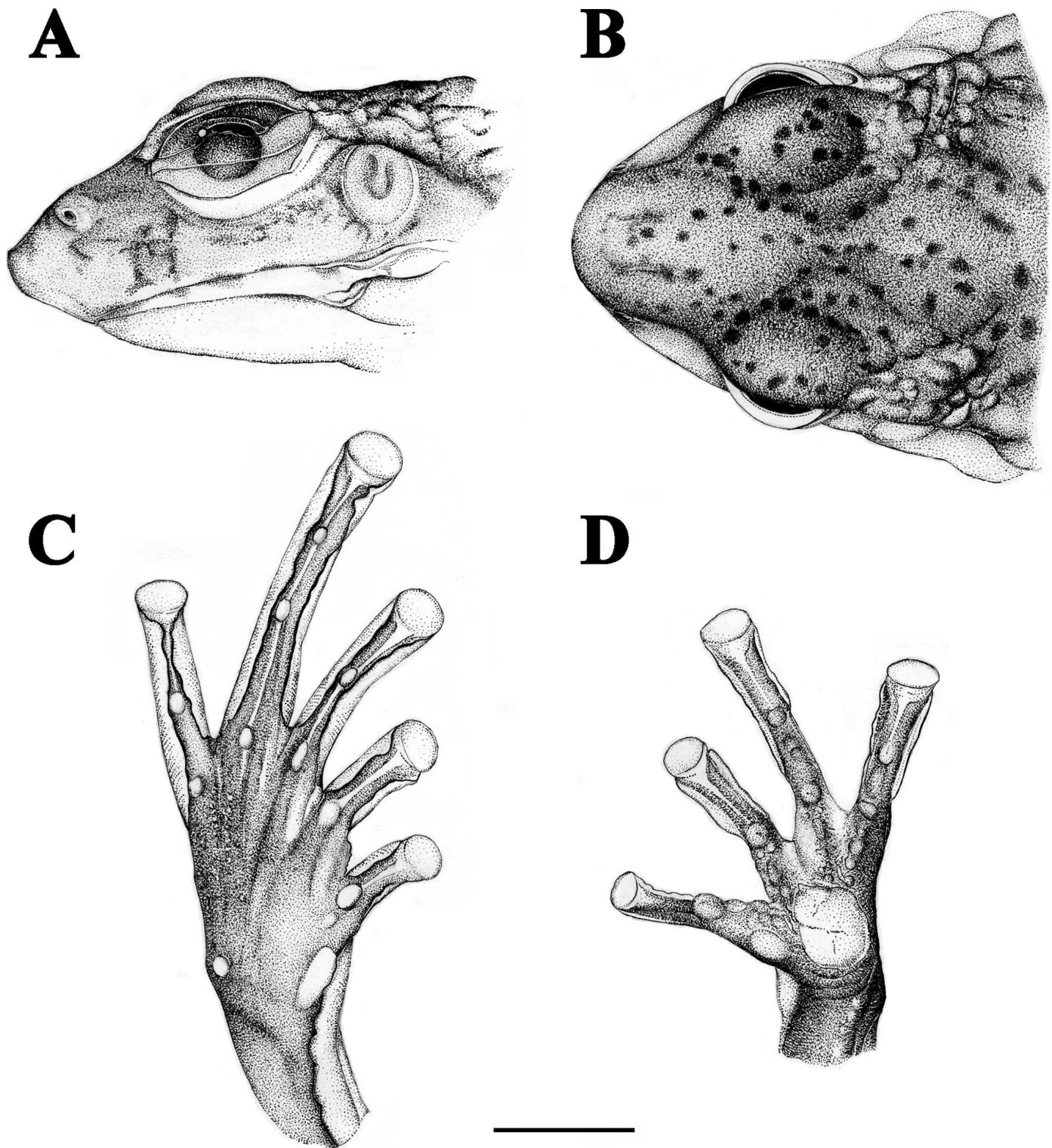
small, elliptical; subarticular tubercles single, round; number of subarticular tubercles on fingers (I to IV) 1–1–2–2; supernumerary tubercles arranged in rows between fingers II, III, and IV; relative lengths of fingers II < I < IV < III; fingers bearing lateral fringes from proximal subarticular tubercle to disc (Fig. 2D); finger III bearing vestigial fringe on outer margin from proximal subarticular tubercle to the distal one; finger discs elliptical, slightly expanded, smaller than tympanum; disc of finger I smaller than other discs; upper surfaces of discs with well developed scutes; finger discs as developed as toe discs. Legs robust; outer metatarsal tubercle small, round, protruding; inner metatarsal tubercle elongated; subarticular tubercles single, rounded or ovoid; number of subarticular tubercles in toes (I to V) 1–1–2–3–2; relative lengths of toes I < II < V  $\approx$  III < IV; toes extensively fringed, fringe on outer margin of toe V exceeds the end of subarticular tubercle in a distance nearly equal the diameter of a subarticular tubercle (Fig. 2C); tarsal fringe extensive, continuous distally with toe fringe on inner margin of toe I; toe discs slightly expanded, nearly elliptical; toe disc I in the left foot malformed; disc of toe V smaller than other discs; upper surfaces of discs with developed scutes. Dorsal skin texture rugose, mainly in flanks, thighs and around vent; undersurfaces smooth; skin fold across abdomen near inguinal region (probably caused by preservation); skin texture rugose around vent and on ventral surfaces of thighs. SVL 41.5; HL 15.3; HW 13.0; TD 2.6; ED 5.5; IOD 3.8; END 3.3; IND 4.9; SND 2.1; THL 21.0; TBL 22.3; FL 20.4; TFL 1.4.

Overall color brown; dorsum with numerous uniformly distributed small brown spots; dorsum of thighs with two irregular dark brown stripes; dorsum of tibia with three irregular dark brown and two brown stripes; dorsum of pes with two dark

**Table 2.** Advertisement Call Characteristics of Members of the *Hylodes nasus* Species Group. CD—call duration (s), NC—notes per call, ND—note duration (ms), and DF—dominant frequency (kHz). \*Pulses in Pavan et al. (2001) are here considered as notes.

Species	CD	NC	ND	DF	Data source
<i>H. asper</i>	1.65–2.73	33–46	20–30	5–6.5	Haddad and Giarretta (1999)
<i>H. cardosoi</i>	0.798–1.686	4–8	101–183	3.9–5.8	Present work
<i>H. dactylocinus</i>	1.95–4.88	44–110*	—	2.6–6.6	Pavan et al. (2001)
<i>H. nasus</i>	0.3–1.6	6–35	20	3.5–5	Viellard and Cardoso (1996)
<i>H. nasus</i>	0.144–0.783	4–17	12–39	3.9–4.9	Wogel et al. (2004)





**Fig. 2.** Holotype of *Hylodes cardosoi*, MNRJ 29751. Lateral (A) and dorsal (B) views of head; ventral views of foot (C) and hand (D). Scale = 5 mm.

brown stripes. Dorsum of brachium with two dark brown stripes; anterior and dorsal surfaces of arms with brown blotches; white tubercles on flanks; lateral aspect of head with irregular brown blotches; abdomen and throat uniformly cream; ventral surfaces of thighs and arms uniformly cream.

**Variation.**—Females (Fig. 3) have poorly developed fringes on toes, fingers, and feet; no tubercles on upper lip; and are slightly larger than males (Table 1). The fringe on the inner

margin of finger III ( $n = 42$ ) may be: complete or nearly complete (73.8%), vestigial (23.8%), or absent (2.4%). The fringe on the outer margin of finger III may be: complete or nearly complete (4.8%), vestigial (66.7%), or absent (28.6%). The fringe on the inner margin of finger IV may be: complete (19.1%), vestigial (76.2%), or absent (4.8%). Specimens ( $n = 50$ ) also vary in color pattern of posterodorsal surface of thighs: 22.0% present scattered light blotches, 56.0% present brown background with anasto-



**Fig. 3.** *Hylodes cardosoi* female in life (MNRJ 39250).

mosed light blotches, 18.0% present brown and cream blotches equally distributed, and 4.0% present cream background with brown blotches.

**Vocalization.**—Advertisement calls are given sporadically and, at air temperature of 25.2°C, intervals between two consecutive calls emitted by the same male are 16.63–40.06 s ( $26.51 \pm 8.71$ ,  $n = 7$  calls), call duration range is 0.798–1.686 s ( $1.378 \pm 0.21$ ,  $n = 13$  calls from 4 males), with 4–8 notes ( $6 \pm 0.97$ ,  $n = 13$  calls from 4 males; Fig. 4A–B), and note duration is 0.101–0.183 s ( $0.144 \pm 0.03$ ,  $n = 63$  notes from 13 calls of 4 males). Each note is composed of 3–6 pulses ( $4.05 \pm 0.718$ ,  $n = 78$  notes from 13 calls of 4 males) with a rapid raise and decay frequency modulation, and pulse duration is from 0.020–0.044 s ( $0.03 \pm 0.005$ ,  $n = 65$  pulses from 13 calls of 4 males). The dominant frequency of a single note is the third harmonic, ranging from 3.9 to 5.8 kHz ( $5.19 \pm 0.33$ ,  $n = 57$  notes from 13 calls of 4 males). Energy of the fundamental frequency and second harmonic is lower (Fig. 4C). The fundamental frequency is around 1.8 kHz and second harmonic around 3.5 kHz. In *Hylodes* the dominant frequency is generally associated with the third harmonic (Haddad and Giaretta, 1999; Pombal et al., 2002; Lingnau and Bastos, 2007). In some calls of *H. cardosoi*

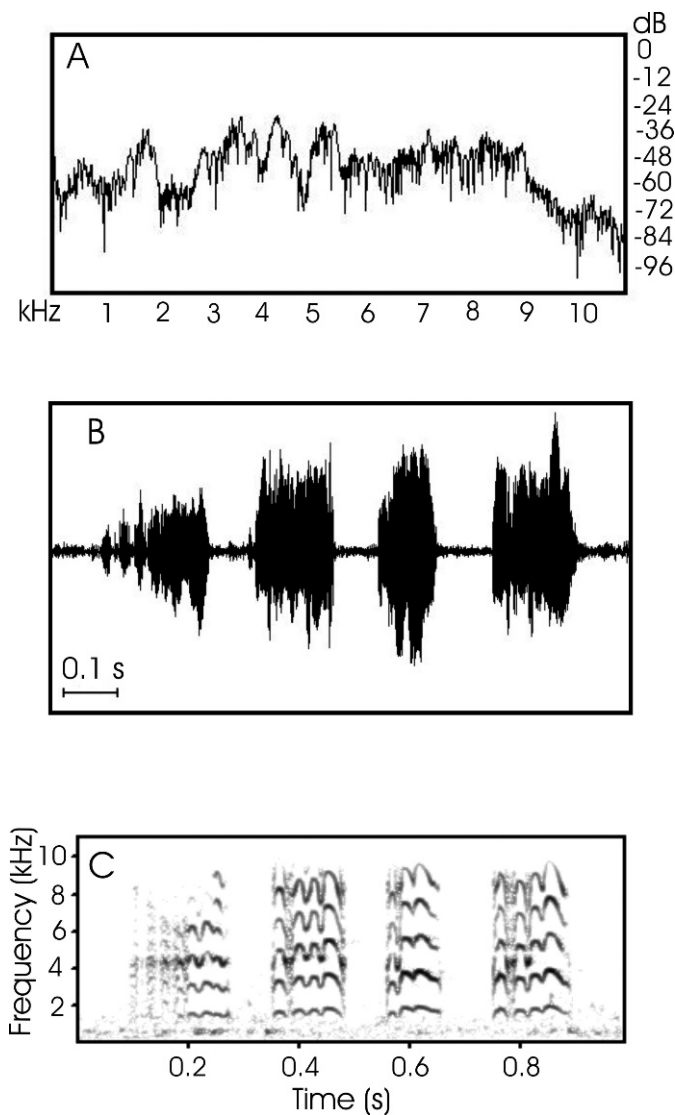
the second and third harmonics appear to have the same amount of energy, making it difficult to discern which one represents the dominant frequency.

**Behavior.**—Frogs are wary, jumping into water when disturbed, but returning to the same place after a few minutes. Males and females seem to exhibit some degree of site fidelity. The new species is sympatric with *H. heyeri* in some streams. Males were observed performing visual signals like body raising and foot-flagging (*sensu* Hödl and Amézquita, 2001), with or without simultaneous emission of advertisement call, as known in all other species of *Hylodes nasus* species group (Haddad and Giaretta, 1999; Wogel et al., 2004; Narvaes and Rodrigues, 2005).

**Distribution.**—*Hylodes cardosoi* is known from Marumbi and São João da Graciosa, both localities in the Municipality of Morretes, State of Paraná, southern Brazil, and from the Municipalities of Apiaí, Capão Bonito, and Iporanga, State of São Paulo, southeastern Brazil (Fig. 5).

**Etymology.**—The name of the new species, a noun in genitive case, honors the late Dr. Adão José Cardoso for his contributions to knowledge of Brazilian anurans.





**Fig. 4.** Advertisement call of *Hylodes cardosoi*. Power spectrum (A) of the last note. Oscillogram (B) and spectrogram (C) of a call with four notes. Vocalization recorded on 19 March 2002; air temperature 25.2°C; MNRJ 29755.

## DISCUSSION

Nascimento et al. (2001) stated the distribution of *Hylodes* to be from the State of Alagoas, northeastern Brazil, to the State of Rio Grande do Sul, southern Brazil. Records for the State of Alagoas, however, are based on misidentification of poorly preserved specimens of *Crossodactylus dantei* (MNRJ 39443–46). Therefore, the genus *Hylodes* is known only from torrents in the Atlantic Forest of the States of Espírito Santo to Rio Grande do Sul, Brazil.

Cochran (1955) mentioned specimens of *H. asper* collected by W. Ehrhardt from Humboldt (now Municipality of Corupá), State of Santa Catarina. Subsequent authors assumed this to be the southernmost distribution limit of *H. asper* (Haddad and Giarretta, 1999; Frost, 2007). The specimens cited by Cochran are currently lost (F. Glaw, pers. comm.), but photographs of another specimen (ZSM 80/1952) from the same collector and locality are clearly *H. perplicatus*, which was recently redescribed based on type-series and specimens collected near type-locality in Corupá (Haddad et al., 2003). Pavan et al. (2001) mentioned that *H.*

*asper* occurs along the Serra do Mar, from Teresópolis, in the State of Rio de Janeiro, to São João da Graciosa, in the State of Paraná. Our analysis of tape recordings from São João da Graciosa, municipality of Morretes, revealed the occurrence of only *H. cardosoi* and *H. heyeri*. The advertisement calls of *H. heyeri* are rather similar to those of *H. asper* and morphologically *H. asper* is more similar to *H. cardosoi*. Therefore, we think specimens reported from Corupá, State of Santa Catarina are *H. perplicatus* and specimens from Morretes, State of Paraná are *H. cardosoi*. Advertisement calls recorded from the Municipality of Iporanga, southern region of the State of São Paulo, also show acoustic patterns like *H. cardosoi*. Hence, southern limit of *H. asper* is regarded here to be Paranapiacaba, Municipality of Santo André, State of São Paulo (Fig. 5).

The discovery of a new species of *Hylodes* from the Atlantic Forest of Brazil is not surprising given the region's high levels of endemism and richness of anurans (Duellman, 1999). Recent descriptions of other new species including *Brachycephalus brunneus* (Ribeiro et al., 2005), *Aplastodiscus eugenioi* (Carvalho-e-Silva and Carvalho-e-Silva, 2005), *Hylodes fredii*, and *H. pipilans* (Canedo and Pombal, 2007) indicate, however, that anuran diversity of the Atlantic Forest is still insufficiently known.

## MATERIAL EXAMINED

*Hylodes amnicola*. Minas Gerais: MZUFV 3953, Aiuruoca; MNRJ 24859 (holotype), CFBH 3719–21, MNRJ 24846–47, 24860–61, 25650–55, 26309, 26856–58, MZUFV 4117–19 (paratypes), Lima Duarte, Parque Estadual do Ibitipoca.

*Hylodes asper*. Rio de Janeiro: MNRJ 666, 1276, 1517, 1554, 1980, 2008, 8116, 8187, 8189, 10472–73, Duque de Caxias, Barro Branco; MNRJ 2316, Duque de Caxias; MNRJ 33090, Mangaratiba; MNRJ 1375, 1631, 7568–72, 32859, Parati; MNRJ 31106–08, 33476, MZUSP 2038, 53426, Teresópolis. São Paulo: MZUSP 23409–11, 23413–14, 23435, 23437–38, 23446, 23450, 23471–72, 23476–77, 23480, 23482–84, 23486, Bocaina; MZUSP 76965–66, 76970, 76975, Campo de Fruticultura; MZUSP 9988 Caraguatatuba; MZUSP 1484, 9979, Ilha Bela; MZUSP 1753, 1761, 1766, 1768, 1784–85, 1787–88, 1793–94, 1797, 1802–03, 1806–07, 1809, 1812, 1814, 4033, 4035, 4037, 4039, 23563–64, 23755, 23759, 23761, 23764, 27983, 37586–87, 37661–63, 37665–66, 37711, 37764, Salesópolis, Boracéia; MZUSP 8852–54, 23497, 23499, 23501, 23506, Santo André, Paranapiacaba; MZUSP 130196–97, Ubatuba, Picinguaba; MZUSP 10012, 10236, 10238, 21897–99, 21903, 21905, 21907–08, 23551, 23554–55, 64748, 97601, Caminho do Mar.

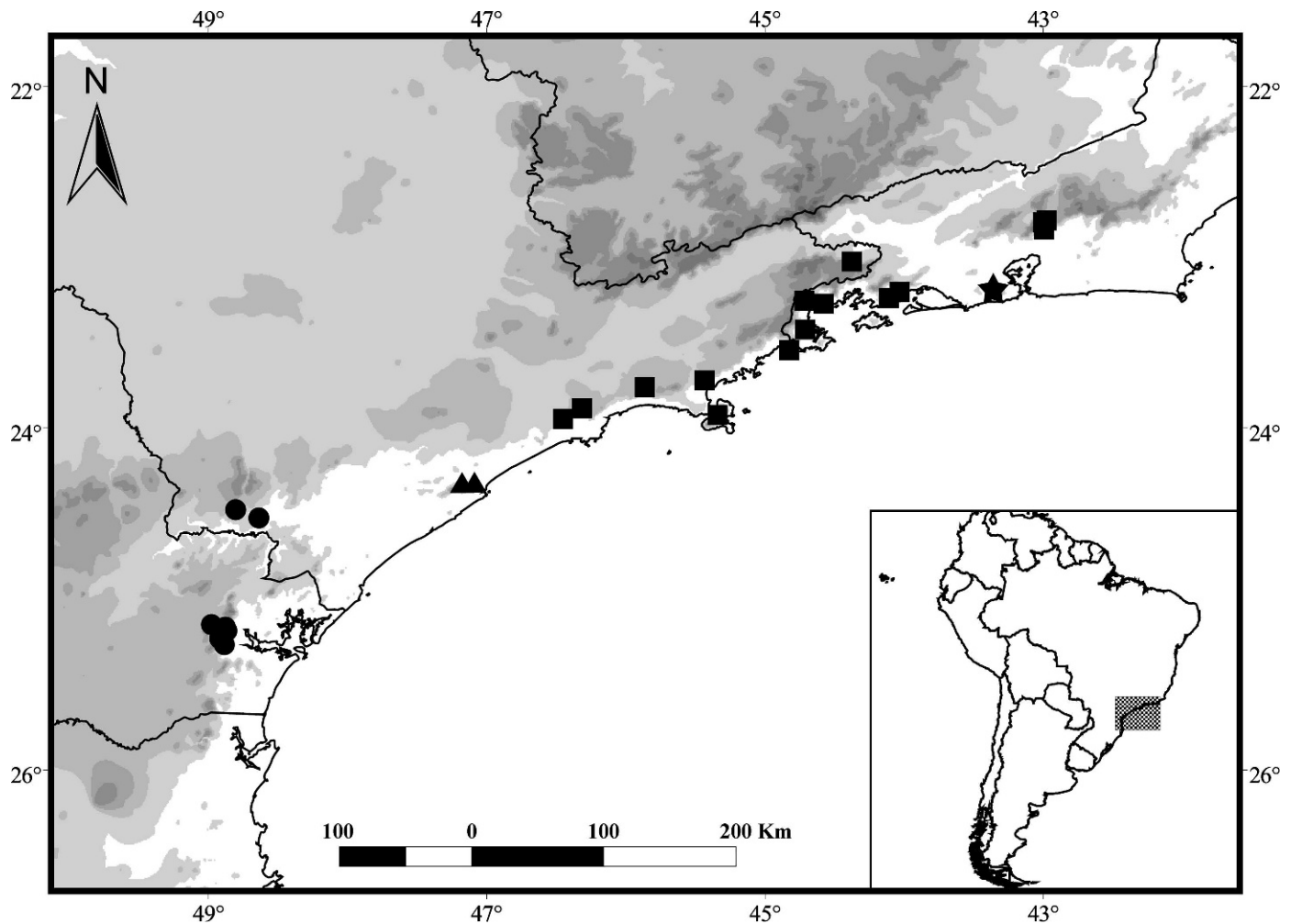
*Hylodes babax*. Minas Gerais: MZUSP 57949 (holotype), Parque Nacional do Caparaó.

*Hylodes cardosoi*. São Paulo: MZUSP 21882, 21886, 21888, MZUFV 4740–41, MZUFV 4753, Apiaí; MZUFV 5119–5123, Capão Bonito; CFBH 8275–77, Iporanga.

*Hylodes charadranetes*. Rio de Janeiro: MNRJ 27074, Nova Friburgo; MZUSP 60663–66 (paratypes), MNRJ 31175–76, 31841–47, 33771, Teresópolis, Serra dos Órgãos.

*Hylodes dactylocinus*. São Paulo: MZUSP 89904 (holotype), MZUSP 89901, 89903, 89906, 89909–14, MNRJ 31199–200 (paratypes), Peruíbe, Estação Ecológica Jurêia-Itatins.

*Hylodes glaber*. Rio de Janeiro: MNRJ 3486, 3564, 3900, 14517, 15238–40, 31105, 31118–20, 31122–25, 31178–79, 31181–84, 31186–88, 31818–19, MZUSP 12732–33, 12735–36, 58994, 60827–28, 60830–38, 60841, Itatiaia.



**Fig. 5.** Distribution of members of the *Hylodes nasus* species group: *H. asper* (squares), *H. dactylocinus* (triangles), *H. nasus* (star), and *H. cardosoi* (circles). Contour shading represents 400 m intervals.

*Hylodes heyeri*. São Paulo: MNRJ 17090 (holotype), CFBH 2465–68, MNRJ 17091, ZUEC 8238, 8240, 8242–43, 8249–50, 8253–54 (paratypes), Eldorado, near Caverna do Diabo; MZUSP 93228, Parque Estadual Turístico do Alto Ribeira.

*Hylodes lateristrigatus*. Rio de Janeiro: MNRJ 23625–27, 33739, Nova Friburgo; MNRJ 2007, 5055, 10467, 23628, 31833–35, 31839, MZUSP 53259–61, Teresópolis.

*Hylodes magalhaesi*. São Paulo: MZUSP 73676 (holotype), MZUSP 73622–29, 73677, 73705, 74439, MNRJ 3973, 14219 (paratypes), MZUSP 112658, 112661–62, 112664–65, Campos de Jordão.

*Hylodes meridionalis*. Rio Grande do Sul: MZUSP 112851, 112853–55, São Francisco de Paula.

*Hylodes mertensi*. São Paulo: MZUSP 74171 (holotype), MZUSP 10017, Caminho do Mar, Km 47.

*Hylodes nasus*. Rio de Janeiro: MNRJ 87–88, 1445, 1856, 1860, 1864, 1866, 1869, 2671, 3089, 10192–93, 10195, 10200, 10204, 10207, 10212–14, 12492, 13698–99, 18478–79, 18481–82, 26894, 26896, 29210–12, 31853–62, 31875–81, 31884, 31894–908, 31932–36, 31938–40, 32075–84, 33398, 33743–44, 34198, 34200–02, 34205, 35113, Rio de Janeiro.

*Hylodes ornatus*. Rio de Janeiro: MZUSP 73679 (holotype), MZUSP 73682–83, 73871–81, 74433 (paratypes), MNRJ 3550, 14521–22, 14544–45, 31112–13, 31115, 32069–70, 33405, MZUSP 60683, 60843–45, 96195, 130384–86, Itatiaia.

*Hylodes otavioi*. Minas Gerais: MNRJ 4163 (holotype), MZUSP 73575–77, Jaboticatubas, Serra do Cipó; MNRJ 41454–56, Morro do Pilar.

*Hylodes perplicatus*. Santa Catarina: MNRJ 89 (lectotype), MNRJ 545, 5589, 5595 (paralectotypes), Humboldt; MZUSP 60697, Jardim; CFBH 3570, 3572–74, MNRJ 30587, São Bento do Sul; MZUSP 60698, 60700, Timbé do Sul.

*Hylodes phyllodes*. Rio de Janeiro: MNRJ 1256, 31849–52, 33393; MNRJ 30933, Angra dos Reis; MNRJ 37900–01, Mangaratiba. São Paulo: MZUSP 59934 (holotype); MZUSP 1700–02, 1704–06, 1708–11, 3308, 23681–91, 23693–97, 36874, 37702–03 (paratypes), Salesópolis, Boracéia; MZUSP 64747, Cubatão; MZUSP 10216, Caminho do Mar; MNRJ 24303–04, São Sebastião, Ilha Bela; MNRJ 23952, 23954, Ilha dos Búzios; MNRJ 34479–83, MZUSP 84582, Ubatuba.

*Hylodes regius*. Minas Gerais: MNRJ 4110 (holotype); MNRJ 4109, 4111–12 (paratypes), Itamonte, Vargem Grande.

*Hylodes sazimai*. São Paulo: ZUEC 9004 (holotype), MNRJ 15869, MZUSP 69637 (paratypes), Campinas, João Egídio; MNRJ 34697, Campinas, Sousas.

*Hylodes uai*. Minas Gerais: MNRJ 23771 (holotype), CFBH 2984–85, MNRJ 23772–75, 23777, MCNAM 1333, 1763 (paratypes), Belo Horizonte, Mangabeiras.

*Hylodes vanzolinii*. Minas Gerais: MZUSP 57950 (holotype), MZUSP 52923 (paratype), Parque Nacional do Caparaó.

## ACKNOWLEDGMENTS

We are grateful to B. Pimenta and W. Heyer for helpful suggestions on the manuscript; P. Nascimento for making line drawings; C. Lingnau, B. Pimenta, D. Sanchez, and M. Segalla for fieldwork assistance; W. Heyer and L. Toledo for providing tape recordings from São João da Graciosa and Iporanga, respectively; F. Glaw for photos of *H. perplicatus* currently deposited in ZSM; R. Feio, C. Haddad, L. Nascimento, D. Rossa-Feres, and H. Zaher for loaning specimens under their care. We thank Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ) for financial support, and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for financial support for RL and JPPJ. The Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) provided collection permits (035/05—IBAMA/RAN and 183/05—IBAMA/RAN).

## LITERATURE CITED

- Canedo, C., and J. P. Pombal, Jr. 2007. Two new species of torrent frog of the genus *Hylodes* (Anura, Hylodidae) with nuptial thumb tubercles. *Herpetologica* 63:224–235.
- Carvalho-e-Silva, A. M. P. T., and S. P. Carvalho-e-Silva. 2005. New species of the *Hyla albofrenata* group, from the States of Rio de Janeiro and São Paulo, Brazil (Anura, Hylidae). *Journal of Herpetology* 39:73–81.
- Cei, J. M. 1980. Amphibians of Argentina. *Monitore Zoologico Italiano (N.S.) Monografie* 2:1–609.
- Cochran, D. M. 1955. Frogs of southeastern Brazil. *United States National Museum Bulletin* 206:1–423.
- Duellman, W. E. 1999. Global distribution of amphibians: patterns, conservation, and future challenges, p. 1–30. *In: Patterns of Distribution of Amphibians: A Global Perspective*. W. E. Duellman (ed.). Johns Hopkins University Press, Baltimore, Maryland.
- Duellman, W. E. 2001. *Hylid Frogs of Middle America*, Volumes 1, 2. Society for the Study of Amphibians and Reptiles, Ithaca, New York.
- Frost, D. R. 2007. Amphibian species of the world: an online reference. Version 5.0 (1 February, 2007). Electronic Database accessible at <http://research.amnh.org/herpetology/amphibia/index.php>. American Museum of Natural History, New York.
- Haddad, C. F. B., P. C. A. Garcia, and J. P. Pombal, Jr. 2003. Redescricao de *Hylodes perplicatus* (Miranda-Ribeiro, 1926) (Amphibia, Anura, Leptodactylidae). *Arquivos do Museu Nacional* 61:245–254.
- Haddad, C. F. B., and A. A. Giarretta. 1999. Visual and acoustic communication in the Brazilian torrent frog, *Hylodes asper* (Anura: Leptodactylidae). *Herpetologica* 55:324–333.
- Heyer, W. R. 1982. Two new species of the frog genus *Hylodes* from Caparaó, Minas Gerais, Brasil (Amphibia: Leptodactylidae). *Proceedings of the Biological Society of Washington* 95:377–385.
- Hödl, W., and A. Amézquita. 2001. Visual signaling in anuran amphibians, p. 121–141. *In: Anuran Communication*. M. J. Ryan (ed.). Smithsonian Institution Press, Washington and London.
- Leviton, A. E., R. H. Gibbs, Jr., E. Heal, and C. E. Dawson. 1985. Standards in herpetology and ichthyology: part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985: 802–832.
- Lingnau, R., and R. P. Bastos. 2007. Vocalizations of the Brazilian torrent frog *Hylodes heyeri* (Anura: Hylodidae): repertoire and influence of air temperature on advertisement call variation. *Journal of Natural History* 41:1227–1235.
- Narvaes, P., and M. T. Rodrigues. 2005. Visual communication, reproductive behavior, and home range of *Hylodes dactylocinus* (Anura, Leptodactylidae). *Phyllomedusa* 4:147–158.
- Nascimento, L. B., J. P. Pombal, Jr., and C. F. B. Haddad. 2001. A new frog of the genus *Hylodes* (Amphibia: Leptodactylidae) from Minas Gerais, Brazil. *Journal of Zoology, London* 254:421–428.
- Pavan, D., P. Narvaes, and M. T. Rodrigues. 2001. A new species of leptodactylid frog from the Atlantic Forests of southeastern Brazil with notes on the status and on the speciation of the *Hylodes* species groups. *Papéis Avulsos de Zoologia* 41:407–425.
- Pombal, Jr., J. P. R. N. Feio, and C. F. B. Haddad. 2002. A new species of torrent frog genus *Hylodes* (Anura: Leptodactylidae) from southeastern Brazil. *Herpetologica* 58:462–471.
- Ribeiro, L. F., A. C. R. Alves, C. F. B. Haddad, and S. F. Reis. 2005. Two new species of *Brachycephalus* Günther, 1858 from the State of Paraná, southern Brazil (Amphibia, Anura, Brachycephalidae). *Boletim do Museu Nacional, Nova Série, Zoologia* 519:1–18.
- Sazima, I., and W. C. A. Bokermann. 1982. Anfíbios da Serra do Cipó, Minas Gerais, Brasil. 5: *Hylodes otavioi* sp. n. (Anura, Leptodactylidae). *Revista Brasileira de Biologia* 42:767–771.
- Vielliard, J. M. E., and A. J. Cardoso. 1996. Adaptações de sinais sonoros de anfíbios e aves a ambientes de riachos com corredeiras, p. 97–119. *In: Herpetologia Neotropical: Actas de II Congreso Latinoamericano de Herpetología*, Vol. II. J. E. Péfaur (ed.). Universidad de Los Andes, Consejo de Publicaciones, Consejo de Desarrollo Científico, Humanístico y Tecnológico, Mérida, Venezuela.
- Wogel, H., P. A. Abrunhosa, and L. N. Weber. 2004. The tadpole, vocalizations and visual displays of *Hylodes nasus* (Anura: Leptodactylidae). *Amphibia-Reptilia* 25:219–227.
- Zar, J. H. 1999. *Biostatistical Analysis*. Fourth edition. Prentice-Hall, Upper Saddle River, New Jersey.