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## A NEW SPECIES OF *HYLA* FROM NORTHEASTERN BRAZIL (AMPHIBIA, ANURA, HYLIDAE)

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**ABSTRACT:** A new medium-sized species of *Hyla* from a montane forest in northeastern Brazil is described (snout–vent length in males 37.3–42.2 mm). The new taxon is diagnosed by the following combination of characters: (1) prepollex and prepollical spine present; (2) dorsal color pattern brown, with bright, metallic tan or yellowish triangular spot covering dorsum of snout; (3) supralabial stripe metallic beige, slightly yellowish; (4) dorsolateral stripe bright, yellow, extending from middle eyelid to groin, breaking into series of small contiguous ovoid spots posteriorly; (5) concealed areas of legs and flanks pale cream; (6) tadpole stream-inhabitant. A large proportion of the tadpoles, which are herein described, revealed oral disk abnormalities that could be potentially associated with infection by chytrid fungus. To our knowledge, this is the first published record of a species of *Hyla* with stream-inhabitant tadpoles in northeastern Brazil.

**Key words:** Amphibia; Anura; *Hyla freicanecae*; *Hyla pulchella*; Hylidae; New species; Northeastern Brazil; State of Pernambuco; Tadpoles

OUR KNOWLEDGE of the amphibian fauna of the Atlantic Rainforest in Brazil has been rapidly increasing over the last few decades. Recent numbers indicate that 322 species of anurans inhabit this biodiversity hotspot, of which approximately 300 are endemic to the region (Duellman, 1999). The genus *Hyla* Laurenti, 1768 is especially well represented in the Atlantic Rainforest domain, with at least 60 known species (Duellman, 1999). *Hyla* is a broadly distributed genus, with more than 250 representatives throughout the Americas, Greater Antilles, northwestern Africa, and Eurasia (Duellman and Trueb, 1994). While phylogenetic relationships among species of *Hyla* are yet to be resolved, it has been common to arrange them into species groups, some of which have been studied in detail by Cruz and Peixoto (1984, 1985), Duellman, (1973), Duellman and Crump (1974), Duellman and Trueb (1983), B. Lutz (1973), and Savage and Heyer (1969), among others.

During surveys in an Atlantic Forest remnant in the State of Pernambuco, Brazil, we collected adults and tadpoles of a previously unknown species of *Hyla*. Herein, we describe this new species and provide information on its natural history.

### MATERIALS AND METHODS

Adults were manually captured and tadpoles were collected with dip nets. A subset of the tadpoles and one egg mass were placed in plastic containers and raised until metamorphosis to ensure proper identification. All individuals were anesthetized in 0.25% chlorotone solution and fixed in 10% (adults) or 5% (tadpoles) formaldehyde solution. Adults were transferred to and kept in a 70% ethanol solution within 7 d of fixation.

Examined specimens are listed in the Appendix. Abbreviations used for the two herpetological collections housing the material are ZUF RJ = Departamento de Zoologia, Instituto de Biologia, Universidade Federal do Rio de Janeiro, Brazil, and EI = Eugenio Izecksohn Collection, Departamento de Biologia Animal, Instituto de Biologia, Universidade Federal Rural do Rio de Janeiro, Brazil.

External body measurements of adults follow those of Duellman (2001) and Heyer et al. (1990). Measurements were taken with a digital caliper and recorded to the nearest 0.1 mm. Abbreviations used are SVL (snout–vent length), HL (head length), HW (head width), SND (snout–nostril distance), IND (internarial distance), END (eye–nostril distance), ED (eye diameter), IOD (interorbital distance), TY (tympanum diameter), TED

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(anterior margin of tympanum–posterior margin of eye distance), HDL (hand length), THL (thigh length), TL (tibia length), FL (foot length), and TFDW (width of disc on third finger). Webbing formula follows that of Savage and Heyer (1967) and modifications proposed by Myers and Duellman (1982).

Morphometric characters of tadpoles follow those of Altig (1970), Heyer et al. (1990), and McDiarmid and Altig (2000). Tadpoles were staged as per Gosner (1960). Measurements were taken with a dial caliper and recorded to the nearest 0.1 mm. Abbreviations used are TL (total length), BL (body length), BW (body width), BH (body height), TH (tail height), IN (internarial distance), NS (nare–snout distance), ED (eye diameter), IO (interorbital distance), and ES (eye–snout distance). Measurements of tadpoles correspond to values obtained from one individual at Stage 25, followed by variation found among seven other individuals at Stages 25 to 29, which is given in parentheses.

#### SYSTEMATICS

##### *Hyla freicanecae* sp. nov.

*Hototype*.—ZUF RJ 8827, male from Serra do Quengo (8° 43' S, 35° 50' W, approximately 700 m), Reserva Particular do Patrimônio Natural Frei Caneca, Municipality of Jaqueira, State of Pernambuco, Brazil. Collected on 23 August 2001, by J. Vicente Filho and A. Carnaval.

*Paratypes*.—ZUF RJ 8828, male, collected at the same site on 25 August 2001 by J. Vicente Filho and A. Carnaval; ZUF RJ 7941 and ZUF RJ 7942, males, collected at the same site by J. Vicente Filho and A. Carnaval on 7 June 1999.

*Diagnosis*.—A medium-sized species (SVL in males 37.3–42.2 mm,  $\bar{x}$  = 40.0, SD = 2.20) with the following combination of characters: (1) prepollex and prepollical spine present; (2) dorsal color pattern of adults brown, with bright, metallic tan or yellowish triangular spot covering dorsum of snout; (3) supralabial stripe metallic beige, slightly yellowish; (4) dorsolateral stripe bright, yellow, extending from middle eyelid to groin, breaking into series of small contiguous ovoid spots posteriorly; (5) concealed areas of legs and flanks pale cream; (6) tadpole stream-inhabitant.

The presence of a distinct prepollex and bright supralabial and dorsolateral stripes is shared among *Hyla freicanecae* and seven other Brazilian tree frogs: *H. cymbalum*, *H. ericae*, *H. marginata*, *H. prasina*, *H. pulchella*, *H. p. joaquina*, and *H. semiguttata* (Bokermann, 1963; Caramaschi and Cruz, 2000; Duellman et al., 1997; Garcia et al., 2001; Kwet and Di-Bernardo, 1999; A. Lutz, 1925; B. Lutz, 1973). The presence of a bright triangular spot on the dorsum of the snout of *H. freicanecae* distinguishes it from these species. Moreover, *H. freicanecae* differs from *H. cymbalum* by its smaller size (mean SVL in *H. freicanecae* 40.0 mm, SVL of male holotype and male paratype of *H. cymbalum* 45 and 49 mm; Bokermann, 1963), overall body color (brownish in *H. freicanecae*, dark green in *H. cymbalum*; Bokermann, 1963), and lack of dark spots in the concealed area of the flanks and legs (present in *H. cymbalum*; Bokermann, 1963). It differs from *H. ericae* by its larger size (SVL in males of *H. ericae* 29.2–34.0 mm; Caramaschi and Cruz, 2000), greater width and shorter extension of dorsolateral stripes, and lack of the numerous dark blotches or spots present on the dorsum of *H. ericae* (Caramaschi and Cruz, 2000). *Hyla freicanecae* differs from *H. marginata* by its smaller size (mean SVL in males of *H. marginata* 46.3 mm; Garcia et al., 2001), body color (brownish in *H. freicanecae*, green in *H. marginata*; Garcia et al., 2001; Kwet and Di-Bernardo, 1999), greater width and shorter extension dorsolateral stripes, and absence of the numerous dark blotches or spots often present on the dorsum of *H. marginata* (Garcia et al., 2001; Kwet and Di-Bernardo, 1999). The new taxon differs from *H. prasina* by its smaller size (SVL of male topotype of *H. prasina* 55 mm; B. Lutz, 1973), body color (brownish in *H. freicanecae*, light green in *H. prasina*; B. Lutz, 1973), lack of dark bars on the concealed area of the flanks and legs, and mode of reproduction (*H. freicanecae* breeds in streams, while *H. prasina* calls in marshy areas near ponds; B. Lutz, 1973). From *H. p. pulchella*, the new species differs by the absence of dark bars in the concealed area of the flanks and legs (present in *H. p. pulchella*; Kwet and Di-Bernardo, 1999; B. Lutz, 1973) and by its reproduction in streams (*H. p. pulchella* lives in open areas and breeds in lentic environ-

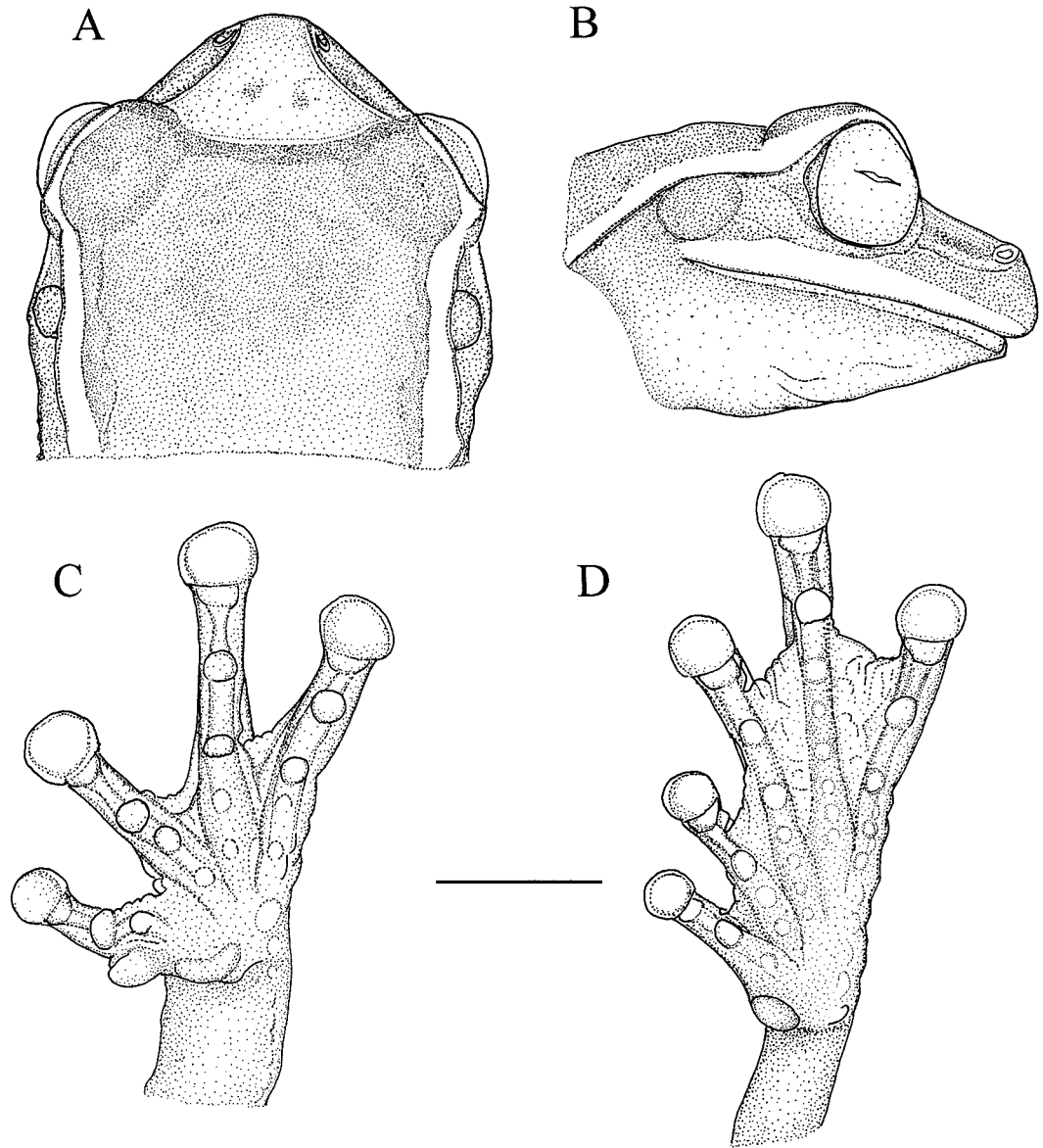


FIG. 1.—Holotype of *Hyla freicanecae* (ZUF RJ 8827). (A) Head in dorsal view, (B) head in lateral view, (C) right hand, (D) right foot. Scale bar = 5 mm.

ments; Kwet and Di-Bernardo, 1999). It differs from *H. p. joaquina* by its smaller size (SVL in type male of *H. p. joaquina* 51.5 mm; B. Lutz, 1973), background color (brownish in *H. freicanecae*, green in *H. p. joaquina*; B. Lutz, 1973), and color pattern (*H. freicanecae* lacks the dark spots present on the dorsal surface of the body of *H. p. joaquina*; B. Lutz, 1973). *Hyla*

*freicanecae* also differs from *H. semiguttata* by the absence of longitudinal dark bands and large dark drops on the dorsal surface of the body (Kwet and Di-Bernardo, 1999; A. Lutz, 1925; B. Lutz, 1973).

In the State of Pernambuco, *H. freicanecae* is the only species of *Hyla* to breed in streams. To the best of our knowledge, there are no

TABLE 1.—Measurements (mm) of the type series of *Hyla freicanecae* (holotype ZUF RJ 8827, paratypes ZURF 8828, 7941, and 7942, all males).

Character	ZUF RJ 8827	ZURF 8828	ZUF RJ 7941	ZURF 7942	Mean	Standard deviation
Snout-vent length	39.2	37.3	42.2	41.3	40.0	2.20
Head length	14.0	13.4	15.0	14.0	14.1	0.66
Head width	14.8	14.6	16.2	15.5	15.3	0.73
Snout-nostril distance	2.6	2.8	2.7	2.5	2.7	0.13
Internarial distance	2.1	2.5	3.1	2.4	2.5	0.42
Eye-nostril distance	4.2	3.4	4.0	4.0	3.9	0.35
Eye diameter	5.4	5.2	5.6	5.5	5.4	0.17
Interorbital distance	4.7	3.9	5.5	4.8	4.7	0.66
Tympanum diameter	2.2	2.1	2.3	2.0	2.2	0.13
Tympanum-eye distance	2.3	2.0	2.3	2.5	2.3	0.21
Hand length	13.6	12.2	13.4	12.8	13.0	0.63
Thigh length	21.7	19.1	20.4	20.3	20.4	1.06
Tibia length	22.5	20.1	22.3	22.0	21.7	1.10
Foot length	16.3	15.6	18.2	16.8	16.7	1.10
Width of disc on third finger	2.0	1.9	2.5	2.4	2.2	0.29

other known species of *Hyla* with similar breeding habitat in northeastern Brazil.

*Description of the holotype.*—A medium-sized, robust frog (Fig. 1); HL 36% of SVL, HL 95% of HW; snout nearly rounded in dorsal view, rounded in profile; nostrils slightly protruding, directed laterally; SND 62% of END; IND 50% of END, IND 39% of ED; eyes large, protruding; IOD 87% of ED; canthus rostralis well defined; loreal region concave; tympanum distinct, round; supratympanic fold distinct; TY 96% of TED; tongue large, cordiform; vocal slits bilateral, extending from the lateral base of tongue to angle of jaw; choanae elliptical, widely separated; two groups of vomerine teeth present in arched series of 10; vocal sac single, median, subgular.

Arms robust; external surface of forearms with ridge of small tubercles; HDL 35% of SVL; relative length of fingers I < II < IV < III; webbing formula I—II 2<sup>-</sup>—3<sup>-</sup> III 2<sup>+</sup>—2<sup>+</sup> IV; subarticular tubercles elevated, rounded; supernumerary tubercles small; palmar tubercle large, partially divided; prepollex present, elongate; prepollical spine present, curved, protruding when base of prepollex is compressed.

Legs moderately robust, elongate; external surface of tarsus with ridge of small tubercles; THL 55% of SVL; TL 57% of SVL; FL 42% of SVL; calcar on heel distinct, small; scattered tubercles present on heel; relative length of toes I < II < V < III < IV; webbing formula I 1½—2 II 1—2 III 1—2 IV 2—1 V; terminal

disks on toes smaller than those on fingers; subarticular tubercles elevated, rounded; supernumerary tubercles small; inner metatarsal tubercle large, ovoid; outer metatarsal tubercle small, rounded.

Skin on dorsum smooth, areas of bright spots or mottlings slightly granular or thickened; throat slightly granular; chest, belly, and ventral surfaces of the thighs granular, other ventral surfaces smooth; anal opening directed posteroventrally at upper ¼<sup>th</sup> of thighs, covered by small anal sheath; scattered perianal tubercles present.

*Measurements of the holotype (in mm).*—SVL 39.2; HL 14.0; HW 14.8; SND 2.6; IND 2.1; END 4.2; ED 5.4; IOD 4.7; TY 2.2; TED 2.3; HDL 13.6; THL 21.7; TL 22.5; FL 16.3; TFDW 2.0 (Table 1).

*Coloration of the holotype.*—In life, dorsum of body, loreal region, forelimbs, femur, tarsus, and foot brown. Dorsum of snout bright metallic tan, outlined in yellow; center of snout with small brown circular spot; supralabial stripe and spot below articulation of jaw metallic beige, slightly yellowish; tip of snout with vertical metallic tan stripe, extending from dorsum of snout to superior lip; iris tan, with thin dark reticulations. Body with sparse pale brown mottlings on dorsum; dorsolateral stripe and associated posterior spots bright, yellow; scattered small yellow mottlings underlying dorsolateral stripe; concealed areas of legs and flanks pale cream; two small horizontal yellow markings above anus; ventral sur-

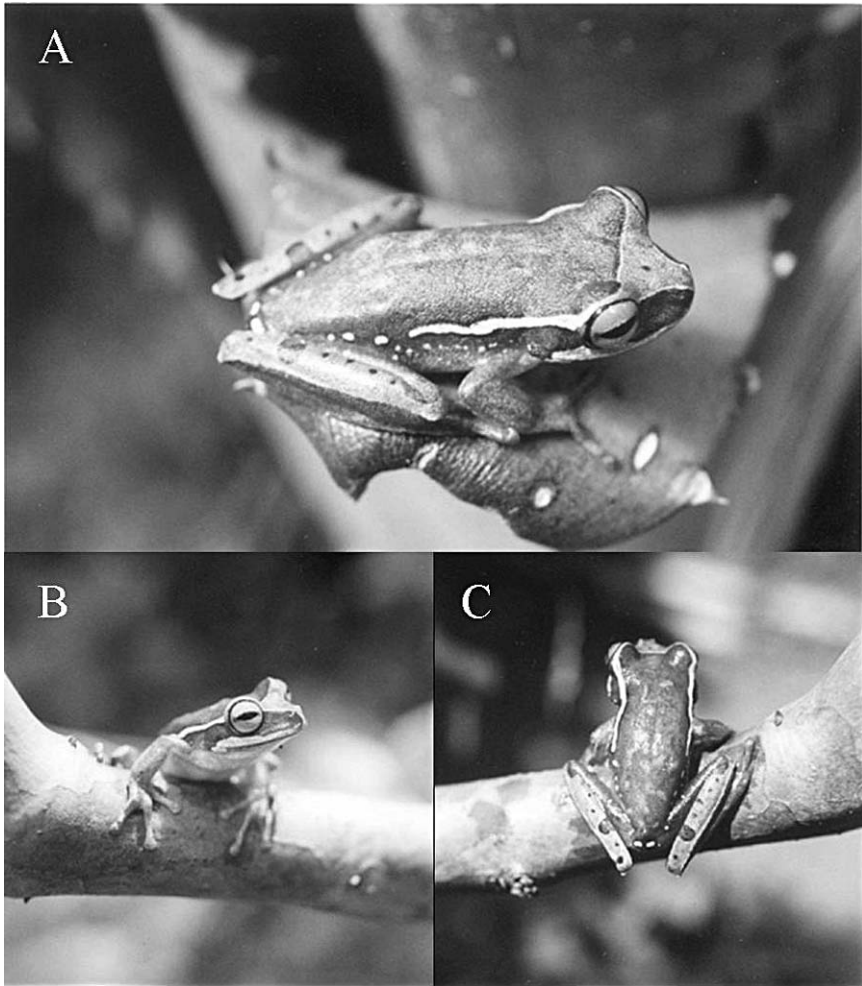


FIG. 2.—Holotype of *Hyla freicanecae* (ZUF RJ 8827). (A) Lateral view, (B) detail of snout in profile, (C) dorsal view.

faces of body pale cream. Dorsum of tibia metallic tan, with rounded dark brown mottlings near inner region; calcar yellowish (Fig. 2).

In preservative, bright, metallic areas of snout and tibia become pale. Dorsolateral and supralabial stripes become white, as well as yellow or light-brown mottlings of dorsum, thighs, flanks, and perianal region. The iris acquires a whitish pale tone.

*Variation*.—HL 34–36% of SVL, 90–95% of HW; SND 62–82% of END; IND 50–78% of END, 39–55% of ED; IOD 75–98% of ED; TY 80–105% of TED; number of vomerine teeth in arched series varying from 5–10; HDL 31–



FIG. 3.—Recently metamorphosed *Hyla freicanecae* (collected as a tadpole with lot EI 9490). Total length 19 mm.

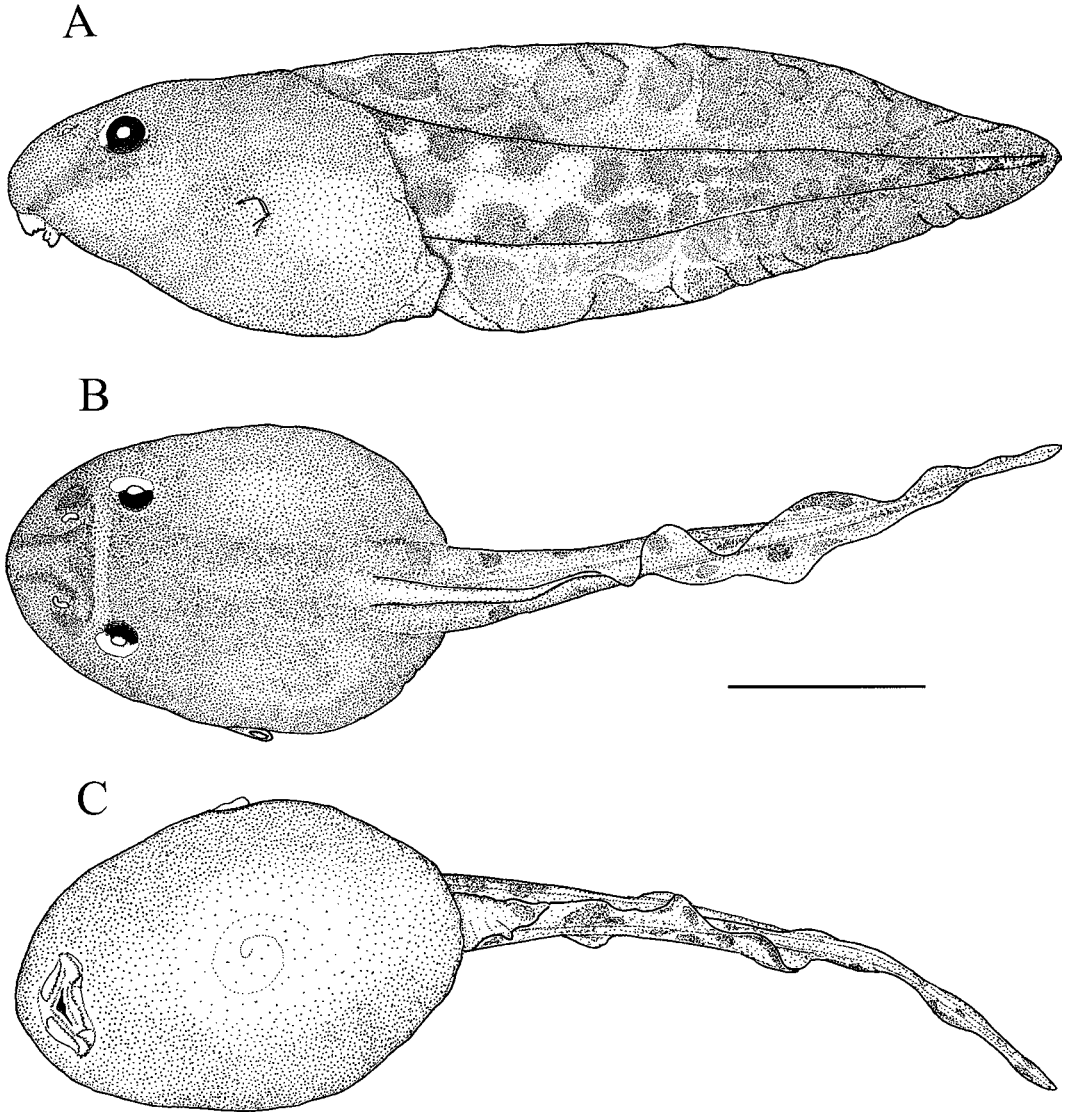


FIG. 4.—Tadpole of *Hyla freicanecae*, Stage 25 (Gosner, 1960), part of EI 9490. (A) Lateral view, (B) dorsal view, (C) ventral view. Scale bar = 10 mm.

35% of SVL; variation in hand webbing formula I—II ( $2^-$ — $2\frac{1}{2}$ )—( $3^-$ — $3\frac{1}{2}$ ) III ( $2\frac{2}{3}$ — $3^+$ )—( $2$ — $2\frac{1}{2}$ ) IV; THL 48–55% of SVL; TL 53–57% of SVL; FL 41–43% of SVL; variation in foot webbing formula I ( $1\frac{1}{2}$ — $2^-$ )—2 II ( $1$ — $1^+$ )—( $2$ — $2^+$ ) III ( $1^-$ — $1^+$ )—( $2$ — $2^+$ ) IV 2—( $1$ — $1^+$ ) V.

Body and limb olivaceous in some specimens; dorsum of snout yellow in a few individuals; bright spot below jaw articulation

absent in some specimens; snout with one to three circular brown spots in center; yellow spots posterior to dorsolateral stripes varying from one to five; number of yellow markings above anus varying from two to four; dorsal surface of thighs with sparse light brown or yellowish mottlings in some specimens; rounded dark brown mottlings near inner region of thighs varying in size among individuals; dorsum of tibia yellow in some specimens.

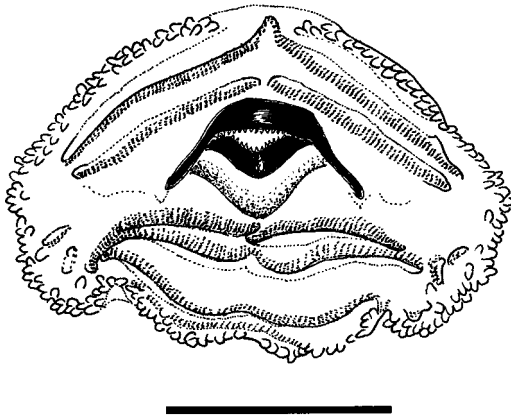


FIG. 5.—*Hyla freicanecae*. Mouthparts of tadpole at Stage 25 of Gosner (1960), part of EI 9490. Scale bar = 2 mm.

Recently metamorphosed specimens have the same color pattern shown by the adults (Fig. 3). The yellowish snout and dorsolateral stripes are outlined by a layer of dark-brown pigments. Ventral surfaces are metallic white, the chest slightly green, ventral surfaces of the limbs yellowish, and dorsal surfaces of the limbs olivaceous. Iris pinkish tan.

*Tadpole*.—Body robust, ovoid in dorsal view, with posteriormost region slightly wider than deep; snout round in dorsal and lateral views; nares closer to eyes than to tip of snout; nare opening reniform, on a low depression; eyes dorsolateral, proportionally small, ED 13% (10%–15%) of BL; spiracle sinistral, situated at medial third of body length; anal tube dextral, slightly longer than wide (width measured at its base), with opening directed to the right; BH 81% (81%–97%) of TH; tail musculature moderate, both tail fins slightly

arched, dorsal fin slightly deeper than ventral fin, reaching body, tail tip rounded. Oral disc ventral, disc width 31% (31%–41%) of BW; marginal papillae present in one or two rows, papillae interrupted anteriorly and slightly interrupted posteriorly; some submarginal papillae present at lateral sides of oral disc, some bearing small rows of denticles; LTRF 2(2)/4[3](1); fourth lower row, if present, shorter than others and with a few broken pieces; lower labium with two discrete indentations; jaw sheaths robust and serrate, upper sheath as a wide arch, lower sheath almost U-shaped (Figs. 4, 5).

*Measurements of tadpoles in mm*.—TL 53.5 (50.3–57.0); BL 21.0 (18.0–22.3); BW 13.7 (13.0–16.1); BH 12.3 (12.0–15.0); TH 15.1 (14.0–16.4); IN 3.0 (3.0–3.6); NS 3.8 (3.5–4.4); ED 2.7 (1.8–3.0); IO 5.0 (4.4–5.1); ES 7.0 (5.8–7.1) (Table 2).

Body coloration in life dark brown to black, with golden dots conferring a slightly marbled aspect from snout to anterior third of tail; large specimens with dark stripes between eyes and nares, creating a W-shaped mark; markings in younger specimens often incomplete; eyes bronze; tail musculature and fins yellowish or beige, with large dark brown to black spots; tail uniformly spotted in younger tadpoles, older tadpoles with distal portion of tail almost solid black; belly translucent with small golden dots. In preservative, dark spots still visible; golden dots absent; background color of tail musculature cream.

*Distribution and ecology*.—*Hyla freicanecae* is known solely from its type locality. Adults were collected in a montane forest, between 1700 and 1900 h. Individuals were found near a small, shallow stream (approxi-

TABLE 2.—Measurements (mm) of seven tadpoles of *Hyla freicanecae* (part of EI 9490) at Stages 25 through 29 of Gosner (1960).

Stage	25	25	26	26	27	27	29
Total length	53.5	54.8	50.3	50.6	53.0	57.0	52.0
Body length	21.0	19.4	18.0	18.5	20.3	22.3	20.0
Body width	13.7	14.5	14.2	13.0	15.2	16.1	14.2
Body height	12.3	13.2	12.4	12.0	13.9	15.0	13.1
Tail height	15.1	14.8	13.2	13.5	14.3	16.4	14.0
Internarial distance	3.0	3.2	3.0	3.1	3.3	3.6	3.3
Nare–snout distance	3.8	4.0	3.7	3.5	4.2	4.4	3.5
Eye diameter	2.7	3.0	2.0	1.8	3.0	2.5	2.4
Interorbital distance	5.0	4.8	4.7	4.4	4.9	5.1	4.7
Eye–snout distance	7.0	6.2	6.0	5.8	6.4	7.1	6.2



mately 1.0 m wide, 0.5 m deep), resting on branches 0.5 to 1.0 m above the ground. None of the individuals was calling at time of collection. Tadpoles were found in slow moving areas of the same stream, hiding underneath dead leaves when disturbed. A spherical egg mass containing approximately 30 eggs was found under water, attached to a fallen plant stem.

*Etymology.*—The name *Hyla freicanecae* is homage to the sugarcane farm and distillation plant Usina Frei Caneca for its effort to conserve one of the few remaining fragments of Atlantic Montane Forest in northeastern Brazil, in which the species was found. Thanks to an agreement with Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), this remnant was recently turned into a private forest preserve.

*Remarks.*—The presence of a prepollex and a prepollical spine, the unique color pattern, and reproduction in streams distinguish *H. freicanecae* from all other species of *Hyla*. When compared to other Brazilian taxa, the new species shares similarities—such as the presence of a marked prepollex and bright supralabial and dorsolateral stripes—with species commonly assigned to the *H. pulchella* group: *H. cymbalum*, *H. ericae*, *H. marginata*, *H. prasina*, *H. p. pulchella*, *H. p. joaquini*, and *H. semiguttata* (Bokermann, 1963; Caramaschi and Cruz, 2000; Duellman et al., 1997; Garcia et al., 2001; Kwet and Di-Bernardo, 1999; B. Lutz, 1973). Similar to *H. freicanecae*, some of these species occur in montane forests and breed in streams (Duellman et al., 1997; Garcia et al., 2001; B. Lutz, 1973). However, because the monophyly and definition of the *H. pulchella* group are yet to be established and resolved through a comprehensive phylogenetic study (see Garcia et al., 2001), we prefer to refrain from assigning the new taxon to any species group at this point.

To our knowledge, this is the first published record of a species of *Hyla* with stream-inhabitant tadpoles in northeastern Brazil. It is interesting and perhaps alarming that a significant portion of the tadpoles exhibited oral disk abnormalities. Forty of the 44 tadpoles in lots EI 9490 and ZUF RJ 8901 showed anomalies such as nearly complete loss of keratin from jaw sheaths, lack of keratinized tooth rows, and a variable degree of de-

velopment and fragmentation of the fourth lower tooth row. Loss of larval keratinized mouthparts has been associated with infection by chytrid fungus in some stream-dwelling species of the families Hylidae and Centrolenidae, and chytrids have been linked to death of adult frogs and population declines in several areas of the world (Lips et al., 2001). Given that this constitutes the single population of *H. freicanecae* known to exist so far, we encourage its long-term monitoring and the preservation of its natural environment. Due to the lack of past inventories in the State of Pernambuco, it is possible, however, that future visits to yet unsurveyed montane forests may provide additional distributional data for this species.

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## APPENDIX I

### *Specimens Examined*

*Hyla freicanecae*: BRAZIL, State of Pernambuco, Municipality of Jaqueira, Reserva Particular do Patrimônio Natural Frei Caneca, Serra do Quengo (8° 43' S, 35° 50' W, approximate altitude 700 m): ZUFRJ 8827, adult male, 23 August 2001; ZUFRJ 8828, adult male, 25 August 2001; ZUFRJ 7941–42, two adult males, 7 June 1999; ZUFRJ 8901, tadpole lot, 26 January 2001; EI 9490, tadpole lot, 26 January 2001.

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