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Description of the tadpole of *Itapotihyla langsdorffii* (Anura: Hylidae)

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Abstract

The tadpole of *Itapotihyla langsdorffii* is described and illustrated. Morphological data are compared with available information on tadpoles of casque-headed frogs occurring in the Atlantic Rainforest (genera *Aparasphenodon* and *Trachycephalus*), and also with *Osteocephalus*. The ontogenetic shift in tooth row formula and the great similarity on tadpole external morphology among these genera do not allow the use of the examined larval characters on generic diagnoses. However, we present some juvenile characters which may support the validity of *Itapotihyla*. The confrontation of the hypotheses concerning oral disk morphology and larval habitat types of the casque-headed tree frogs with the phylogeny of the Lophiohylini indicates that the ancestral larval habitat of this tribe was lentic and that the high number of tooth rows in this clade is not related to larval habitat.

Key words: *Itapotihyla*, *I. langsdorffii*, tadpole external morphology, juvenile characters, larval habitat, Lophiohylini

Resumo

O girino de *Itapotihyla langsdorffii* é descrito e figurado. Dados morfológicos são comparados com as informações disponíveis para os girinos de outras "pererecas-de-capacete" que ocorrem na Mata Atlântica (gêneros *Aparasphenodon* e *Trachycephalus*), e também com *Osteocephalus.* A mudança ontogenética na formula dentária e a grande similaridade na morfologia externa dos girinos não permite a utilização dos caracteres larvários examinados em diagnoses genéricas. No entanto, apresentamos alguns caracteres de juvenis que poderiam suportar a validade de *Itapotihyla*. O confronto das hipóteses sobre morfologia do disco oral e tipos de ambiente larvários em "pererecas-de-capacete" com a filogenia de Lophiohylini indica que o ambiente larvário ancestral dessa tribo era lêntico e que o elevado número de fileiras de dentes nesse clado não se relaciona com o ambiente larvário.

Palavras-chave: *Itapotihyla*, *I. langsdorffii*, morfologia externa de girinos, caracteres juvenis, ambiente larvário, Lophiohylini

Introduction

Hyla langsdorffii was described by Duméril & Bibron (1841) from Brazil, probably from the lowlands of the State of Rio de Janeiro (Bokermann 1966). Cope (1867) transferred the species to the genus *Osteocephalus* Steindachner. It was the only species of the genus occurring in the Atlantic Rainforest Domain (sensu Ab'Saber 1977); the remaining 17 species are Amazonian (Frost 2006). Faivovich *et al.* (2005) recently erected the monotypic genus *Itapotihyla* to allocate *Osteocephalus langsdorffii*. The exclusion of *I. langsdorffii* (Duméril & Bibron) from *Osteocephalus* was proposed exclusively in the basis of molecular characters, but the authors suggest the presence of the prominent subcloacal flap as a possible morphological autapomor-

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phy to *Itapotihyla* (Faivovich *et al.* 2005; unchanged in Frost *et al.* 2006).

Itapotihyla langsdorffii is a large tree frog (males reaching SVL 77 mm, females 99 mm; Lutz 1973) distributed from the southern region of the State of Bahia, Brazil, to northeastern Argentina (Frost 2006). Duellman (1974) illustrated and made anedoctal observations on coloration of preserved specimens and number of labial tooth rows of the tadpole, but provided no detailed description of the external morphology or measurements.

Herein, we describe and illustrate the tadpole of *I. langsdorffii* based on a series of tadpoles at different developmental stages, comparing it with known larvae of other casque-headed frogs occurring in the Brazilian Atlantic Rainforest (genera *Aparasphenodon* Miranda-Ribeiro and *Trachycephalus* Tschudi). We also compare tadpoles and juveniles of *I. langsdorffii* with those of *Osteocephalus*.

Materials and methods

Tadpoles at stages 35–38 (Gosner 1960) were collected from a temporary pond inside the forest at Estação Biológica de Santa Lúcia, Municipality of Santa Teresa (19º56'S, 40º35'W), State of Espírito Santo, Brazil, and reared in laboratory. The region of Santa Teresa is located over a mountain ridge, comprised of patches of secondary and undisturbed forests. The pond where tadpoles were collected was formed by heavy rainfall from previous night. Considering the development stages of tadpoles, the oviposition did not occur in this pond, so tadpoles were probably carried by the flooding from other water bodies. Four specimens reached metamorphosis and confirmed species identity. A lot of 14 tadpoles (MNRJ 31753) and four metamorphosed specimens (MNRJ 31754–57) are deposited at the Museu Nacional, Rio de Janeiro.

Descriptions and measurements are based on six tadpoles in stages 39–40 (Gosner 1960). Tadpoles at stages 35, 36 and 38 were used to corroborate variations in labial tooth row formula. Nomenclature and measurements follow Altig and McDiarmid (1999), except for the interorbital distance, which was taken between the inner margins of eyes. Measurements (in millimeters) were taken using an ocular grid in a Zeiss stereomicroscope, except for total length, body length, body height, body width, tail length, and tail height, which were measured with calipers to the nearest 0.1 mm.

Data about morphological characters of tadpoles of the genera *Aparasphenodon*, *Osteocephalus* and *Trachycephalus* (including the prior *Phrynohyas* Fitzinger; see Faivovich *et al.* 2005) were obtained from Trueb and Duellman (1970), Henle (1981), Hero (1990), Jungfer and Schiesari (1995), Prado *et al.* (2003), Schiesari and Moreira (1996), Schiesari *et al.* (1996), Wogel *et al.* (2000, 2006), Zimmerman and Hödl (1983), and also from comparison with material deposited at the Museu Nacional, Rio de Janeiro [*T. mesophaeus* (Hensel), MNRJ 28874].

Results

Tadpole description. Stages 39–40 (Gosner 1960). Mean total length 53.1 (*sd* = 2.72 mm). Body robust and elongated, elliptical in lateral, dorsal, and ventral views; snout rounded in dorsal view and truncated in lateral view (Fig. 1A, B, C). Body length approximately 34% (32.6–36%) of total length; body width about 55.3% (55.1–55.4%) of body length. Nostrils rounded, closer to eyes than to snout, located and oriented anterodorsally; internostril distance about 65.4% (61–70.6%) of interorbital distance; eyes located laterally; eye-nostril distance approximately equal to eye diameter; spiracle single, sinistral, short and tightly attached to body, with its opening situated on the body middle third, slightly below the midline of body, and posterodorsally oriented; spiracle inner wall absent; anal tube dextral, short and wide, attached to ventral fin. Tail *ca.* 2.0 mm higher than body; tail muscle height about 29.3% (27.1–35.5%) of tail height; dorsal fin slightly higher than

ventral fin; dorsal and ventral fins originating at body-tail junction; tail musculature nearly reaches tail tip, which is obtusely pointed. Oral disc anteroventral, not emarginated, its width approximately 49.5% (47.4–52.2%) of body width; two rows of marginal papillae, with a medial gap on upper lip; a few scattered submarginal papillae on ventrolateral portions; labial tooth row formula 2(2)/6(1) in younger tadpoles (stages 35–36); the sixth posterior teeth row is fragile and laterally fragmented. On stages 38 to 40, we no longer considered it a teeth row, because it is completely fragmented and denticles are scarce, so labial tooth row formula becomes 2(2)/5(1); upper jaw sheath arched, nearly "U"-shaped, and lower sheath "V"-shaped (Fig. 1D). Measurements are shown in Table 1.

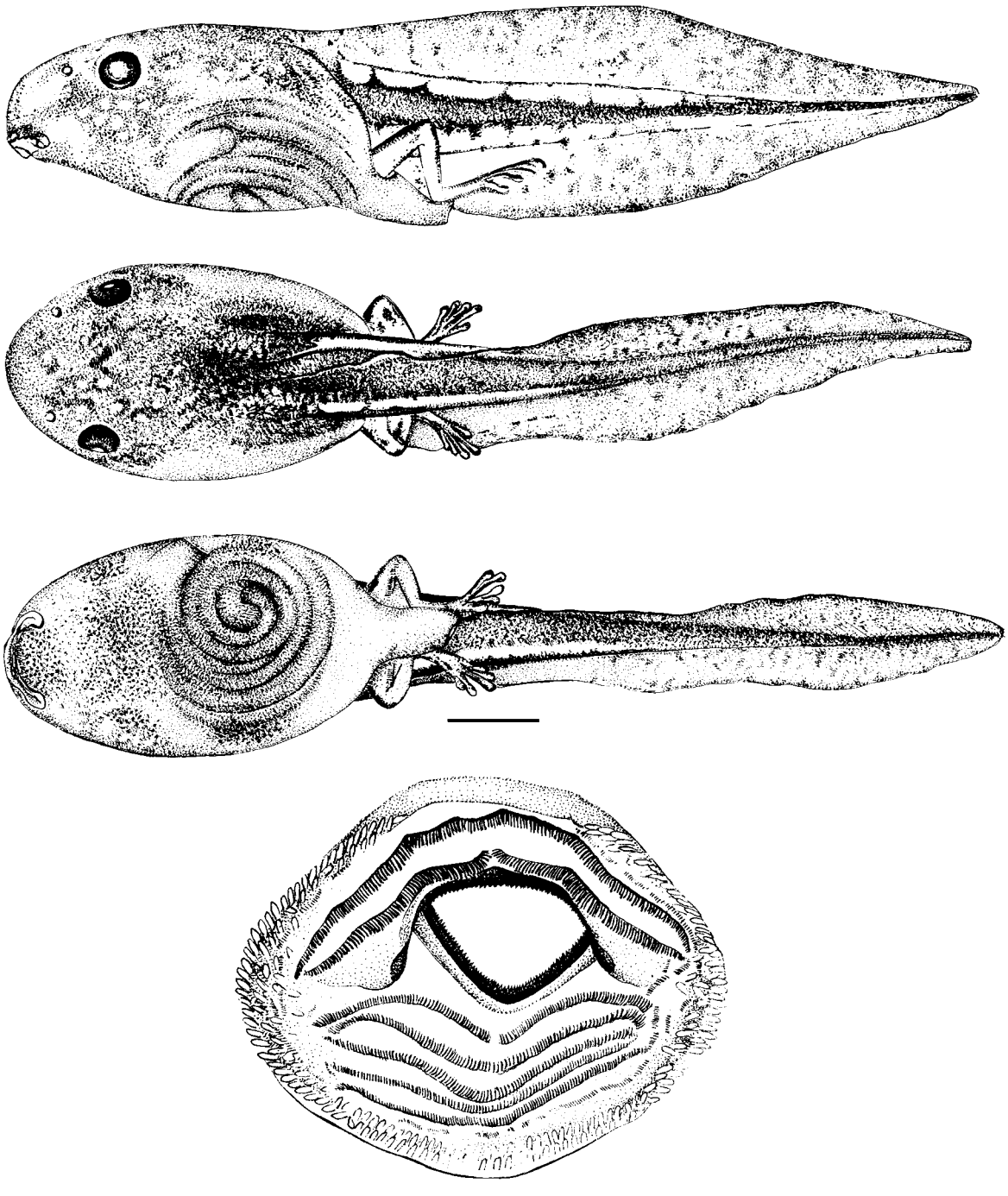

FIGURE 1. Tadpole of *Itapotihyla langsdorffii*, stage 40 of Gosner (1960): (A) lateral view; (B) dorsal view; (C) ventral view (scale = 5 mm); (D) oral disc (scale = 1 mm).

TABLE 1. Measurements (in mm) of six *Itapotihyla langsdorffii* tadpoles, stages 39–40 (Gosner 1960).

Character	Mean	sd	Range
Total length	53.1	2.72	49.4–56.3
Body length	18.2	0.68	17.3–19.1
Body height	9.7	0.69	8.7–10.8
Body width	10.7	0.29	10.2–10.9
Tail length	34.9	2.06	32.1–37.2
Tail height	11.5	0.67	10.8–12.6
Tail muscle height	3.4	0.36	3.1–4.1
Interorbital distance	8.1	0.20	7.8–8.3
Internostril distance	5.3	0.33	4.9–5.7
Eye diameter	1.9	0.11	1.8–2.1
Distance eye-nostril	1.9	0.48	1.4–2.6
Distance nostril-snout	3.8	0.58	2.9–4.3
Oral disc width	5.3	0.22	5.1–5.6

Tadpole color. General color pattern in life is greenish brown, with scattered black dots over body and tail. A roughly "U"-shaped set of cream blotches is observed under the eyes. A grayish brown stripe is observed from the anterior margin of eyes to mouth, and a cream stripe from the anterior margin of eyes to nostrils. Tail musculature is cream, with a longitudinal black stripe from the beginning to the end of tail. A narrow line of small black dots marginates tail musculature dorsally. Fins are reddish and translucent, with small, scattered black dots. Venter is cream. Iris is golden, divided horizontally by a thin black line. Legs have the same color of body, with black blotches mainly on toes.

In 5% formalin, body remains greenish brown, with scattered black dots on dorsum. Venter and fins become transparent, and legs are cream. Black and cream coloration are maintained.

Juvenile color. General color pattern is green with two large brownish transversal stripes between the eyes and on the middle of body, dorsal skin tubercles covered by black or white dots. Subcloacal folds and glandular ridges of arms and legs white. Metamorphosed specimens have a mean snout-vent length of 19.7 mm (18.2-20.4 mm; n = 4).

Discussion

Comparison with other genera. The gap on upper lip papillae rows is a common characteristic among *Aparasphenodon*, *Osteocephalus*, and *Trachycephalus*, but the number and distribution of papillae rows are widely variable. *Itapotihyla langsdorffii* presents a double series of marginal papillae rows, as in *O. taurinus* Steindachner, *O. verruciger* (Werner), *T. mesophaeus* (Hensel), and *T. resinifictrix* (Goeldi). *Osteocephalus oophagus* Jungfer and Schiesari and *T. venulosus* (Laurenti) also present two marginal papillae rows, but the inner row is discontinuous. *Trachycephalus nigromaculatus* Tschudi presents a single papillae row on upper lip, but on the lower lip rows are biserial to multiserial. In *Aparasphenodon brunoi* Miranda-Ribeiro papillae are uni- to biserial in the upper labium and bi- to triserial in the lower labium. The number of marginal papillae rows in *T. coriaceus* (Peters) varies from one to two, with up to 10 rows on lateral portions. *Osteocephalus buckleyi* (Boulenger), *O. elkejungingerae* (Henle), and *T. jordani* (Stejneger & Test) present a single, continuous papillae row. *Aparasphenodon brunoi* is the only species presenting scattered submarginal papillae on dorsolateral portions of the oral disk (present on lateral or ventrolateral portions in the other species).

The *Itapotihyla langsdorffii* tadpole is much larger than tadpoles of *Osteocephalus* and *Trachycephalus* (maximum total length 56.3 mm on stage 40 in *I. langsdorffii*; combined total length for *Osteocephalus* and *Trachycephalus* larvae 30.2–53.2 mm on stages 33–41), but is smaller than *A. brunoi* (mean total length 63.2 mm on stage 40). *Itapotihyla langsdorffii* is also distinguished from the species of *Osteocephalus* due to its laterally directed eyes, also present in *A. brunoi* and in all the known tadpoles of *Trachycephalus*. The position of nostrils, closer to the eyes, is a character shared only with *A. brunoi* and *O. oophagus*, and the "U"-shaped upper jaw sheath is a character shared only with *T. nigromaculatus*. Table 2 summarizes other comparative morphological data.

TABLE 2. Comparison among morphological characteristics of larvae of *Aparasphenodon, Itapotihyla*, *Osteocephalus*, and *Trachycephalus*. Data on number and distribution of papillae rows are compared in Discussion. Data from Trueb and Duellman (1970), Henle (1981), Hero (1990), Jungfer and Schiesari (1995), Prado *et al.* (2003), Schiesari and Moreira (1996), Schiesari *et al.* (1996), Wogel *et al.* (2000, 2006), Zimmerman and Hödl (1983), and present study. Stages follow Gosner (1960). Measurements in mm. Abbreviations: TL = total length; CL = caudal length; ED = Eyes direction; PN = Position of nostrils; TRF = tooth row formula (presence and position of gaps not indicated); UJS = Upper jaw sheath; LJS = Lower jaw sheath; SP = Spiracle; mid = midway between eyes and snout; M-SD = medial to subdextral.

Species	TL (stage)	CL / TL	ED	PN	TRF (stage)	UJS	LJS	SP	SP inner wall	Vent tube
A. brunoi	63.2 (40)	2/3	lateral	near eyes	2/6 (41)	arch-shaped	"V"-shaped	sinistral	present	medial
I. langsdorffii	56.3 (40)	2/3	lateral	near eyes	2/3 (40)	"U"-shaped	"V"-shaped	sinistral	absent	dextral
O. buckleyi	36.3 (38)	2/3	dorsolateral	mid	2/8 (38)	arch-shaped	"V"-shaped	sinistral	?	dextral
O. elkejungingerae	30.2 (33)	2/3	dorsolateral	near snout	2/6 (30)	arch-shaped	"V"-shaped	sinistral	?	?
O. oophagus	36.2 (40)	3/5	dorsolateral	near eyes	2/3 (40)	arch-shaped	"V"-shaped	sinistral	absent	M-SD
O. taurinus	38.3 (39)	3/5	dorsolateral	mid	2/5-6 (39)	arch-shaped	"V"-shaped	sinistral	?	M-SD
O. verruciger	40.8 (37)	3/4	dorsolateral	mid	2/5 (37)	arch-shaped	"V"-shaped	sinistral	?	dextral
T. coriaceus	53.2 (37)	3/4	lateral	near snout	4/5-6 (37)	arch-shaped	"U"-shaped	sinistral	absent	medial
T. jordanensis	37.9 (34)	3/4	lateral	near snout	4/6 (34)	arch-shaped	"V"-shaped	sinistral	present	medial
T. mesophaeus	41.5 (36)	2/3	lateral	near snout	4/6 (36)	arch-shaped	"V"-shaped	sinistral	present	medial
T. nigromaculatus	44.6 (38)	2/3	lateral	near snout	3/5 (38)	"U"-shaped	"V"-shaped	sinistral	present	medial
T. resinifictrix	47.0 (39)	3/5	lateral	near snout	2/4 (41)	arch-shaped	"V"-shaped	sinistral	absent	M-SD
T. venulosus	49.4 (41)	3/5	lateral	near snout	3/5 (40)	arch-shaped	"V"-shaped	sinistral	absent	M-SD

The several ontogenetic shifts on labial tooth row formula are known to occur during larval period on *A. brunoi* and most species of *Osteocephalus* and *Trachycephalus* (see Henle 1981; McDiarmid & Altig 1990; Schiesari & Moreira 1996; Schiesari *et al.* 1996; Wogel *et al.* 2006) and the heterogeneity of this formula

within these genera makes the comparison of this character difficult. The pattern for *Aparasphenodon* is 2/5–6; the pattern for *Osteocephalus* varies from 2/3 to 2/8; *Trachycephalus* present the formulae 3/5 or 4/6. In Table 2, we use tooth row formulae presented by the latest stages described for all species.

Remarks

Trueb and Duellman (1971) reviewed the genus *Osteocephalus* and recognized four species. Since then, the inclusion of new species added new characters to those used to define the genus (Jungfer & Hödl 2002). Faivovich *et al.* (2005) were not aware of any morphological synapomorphies supporting *Osteocephalus* and described *Itapotihyla* suggesting the presence of the prominent subcloacal flap as a possible morphological autapomorphy for this genus. The extensive ontogenetic shifts on oral disc structures, the large number of breeding habitats, and the great similarity on tadpole external morphology among *Aparasphenodon*, *Itapotihyla*, *Osteocephalus*, and *Trachycephalus* do not allow the use of the examined larval characters on generic diagnoses.

Jungfer and Hödl (2002) recognized some similarities on juvenile morphology of some species of *Osteocephalus*, such as red eyes and white spots on heels, knees, and arms, also mentioning that they resemble each other very closely difficulting species identification. According to these authors, these similar characters of juveniles could indicate that the species of *Osteocephalus* are really closely allied. Therefore, the red eyes in juveniles should be a putative morphological synapomorphy supporting the genus *Osteocephalus*, but this feature is also present in *A. brunoi* (BVSP, pers. obs.). On the other hand, juvenile characters seem to easily separate *Itapotihyla* and *Osteocephalus*. Juveniles of *I. langsdorffii* do not undergo great ontonegetic changes as in *Osteocephalus*, presenting adult characters as glandular ridges on arms and legs, subcloacal folds, and a similar color pattern.

According to Wassersug and Heyer (1988), anuran larval morphology has better correlation with ecology than with phylogeny. Stream-dwelling species are expected to present a higher number of labial tooth rows than pond-dwelling and phytotelmonous species (Altig & Johnston 1989). However, many authors found a large number of labial tooth rows in species of *Aparasphenodon*, *Osteocephalus*, and *Trachycephalus* with larvae associated to lentic environments (ponds, bromeliads, and tree-holes) (e.g. Schiesari *et al.* 1996; Wogel *et al.* 2000, 2006; Prado *et al.* 2003; present study). Faivovich *et al.* (2005) joined the casque-headed frogs and the phytotelmonous genus *Phyllodytes* Wagler in the monophyletic tribe Lophiohylini Miranda-Ribeiro, indicating the presence of at least four posterior labial tooth rows as a putative morphological synapomorphy for this clade.

Schiesari *et al.* (1996) suggested the hypothesis of "persistent influence of ancestral patterns" to explain the high number of tooth rows on pond-dwelling or phytotelmonous tadpoles of *Osteocephalus* and *Trachycephalus*. Although the ancestral pattern of the oral disk presented by the Lophiohylini reflects a typical stream-dwelling tadpole, this was not the ancestral larval habitat of this tribe. According to the phylogeny of Lophiohylini (Faivovich *et al.* 2005) the basal group of the tribe is *Phyllodytes*, a exclusively phytotelmonous genus (Caramaschi & Peixoto 2004); the pond-dwelling *Itapotihyla* is the sister group of the remaining genera; and the monophyletic clade composed of *Trachycephalus*, *Corythomantis* Boulenger, *Argenteohyla* Trueb, *Aparasphenodon*, and *Nyctimantis* Boulenger breeds in both phytotelms and ponds (Duellman & Trueb 1976; Schiesari *et al.* 1996; Jared *et al.* 1999; Céspedez 2000; Wogel *et al.* 2006). The larval lotic habitat appear only in one species of *Osteopilus* Fitzinger and a few species of *Osteocephalus* (Noble 1925; Schiesari *et al.* 1996), genera which forms with *Tepuihyla* Ayarzagüena, Señaris & Gorzula the monophyletic sister-group of the previous clade. Hence, we can infer that the ancestral larval habitat of the tribe Lophiohylini was lentic and conclude that the high number of tooth rows in this clade is not related to larval habitat.

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References

Ab'Saber, A.N. (1977) Os domínios morfoclimáticos na América do Sul: primeira aproximação. *Geomorfologia*, 52, 1–23.

Altig, R. & McDiarmid, R.W. (1999) Body plan: development and morphology. *In:* McDiarmid, R.W. & Altig, R. (Eds.), *Tadpoles: the Biology of Anuran Larvae*, The University of Chicago Press, Chicago, pp. 24–51.

Altig, R. & Johnston, G.F. (1989) Guilds of anuran larvae: relationships among developmental modes, morphologies, and habitats. *Herpetological Monographs*, 3, 81–109.

Bokermann, W.C.A. (1966) *Lista Anotada das Localidades Tipo de Anfíbios Brasileiros*, Serviço de Documentação da Reitoria da Universidade de São Paulo, São Paulo, 183 pp.

Caramaschi, U. & Peixoto, O.L. (2004) A new species of *Phyllodytes* (Anura: Hylidae) from the State of Sergipe, Northeastern Brazil. *Amphibia-Reptilia*, 25, 1–7.

Céspedez, J.A. (2000) Historia natural de la rana de Pedersen *Argenteohyla siemersi pederseni* (Anura: Hylidae), y descripción de su larva. *Boletin de la Asociación Herpetologica Española*, 11, 75–80.

Cope, E.D. (1867) On the structure and distribution of the genera of the arciferous Anura. *Journal of the Academy of Natural Sciences of Philadelphia*, 6, 67–112.

Duellman, W.E. (1974) A reassessment of the taxonomic status of some neotropical hylid frogs. *Occasional Papers of the Museum of Natural History of Kansas University*, 27, 1–27.

Duellman, W.E. & Trueb, L. (1976) The systematic status and relationships of the hylid frog *Nyctimantis rugiceps* Boulenger. *Occasional Papers of the Museum of Natural History of Kansas University*, 58, 1–14.

Duméril, A.M.C. & Bibron, G. (1841) *Erpétologie générale ou histoire naturelle complète des reptiles. Tome 8. Comprenant l'Histoire Générale des Batraciens, et la description des cinquante-duex generes et des cent soixante-trois espéces des duex premiers sous-ordres: Les péromèles qui n'ont pas de members, et les anoures qui sont privés de la queue*, Librairie Encyclopédique de Roret, Paris, 792 pp.

Faivovich, J., Haddad, C.F.B., Garcia, P.C.A., Frost, D.R., Campbell J.A. & Wheeler, W.C. (2005) Systematic review of the frog Family Hylidae, with special reference to Hylinae: phylogenetic analysis and taxonomic revision. *Bulletin of the American Museum of Natural History*, 294, 1–240.

Frost, D.R. 2006. *Amphibian Species of the World: an Online Reference*, American Museum of Natural History, New York. Available from http://research.amnh.org/herpetology/amphibia/index.html (accessed 20 May 2005).

Frost, D.R., Grant, T., Faivovich, J., Bain, R.H., Haas, A., Haddad, C.F.B., De Sá, R.O., Channing, A., Wilkinson, M., Donnellan, S.C., Raxworthy, C.J., Campbell, J.A., Blotto, B.L., Moler, P., Drewes, R.C., Nussbaum, R.A., Lynch, J.D., Green, D.M. & Wheeler, W.C. (2006) The amphibian tree of life. *Bulletin of the American Museum of Natural History*, 297, 1–371.

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 Hylide 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*, XI, 201–262.

Jared, C., Antoniazzi, M. M., Katchburian, E., Toledo, R. C. & Freymüller, E. (1999) Some aspects of the natural history of the casque-headed tree frog *Corythomantis greeningi* Boulenger (Hylidae). *Annales des Sciences Naturelles - Zoologie et Biologie Animale*, 20, 105–115.

Jungfer, K.H. & Hödl, W. (2002) A new species of *Osteocephalus* from Ecuador and a redescription of *O. leprieurii* (Duméril & Bibrón, 1841) (Anura, Hylidae). *Amphibia-Reptilia*, 23, 21–46.
Jungfer, K.H. & Schiesari, L.C. (1995) Description of a central Amazonian and Guianan tree frog, genus *Osteocephalus* (Anura, Hylidae), with oophagous tadpoles. *Alytes*, 13, 1–13.
Lutz, B. (1973) *Brazilian Species of Hyla*. University of Texas Press, Austin, XIX+265 pp.
McDiarmid, R.W. & Altig, R. (1990) Description of a bufonid and two hylid tadpoles from western Ecuador. *Alytes*, 8, 51–60.
Noble, G.K. (1925) An outline of the relation of ontogeny to phylogeny within the Amphibia. I. *American Museum Novitates*, 165, 1–17.
Prado, G.M., Borgo, J.H., Abrunhosa, P.A. & Wogel, H. (2003) Comportamento reprodutivo e redescrição do girino de *Phrynohyas mesophaea* (Hensel, 1867) do sudeste do Brasil (Anura, Hylidae). *Boletim do Museu Nacional, Nova Série, Zoologia*, 510, 1–11.
Schiesari, L.C., Grillitsch, B. & Vogl, C. (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.
Schiesari, L.C. & Moreira, G. (1996) The tadpole of *Phrynohyas coriacea* (Hylidae) with comments on the species' reproduction. *Journal of Herpetology*, 30, 404–407.
Trueb, L. & Duellman, W.E. (1970) The systematic status and life history of *Hyla verrucigera* Werner. *Copeia*, 1970, 601–610.
Trueb, L. & Duellman, W.E. (1971) A synopsis of the neotropical hylid frogs, genus *Osteocephalus*. *Occasional Papers of the Museum of Natural History of the University of Kansas*, 1, 1–47.
Wassersug, R.J. & Heyer, W.R. (1988) A survey of internal oral features of leptodactylidae larvae (Amphibia: Anura). *Smithsonian Contributions to Zoology*, 457, 1–99.
Wogel, H., Abrunhosa, P.A. & Pombal Jr, J.P. (2000) Girinos de cinco espécies de anuros do sudeste do Brasil (Amphibia: Hylidae, Leptodactylidae, Microhylidae). *Boletim do Museu Nacional, Nova Série, Zoologia*, 427, 1–16.
Wogel, H., Weber, L.N. & Abrunhosa, P.A. (2006) The tadpole of the casque-headed frog *Aparasphenodon brunoi* Miranda-Ribeiro (Anura: Hylidae). *South American Journal of Herpetology*, 1, 54–60.
Zimmerman, B. & Hödl, W. (1983) Distinction of *Phrynohyas resinifictrix* (Goeldi, 1907) from *Phrynohyas venulosa* (Laurenti, 1768) based on acoustical and behavioral parameters (Amphibia, Anura, Hylidae). *Zoologischer Anzeiger*, 211, 341–352.