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ORIGINAL ARTICLE

The stream-dwelling tadpole of *Hyloscirtus charazani* (Anura: Hylidae) from Andean Bolivia

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Abstract
We describe the lotic larva of *Hyloscirtus charazani* from Charazani and nearby areas, Departamento La Paz, Bolivia (2700 – 3200 m a.s.l.). It is morphologically undistinguishable from tadpoles of *H. armatus* sensu lato. These tadpoles show stream adaptation through a robust body with strong tail musculature, enlarged oral disc, increased number of labial tooth rows, and complete marginal papillae. Furthermore, they have a large saccular structure that underlies the limb buds, encloses the vent tube, and partially covers the hindlimbs during their development.

Resumen
Describimos la larva lótica de *Hyloscirtus charazani* de Charazani y de otra localidad cercana, Departamento La Paz, Bolivia (2700 – 3200 m sobre el nivel del mar). Morfologicamente es identica con renacuajos de *H. armatus* sensu lato. Estos renacuajos muestran caracteres comunmente entendidos como adaptaciones a la vida en arroyos rapidos, como ser el cuerpo robusto, musculatura de la cola robusta, disco oral ensanchado, un aumento en las filas de dientes labiales y papila marginal completa. Ademas, tienen una estructura sacular grande, bajo los primordios de los miembros posteriores, que contiene al tubo cloacal, y que envuelve parcialmente a los miembros durante su desarrollo.

Keywords: Amphibia, Hylinae, lotic larva, Bolivia

Introduction

Compared with other areas of the Neotropics, the Andes are relatively poor in terms of specific diversity of Hylinae tree frogs (Duellman, 1999). One of the most conspicuous elements of Andean hylines is the genus *Hyloscirtus*. The monophyly of three species groups of Andean stream-breeding frogs formerly included in *Hyla* was suggested by Duellman et al. (1997), and it was recently corroborated by Faivovich et al. (2005), who resurrected the generic name *Hyloscirtus* Peters, 1873 for them. *Hyloscirtus* is composed of the *H. armatus*, *H. bogotensis*, and *H. larinopygion* groups. The *H. armatus* group was defined by Duellman et al. (1997). Frogs in this group are large (adult snout-vent-length $\geqslant$ 55 mm) with greatly hypertrophied arms in adult males. They are known from riparian habitats along the eastern slopes of the Andean system (1400 – 3200 m a.s.l.) from central Peru southeastward into central Bolivia (Duellman et al., 1997; De la Riva et al., 2000). Although originally considered a monotypic group, De la Riva et al. (2000) reported that *H. charazani* (Vellard, 1970) also belongs to this group. Besides, it is evident that *H. armatus* is a composite of cryptic species (cf. De la Riva et al., 2000; Köhler, 2000). *Hyloscirtus charazani* is only known from its type locality, Charazani (3200 m a.s.l.), Departamento La Paz, Bolivia (Vellard, 1970; De la Riva et al., 2000).

Tadpoles associated with *H. armatus* sensu lato are known from sites in Peru (Amaybamba and

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Paucartambo, Departamento Cuzco; Cadle & Altig, 1991; Haas & Richards, 1998) and Bolivia (40 km N Caranavi, Departamento La Paz, and Karahuasi, Departamento Cochabamba; Duellman et al., 1997). These larvae are moderately large (total length ca. 73–81 mm between Stages 25 and 37 *fide* Gosner, 1960), with enlarged oral disc, numerous labial tooth rows, and complete marginal papillae. These features are usually considered as adaptations to torrential stream habitats, where they develop (Cadle & Altig, 1991; Duellman et al., 1997).

Two of us (SR and RHB) independently found larvae and adults of *H. charazani* at the type locality, and at a locality ca. 18 km NE from it. Along with adults, a total of eight lotic larvae were collected matching the tadpole morphology of the *H. armatus* group. There is little doubt about the identity as *H. charazani* since no other species of the *H. armatus* group is known to occur syntopically. It is our purpose to describe these tadpoles, as well to provide comments on their habitat and color notes of one juvenile.

Material and methods

Two larvae have been deposited at Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn (ZFMK 83308–309). They were collected by James Aparicio and Steffen Reichle in January 1997 in a small stream at the type locality, Charazani, Departamento La Paz, Bolivia (15°11.5' S, 69°2.6' W, approximately 3200 m a.s.l.). ZFMK specimens were deposited in 70% ethanol. Six tadpoles have been deposited in the American Museum of Natural History, New York (AMNH 165098, 168924–928). They were collected by Arturo Muñoz and Raoul H. Bain on 7 November 2000 on a tributary to the Río Quelhuacota, near Wakella Village, Canton Miguel de Chulina, at the base of the north face of Serranía Uyacaya, Area de Manejo Integrado y Parque Nacional Apolobamba, Bautista Savedra Province, Departmento La Paz, Bolivia. AMNH specimens were deposited in a buffered 13:1 solution of formalin. In addition, a newly metamorphed juvenile specimen of *H. charazani* (AMNH FS-15690) was collected from a rock in the middle of the same stream as the AMNH tadpoles. This juvenile is currently kept in 70% ethanol at Colección Boliviana de Fauna, La Paz (CBF unnumbered).

The Gosner (1960) system was used for larval staging. The morphological description in general follows Cadle and Altig (1991), with body terminus defined as the junction of the posterior margin of the body with the flexion of the tail myotomes. Measurements are in mm; they were taken to the nearest 0.1 with calipers—those of nares, eyes and spiracle were taken to their centers.

Results

Hyloscirtus charazani (Vellard, 1970)

Description of larvae

Tadpoles belong to the Type-IV of Orton (1953); two specimens in stage 26 have the following measurements: total length 68.9, 70.9; body length 26.3, 28.0; tail muscle height at base 8.5, 9.2; tail muscle width at base 8.0, 7.8; maximum dorsal and ventral fin heights 5.7, 5.4 and 3.8, 3.6; maximum dorsal and ventral fin heights located 23.6, 25.4 and 22,5, 21.3 from body terminus; body width 15.4, 14.3; body depth 11,4, 11.7; eye diameter 2.2, 2.0; pupil diameter 0.7, 0.9; interorbital distance 6.4, 6.3; greatest and least nostril diameters 1.1×0.5, 1.0×0.3; internarial distance 5.5, 5.5; snout–nostril 9.0, 9.3; snout–eye 12.0, 11.7; snout–spiracle 18.4, 20.0; eye–nostril 2.7, 2.6; transverse oral disc diameter 12.1, 12.3. Other major characteristics: oral disc ventral with complete marginal papillae; spiracle sinistral; eyes dorsal; vent dextral; dorsal fin terminating at dorsal extent of tail–body junction. Lightly colored neuromasts obvious against darker ground color. Labial tooth row formulas: 14(14)/15(1) and 14(14)/17(1).

Outer wall of spiracle longer than inner; distal part of inner wall not fused with body wall; aperture small, round, facing posteriorly. Small aperture of vent tube opening from large saccular structure that underlies limb buds. Oval nares slightly medial to center of eyes, recessed, weakly rimmed, and with a slight ovoid projection in the inner margin. Snout broadly rounded viewed from above, gradually sloping in profile.

Oral disc distinctly set off from the adjacent snout, slightly emarginate ventrolaterally. About 100 teeth/mm at center of first anterior labial tooth row, and circa 30 short conical marginal papillae/mm mid-ventrally. Teeth in distal three rows of anterior labium smaller and more closely spaced than in other rows. Jaw sheath serrations (about 70/mm) short, blunt and closely spaced. Upper jaw narrow with prominent wide shelf extending almost the length of the sheath. Shorter lower sheath narrow, broadly V-shaped and with a similar, less prominent shelf. Submarginal papillae not traceable. Scattered melanophores in anterior and lateral outer wall of oral disc.

Depressed body darkly brownish pigmented by filiform melanophores, which are less close distal to nostril area. Tail muscle with similar pigment pattern underlain by spare layer of punctuate melanophores; reticulated dorsal and ventral fins evenly scattered with pigment. Tail ending in broad point.

Other specimens at stages 25 (Figure 1A and B), 34, 35–36, and 38, in general match this description.

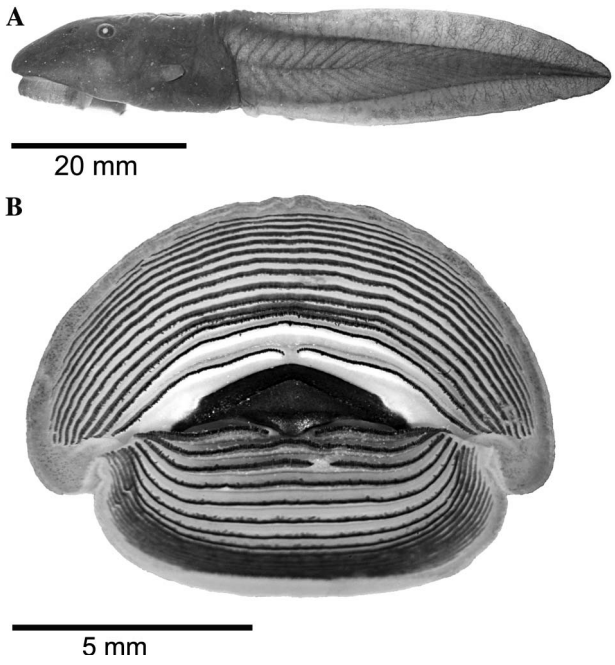

Figure 1. Stage 25 tadpole of *Hyloscirtus charazani*: lateral aspect (AMNH 168927) and oral disc in ventral view (the outermost labial tooth rows cannot be seen) (AMNH 168928).

The maximum total length (81.8) is recorded in a specimen in stage 35–36. Labial tooth row formulas vary as follows: 14 (14)-17(17)/17(1)-19(1). Few sparse submarginal papillae are present in the posterior fold of the oral disc and in the posterior margin, barely separated from the marginal papillae. In stages 35–36 and 38, the nasolacrimal duct becomes evident by transparency. There are noticeable ontogenetic differences in the relative size of the saccular structure that underlies the limb buds, and where the vent opens. This structure is already evident in stage 25, and during the ontogeny it expands posteriorly, covering almost totally (ventrally and laterally) the developing limbs. In stage 38, the saccular structure is still evident, covering the femora (see Figure 2A–C).

The single juvenile specimen collected (Figure 3) has a very different coloration from adults of this species (see color photograph in De la Riva et al., 2000): median dorsum dark green, outlined laterally with black stripe; a light brown streak from snout, continuing along the top of the canthus rostralis, behind the eye, and along the flank, diffusing to green towards the venter; hind-limbs green with light brown blotchy bars; hands and feet orange. Lower jaw golden; throat, chest, belly white; limbs green, with green long bones and green musculature; white parietal peritoneum evident by transparency. Measurements: snout–vent length 37.1; head length 16.6; head width 11.6; snout length 4.8; eye diameter 4.1; interorbital distance 4.80; width of finger III disc 1.9; foot length 28.2.

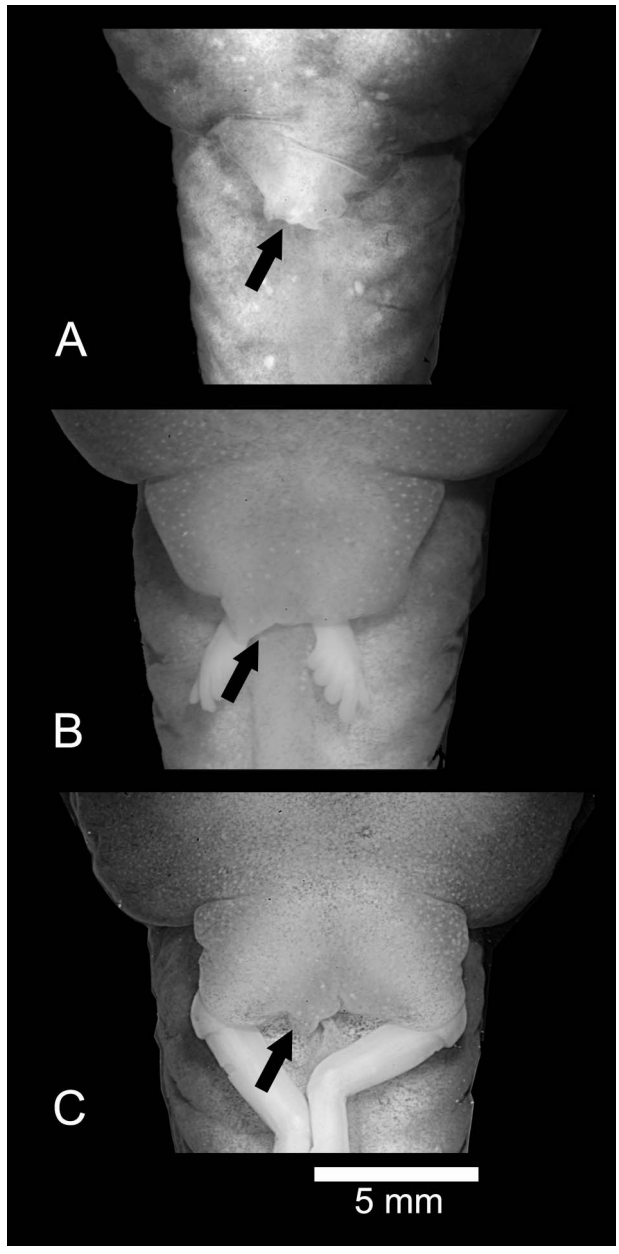

Figure 2. Ventral views of larvae of *Hyloscirtus charazani* showing the ontogenetic change in the size of the saccular structure that encloses the vent tube, and after stage 25 underlies the limb buds. The arrow points at the vent aperture. (A) Stage 25 (AMNH 168927); (B) stage 35–36 (AMNH 168925); (C) stage 38 (AMNH 168926).

Habitat

In Charazani, the free swimming larvae were collected in the periphery of an approximately 6 m wide stream by hand during the day. Additional tadpoles were not observed.

In Wakella, *H. charazani* tadpoles were found at night between 20.00 and 21.45, clinging to mossy rocks with their mouths. They were collected sympatrically with tadpoles of *Telmatobius* sp. The stream was slow, shallow (15 cm at its deepest, 3 m wide), and

Figure 3. Juvenile of *Hyloscirtus charazani* (AMNH-Field series 15690; now CBF unnumbered). Snout–vent length 37.1 mm.

ran with a red tinge from scrubby secondary growth. The tadpoles were collected in an area of the stream that stretched across the rocky floodplain of the Río Quelhuacota. Adult specimens of *H. charazani* were found in slow, muddy streams within areas of active agriculture, and alongside fast cold tributaries to the Río Quelhuacota. The latter was approximately 15–18 m wide and fast flowing. Its high water mark extends on either side to another 20 m. The valley around the Río Quelhuacota has been altered significantly for agriculture. The North face of Serranía Uyacaya is completely denuded of original vegetation, save for some steep tributaries. Scrubby secondary vegetation is heavily grazed by livestock, and ancient terraced fields are present in the whole valley.

Discussion

As with *Hyloscirtus armatus* sensu lato, tadpoles described here show modifications of the body plan commonly believed to reflect adaptation to fast lotic lifestyle, i.e., robust body with strong tail musculature, enlarged oral disc, increased number of labial tooth rows, and complete marginal papillae (cf. Cadle & Altig, 1991; Duellman et al., 1997). Tadpoles here assigned to *H. charazani* are morphologically identical to those described of *H. armatus* sensu lato from Peru and Bolivia, and corroborate the larval synapomorphies of the *H. armatus* group suggested by Duellman et al. (1997) (long, muscular tail with low fins and bluntly rounded tip; upper jaw sheath with prominent wide shelf extending almost the length of the sheath).

The conspicuous saccular structure that overlies the limb buds from where the vent tubes open deserves a few comments. The first is its relationship with the vent tube. Our preliminary gross dissections suggest that the wall of the saccular structure that is proximal to the tail includes the vent tube; but further detailed histological work is necessary to better understand their relationships. A similar saccular structure has been reported for the stream dwelling larvae of other anurans such as *Ascaphus* (Gaige, 1920; Van Dijk, 1959), *Heleophryne* (Altig & McDiarmid, 1999), *Telmatobufo* (Formas, 1988), the *Hyloscirtus bogotensis* group (Altig & McDiarmid, 1999), and *Petropedetes natator* (Lamotte & Zuber-Vogeli, 1954). Preliminary observations in larval *Ascaphus* (AMNH 37238) indicate that the saccular structure is flatter than in comparable stages of *H. charazani*, where it is quite voluminous. Furthermore, it does not seem to cover the developing limb laterally, as in *H. charazani*, but only ventrally. A possibly similar structure is the ''hind limb sac'' reported in larvae of *Mixophyes* (Watson & Martin, 1973; Anstis, 2002), and discussed by Gradwell (1975). There is a hind limb sac on each side, containing the developing legs that by stage 37 protrude through openings (Gradwell, 1975). This situation is different from the saccular structure that is independent of the developing limb. Considering that larvae which cling to rocks in torrential streams need to apply their flattened undersides closely to the substratum, Gradwell (1975) advanced the hypothesis that the hind limb sacs could protect the developing legs from possible abrasion by the substratum. While additional research on the comparative morphology of the saccular structure in the *Hyloscirtus armatus* and *H. bogotensis* group is evidently necessary, it is worth mentioning that this structure has not been reported in descriptions of larvae of the *H. larinopygion* group (e.g., Duellman & Hillis, 1990; Duellman & Coloma, 1993).

The presence of green bones in the juvenile possibly corresponds to the impregnation of bones and soft tissue with biliverdin, as described by Barrio (1965) for several hylid frogs. Green bones are also reported for some members of the *H. bogotensis* group (Ruiz-Carranza & Lynch, 1982). Similarly, a white parietal peritoneum occurs in members of this group (Ruiz-Carranza & Lynch, 1991), as we report here in the juvenile of *H. charazani*.

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