

The tadpole of *Osteocephalus cabrerai* (Anura: Hylidae) from central Amazonia, Brazil

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Abstract

The tadpole of *Osteocephalus cabrerai* (Anura: Hylidae) from central Amazonia, Brazil. Herein we describe the tadpoles of *Osteocephalus cabrerai* based on 37 individuals of eight different development stages. We provide comments on spawning sites and breeding period, and compare these tadpoles with those of congeners. The tadpole of *O. cabrerai* (Stage 39) is characterized by an ovoid body, elongated in lateral view and oval in dorsal view. The snout is rounded, the nostrils oval and the eyes lateral. The tail length is 67% of total length. The larva has a single, sinistral spiracle that is ventrolateral in position. The short vent tube is dextral and attached to the ventral fin. The anteroventral oral disc has marginal and submarginal papillae and a labial tooth row formula 2(2)/6(1). Tadpoles inhabit streams in terra firme forest.

Keywords: Breeding site, larval morphology, terra firme forest.

Resumo

O girino de *Osteocephalus cabrerai* (Anura: Hylidae) da Amazônia Central, Brasil. Neste estudo, descrevemos o girino de *Osteocephalus cabrerai* utilizando 37 indivíduos em oito diferentes estágios de desenvolvimento. Também fornecemos informações sobre o sítio e período de reprodução da espécie e comparamos os girinos com outros já descritos do mesmo gênero. O girino de *O. cabrerai* (Estádio 39) é caracterizado por um corpo ovóide alongado em vista lateral e oval em vista dorsal. O focinho é arredondado, as narinas são ovais e os olhos são laterais. A cauda representa 67% do comprimento total. O girino tem espiráculo único, sinistro e ventrolateral. O tubo anal é destro, curto e aderido à nadadeira ventral. O disco oral é anteroventral, com papilas marginais e submarginais; a fórmula dentária é 2(2)/6(1). Os girinos são encontrados em riachos dentro de floresta de terra firme.

Palavras-chave: Floresta de terra firme, habitat de reprodução, morfologia.

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Introduction

The Neotropical hyliid genus *Osteocephalus* Steindachner, 1862, comprises 24 species (Jungfer 2010), 15 of which are found in Brazil (SBH 2010, Frost 2011). Many new or resurrected species have been described recently (reviewed by Jungfer 2010). However, the larvae of only five species of this genus have been formally described—*O. festae* (Peracca, 1904); *O. mimeticus* (Melin, 1941) [= *O. elkejungingeriae* Henle, 1981]; *O. oophagus* Jungfer and Schiesari, 1995; *O. taurinus* Steindachner, 1862; and *O. verruciger* (Werner, 1901) (Trueb and Duellman 1970, Henle 1981, Hero 1990, Rodríguez and Duellman 1994, Jungfer and Schiesari 1995, Schiesari et al. 1996, Duellman 2005, Ron et al. 2010).

Osteocephalus cabrerai (Cochran and Goin, 1970), a member of the *Osteocephalus buckleyi* (Boulenger, 1882) complex, is known from Amazonian Colombia and Peru, on the Guiana Shield, and in the Orinoco Delta in Venezuela (Jungfer 2010, Frost 2011). In spite of this wide distribution, there is little information on the reproductive biology and natural history of this species. *Osteocephalus cabrerai* breeds mainly in the dry season between June and December, and eggs are deposited in streams (Hero 1990, Hödl 1990, Lima et al. 2006 [all of them as *O. buckleyi*], Lescure and Marty 2000). Hero (1990) was the first to illustrate and describe few external features of the tadpole (e.g., LTRF and body coloration) for an identification key of tadpoles of the Brazilian central Amazon.

In this paper, we describe the tadpole of *O. cabrerai* based on 37 individuals from Manaus, Brazil and eight developmental stages. We compare these larvae with those of congeners and provide and comment on the breeding sites.

Materials and Methods

Clutches of *Osteocephalus cabrerai* were collected from Acará stream by A. P. Lima and J.-M. Hero on October 17, 1986, and March 29, 1987, at Reserva Florestal Adolpho Ducke

(RFAD: 02°55' and 03°01' S and 59°53' and 59°59' W), near the city of Manaus, Amazonas, Brazil. The reserve covers 10,000 ha of *terra firme* (non-flooded) rainforest, a well-drained forest not subject to seasonal flooding. The site is characterized by a forest that has a closed canopy at heights from 30–37 m with emergent trees from 40–45 m tall (Ribeiro et al. 1999). The understory contains abundant sessile palms (Ribeiro et al. 1999). The rainy season is from November–May (Marques Filho et al. 1981) and the mean annual rainfall is 2489 mm (between 1985 and 2004). Mean annual temperature is approximately 26°C (Marques Filho et al. 1981).

One group of tadpoles was obtained from an amplexant pair on 29 March 1987, from which 28 individuals at Stage 25 were preserved. Eggs were collected from Acará stream and the tadpoles were kept in plastic basins (40 × 40 × 10 cm) in the laboratory until individuals reached metamorphosis. Tadpoles were fed with commercial rabbit food. Tadpoles in different stages were preserved in 10% formalin.

Tadpole stages are based on Gosner's (1960) developmental table. Descriptive terminology and morphometric variables follow those of Altig and McDiarmid (1999). Measurements were taken with millimetric oculars. Voucher specimens collected at RFAD were deposited in the Herpetological Collection of the Instituto Nacional de Pesquisas da Amazônia (Tadpole lot: INPA-H 1585, 1595, as *O. buckleyi*).

Results

Tadpole Description and Variation

The description is based on a Stage-39 tadpole (INPA-H 1595). Body ovoid, elongated in lateral view (Figure 1A) and oval in dorsal view (Figure 1B). Body and tail 33% and 67% of total length, respectively. Body wider than high. Posterior third of body highest and midlength of body widest. Snout rounded in dorsal and lateral views. Eyes dorsolateral. Interorbital distance approximately four times

greater than eye diameter. Nostril ovoid, anterolateral, and nearer to end of snout than to eye. Internostril distance about 70% of interorbital distance. Spiracle single, sinistral, ventrolateral, short, and directed posterodorsally. Spiracle inner wall absent. Vent tube dextral, short, attached to ventral fin, visible in lateral view. Dorsal fin originating at body-tail junction, increasing gradually in height throughout the first two thirds of the tail, and diminishing gradually in the posterior third of tail to a rounded tip. Ventral fin originating at the posteroventral end of body, slightly arched and diminishing gradually in height toward tail tip. Oral disc (Figure 1C) anteroventral and not emarginate. Marginal papillae with a medial gap on upper labium. Submarginal papillae on ventrolateral portions of upper and lower labium. Marginal and submarginal papillae with rounded tips. Labial tooth row formula 2(2)/6(1). Upper jaw sheath arched and lower jaw sheath V-shaped, both with serrations. Measurements of tadpoles at other developmental stages are presented in Table 1.

In preserved specimens, dorsal and dorso-lateral regions of body, superior region of the limbs, and caudal musculature dark brown; venter whitish and translucent posteriorly; anterior region of the venter with brownish melanophores; fins light brown and translucent.

Individuals of Stages 25, 27, 28, 29, 30, and 38 have the following labial tooth row formulae: 2(2)/3, 2(2)/3(1), 2(2)/4, 2(2)/5, or 2(2)/6(1) (Table 1).

Natural History

We found 11 clutches, two of which had 1100 and 879 eggs, respectively. The eggs were deposited in small inlets along the stream bank, where they were protected from the main current. All clutches were spread over the surface of the water in pools formed by roots or depressions in the rocks. We only found tadpoles up to Stage 29 in the inlets; the whereabouts of older tadpoles are unknown. *Osteocephalus cabrerai* breeds mainly

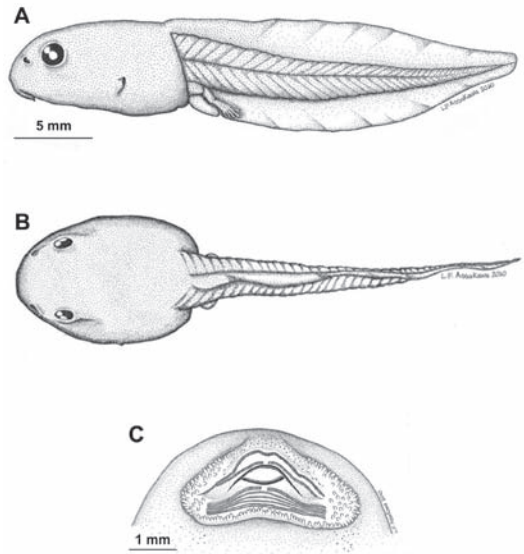


Figure 1. *Osteocephalus cabrerai* (INPA-H 1595) at Stage 39. (A) Lateral view, (B) dorsal view, and (C) oral disc. Specimen from Reserva Florestal Adolpho Ducke, Manaus, Amazonas, Brazil.

in the dry season between June and November, but one clutch of eggs was found in March.

Discussion

The general morphology of the tadpoles of *Osteocephalus cabrerai* resembles that described for its congeners. However, the tadpoles of *O. cabrerai* are smaller than tadpoles of *O. festae* (total length [TL] = 40.4 mm, Stage 39 of Gosner 1960), *O. taurinus* (TL = 33.3–38.3 mm, Stage 39), and *O. verruciger* (TL = 40.8 mm, Stage 37), and larger than *O. mimeticus* (TL = 10.2 mm, Stage 33) and *O. oophagus* (TL = 28.4–31.4 mm, Stage 39) (Trueb and Duellman 1970, Henle 1981, Jungfer and Schiesari 1995, Schiesari *et al.* 1996, Duellman 2005, Ron *et al.* 2010). The tadpoles of *O. cabrerai* also differ from their congeners in the following characters: rounded snout in dorsal aspect (truncate in *O. oophagus*

Table 1. Measurements (in mm) of 37 tadpoles of *Osteocephalus cabrerai* tadpoles Stages 25, 27–31, 38, and 39. Values are means \pm standard deviation and range for stages with three or more individuals. For stages with one or two individuals, the values are presented for each individual. LTRF = labial tooth row formula.

Characters	Stage							
	25 n = 28	27 n = 2	28 n = 2	29 n = 1	30 n = 1	31 n = 1	38 n = 1	39 n = 1
Total length	10.37 \pm 0.95 9.24–12.50	21.27 22.17	22.29 22.73	23.68	24.96	27.91	30.56	32.37
Body length	3.57 \pm 0.40 3.00–4.50	7.67 8.04	8.33 8.37	8.48	8.96	9.51	10.78	10.56
Tail length	6.80 \pm 0.67 5.88–8.25	13.60 14.13	13.92 14.40	15.20	16.00	18.40	19.78	21.81
Maximum tail height	2.34 \pm 0.41 1.75–3.10	2.96 3.20	1.76 4.00	3.76	4.00	5.44	6.80	6.24
Tail muscle height	0.95 \pm 0.10 0.75–1.25	1.75 2.00	2.00 2.00	2.00	2.00	2.50	2.75	2.90
Tail muscle width	0.80 \pm 0.14 0.65–1.10	1.50 1.75	1.84 1.84	1.84	2.00	2.80	2.80	2.96
Internarial distance	1.34 \pm 0.21 1.05–1.75	2.60 2.75	2.75 2.80	2.64	2.80	2.96	3.20	3.36
Interorbital distance	1.41 \pm 0.21 1.15–1.80	2.88 3.20	3.44 3.75	3.36	3.75	4.00	4.48	4.80
Eye diameter	0.36 \pm 0.04 0.30–0.45	0.88 0.90	1.10 1.10	1.20	1.20	1.20	1.36	1.36
Oral disc width	1.27 \pm 0.21 1.00–1.70	2.50 2.55	2.25 2.75	2.56	2.75	3.10	3.20	3.60
LTRF	2(2)/3-5	2(2)/3 2(2)/4[1]	2(2)/3-4	2(2)/4	2(2)/4	2(2)/5	2(2)/6	2(2)/6(1)

and bluntly rounded in *O. taurinus*); eyes lateral (dorsolateral in *O. festae*, *O. mimeticus*, *O. oophagus*, *O. taurinus*, and *O. verruciger*); nostrils near end of snout (nostrils closer to eyes than end of snout in *O. festae* and *O. oophagus* and intermediate in *O. taurinus* and *O. verruciger*); labial tooth-row formula 2(2)/6(1) at Stage 39 (LTRF 4/7 or 5/7 in *O. festae*; 2(2)/6 in *O. mimeticus*; 2(2)/3 in *O. oophagus*; 2(2)/3-7(1) in *O. taurinus*; 2(2)/5(1) in *O. verruciger*); and body dark brown in preserved individuals (dorsum brown with darker marks between eyes and dorsolateral stripes in *O. festae*; body brown and caudal musculature cream, fins translucent in *O. taurinus*; Trueb and Duellman 1970, Hero 1990, Henle 1981, Jungfer and Schiesari 1995,


Schiesari *et al.* 1996, Duellman 2005, Ron *et al.* 2010). Variation in the LTRF also was observed in tadpoles of *O. festae* and *O. taurinus* (Schiesari *et al.* 1996, Ron *et al.* 2010).

The coloration of tadpoles of *Osteocephalus cabrerai* (as *O. buckleyi*) in life was described by Hero (1990) and Lima *et al.* (2006): dorsum dark blue with a clear medial band; caudal musculature dark blue; abdomen and fins transparent. This pattern differs from *O. festae* (dorsum dark brown with darker marks between the eyes; dark brown dorsolateral lines; tail musculature light brown), *O. mimeticus* (body dark gray or dark blue; tail dark gray; venter light gray), *O. oophagus* (chestnut brown dorsally; venter and caudal musculature lighter),

O. taurinus (body transparent olive with scattered white chromatophores; tail transparent or body and caudal musculature dull brown with no evident pattern), and *O. verruciger* (dorsum black brown with a bluish sheen to the venter; fins dark grey; caudal musculature brownish black) (Trueb and Duellman 1970, Henle 1981, Hero 1990, Jungfer and Schiesari 1995, Duellman 2005, Ron *et al.* 2010).

The breeding site of *Osteocephalus cabrerai* is small streams in terra firme forest, similar to that described for *O. mimeticus* (small streams; Henle 1981), but differing from *O. festae*, *O. lepreurii* (Duméril and Bibron, 1841), *O. taurinus*, and *O. verruciger*, which reproduce in temporary or permanent ponds at streams margins (*Osteocephalus taurinus* also reproduces in temporary ponds distant from streams margins) (Trueb and Duellman 1970, Hero 1990, Rodríguez and Duellman 1994, Schiesari *et al.* 1996, Lescure and Marty 2000, Duellman 2005, Lima *et al.* 2006, Menin *et al.* 2008, Ron *et al.* 2010). *Osteocephalus oophagus* deposits clutches in small water bodies formed in epiphytes, bromeliads, bases of palm leaves and tree holes (Jungfer and Schiesari 1995, Schiesari *et al.* 1996, Lima *et al.* 2006, Menin *et al.* 2008).

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References

- Altig, R. and R. W. McDiarmid. 1999. Body plan: development and morphology. Pp. 24–51 in R. W. McDiarmid and R. Altig (eds.), *Tadpoles: The Biology of Anuran Larvae*. Chicago and London. The University of Chicago Press.
- Duellman, W. E. 2005. *Cusco Amazónico. The Lives of Amphibian and Reptiles in an Amazonian Rainforest*. Ithaca. Cornell University Press. 433 pp.
- Frost, D. R. 2011. Amphibian Species of the World: an Online Reference. Version 5.5 (31 January 2011). Electronic database accessible at <http://research.amnh.org/vz/herpetology/amphibia/>American Museum of Natural History, New York, USA. Accessed on 26 July 2011.
- Gosner, K. L. 1960. A simplified table for staging anuran embryos and larvae with notes on identification. *Herpetologica* 16: 183–190.
- Henle, K. 1981. *Hyla elkejungingerae*, ein neuer Hylidae aus dem peruanischen Regenwald (Amphibia: Salientia: Hylidae). *Amphibia-Reptilia* 2: 123–132.
- Hero, J.-M. 1990. An illustrated key to tadpoles occurring in the Central Amazon rainforest, Manaus, Amazonas, Brasil. *Amazoniana* 11: 201–262.
- Hödl, W. 1990. Reproductive diversity in Amazonian lowland frogs. Pp. 41–60 in W. Hanke (ed.), *Biology and Physiology of the Amphibians*. Stuttgart and New York. G. Fischer Verlag.
- Jungfer, K. H. 2010. The taxonomic status of some spiny-backed treefrogs, genus *Osteocephalus* (Amphibia: Anura: Hylidae). *Zootaxa* 2407: 28–50.
- Jungfer, K. H. and L. C. Schiesari. 1995. Description of a central Amazonian and Guianan tree frog, genus *Osteocephalus* (Anura, Hylidae), with oophagous tadpoles. *Alytes* 13: 1–13.
- Lescure, J. and C. Marty. 2000. Atlas des Amphibiens de Guyane. *Patrimoines Naturels* 45: 1–388.
- Lima, A. P., W. E. Magnuson, M. Menin, L. K. Erdtmann, D. J. Rodrigues, C. Keller, and W. Hödl. 2006. *Guia de Sapos da Reserva Adolpho Ducke, Amazônia Central. Guide to the Frogs of Reserva Adolpho Ducke, Central Amazonia*. Manaus. Átemma. 168 pp.
- Marques Filho, A. O., M. N. G. Ribeiro, H. M. Santos, and J. M. Santos. 1981. Estudos climatológicos da Reserva Florestal Ducke – Manaus – AM. IV. Precipitação. *Acta Amazonica* 11: 759–768.
- Menin, M., F. Waldez, and A. P. Lima. 2008. Temporal variation in the abundance and number of species of frogs in 10,000 ha of a forest in Central Amazonia, Brazil. *South American Journal of Herpetology* 3: 68–81.

- Ribeiro, J. E. L. S., M. G. Hopkins, A. Vicentini, C. A. Sothers, M. A. S. Costa, J. M. Brito, M. A. D. Souza, L. H. P. Martins, L. G. Lohmann, P. A. C. L. Assunção, E. C. Pereira, C. F. Silva, M. R. Mesquita, and L. Procópio. 1999. *Flora da Reserva Ducke: Guia de Identificação das Plantas Vasculares de uma Floresta de Terra Firme na Amazônia Central*. Manaus. Instituto Nacional de Pesquisas da Amazônia. 800 pp.
- Rodríguez, L. O. and W. E. Duellman. 1994. Guide to the frogs of the Iquitos region, Amazonian Peru. *The University of Kansas, Natural History Museum, Special Publication* 22: 1–80.
- Ron, S. R., E. Toral, P. J. Venegas, and C. W. Barnes. 2010. Taxonomic revision and phylogenetic position of *Osteocephalus festae* (Anura, Hylidae) with description of its larva. *ZooKeys* 70: 67–92.
- SBH. 2010. Brazilian amphibians – List of species. Eletronic database accessible at <http://www.sbherpetologia.org.br>. Sociedade Brasileira de Herpetologia, São Paulo, Brazil. Accessed on 1 July 2011.
- Schiesari, L. C., B. Grillitsch, and C. Vogl. 1996. Comparative morphology of phytotelmonous and pond-dwelling larvae of four Neotropical treefrog species (Anura, Hylidae, *Osteocephalus oophagus*, *Osteocephalus taurinus*, *Phrynohyas resinifictrix*, *Phrynohyas venulosa*). *Alytes* 13: 109–139.
- Trueb, L. and W. E. Duellman. 1970. The systematic status and life history of *Hyla verrucigera* Werner. *Copeia* 1970: 601–610.