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Tadpole of *Atelopus mindoensis* Peters (Anura, Bufonidae) from Northwestern Ecuador

STEFAN LÖTTERS

The tadpole of *Atelopus mindoensis* is described. In general morphology, it is similar to the other larvae known for the genus. Based on its color pattern, it is placed in the group of tadpoles with multiple symmetrical or asymmetrical light marks in life.

Se describe el renacuajo de *Atelopus mindoensis*. En su morfología general es similar a las otras larvas del género conocidas. Basada en su patrón de coloración, se pone en el grupo de los renacuajos con múltiples manchas corporales con una organización simétrica o asimétrica.

ATELOPUS is a group of relatively small, dull- to brilliant-colored toad species from the Neotropics. Monophyly of the approximately 65 taxa recognized has repeatedly been suggested (e.g., Graybeal and Cannatella, 1995; but see Coloma, 1997). Lötters (1996) summarized the knowledge on the genus and noted that tadpoles of 10 species are known. Additional larva descriptions have been published (Lavilla et al., 1997; Mijares-Urrutia, 1997; Lindquist and Hetherington, 1998) or have been included in more comprehensive revisions (Coloma, 1997; Coloma et al., 2000), because his assessment, bringing the number of known tadpoles of *Atelopus* to 15. Moreover, Ruiz-Carranza and Osorno-Muñoz (1994), Ruiz-Carranza et al. (1994), and Vélez-Rodríguez and Ruiz-Carranza (1997) provided information on larval color patterns in life of 16 *Atelopus* species. Larvae of this genus possess a large belly sucker, which is an adaptation to lotic habitats. Together with tadpoles of a few other anurans, they belong to the gastromyzophorous ecomorphological guild of anuran larvae, as defined by Altig and Johnston (1989). Differences among *Atelopus* tadpoles are evident mainly in tail length and height, suctorial disc size, and coloration (e.g., Duellman and Lynch, 1969; Coloma and Lötters, 1996). The phylogenetic significance of larval features in *Atelopus* has not yet been analyzed.

Atelopus mindoensis Peters, 1973 is a species from the humid montane forest of northwestern Ecuador (Lötters, 1996). Its tadpole has not been described. On 8 July 1977, *A. mindoensis* was common at Quebrada Zapadores (approximately 1920 m elevation), Pichincha Province, Ecuador. Together with amplexant pairs, typical *Atelopus* larvae were found. Because no other species of the genus is known from this locality, and syntopic occurrence of different species of *Atelopus* is rare (Lötters, 1996:99), the tadpoles

found can be assigned to *A. mindoensis*. The purpose of this paper is to describe these larvae.

MATERIAL AND METHODS

The description is based on a series of 33 larvae between developmental stages 25 and 36 (using the system for staging anuran larvae of Gosner, 1960). Tadpoles are deposited at the Museum of Natural History at the University of Kansas (KU 180277). They were collected by J. D. Lynch (field number JDL 9269). Lynch's field notes are available at the University of Kansas and were used for comments on life coloration. Terminology of larval features follow Altig and Johnston (1989); description format follows Coloma and Lötters (1996). Measurements were taken to the nearest 0.1 mm with dial calipers.

RESULTS

Measurements of the entire series of tadpoles in 11 different developmental stages are given in Table 1. The following description is based on an individual at stage 36 (Fig. 1). Type IV tadpole of Orton (1953), belonging to the gastromyzophorous ecomorphological guild (defined by Altig and Johnston (1989). Total length 13.0 mm, body length 5.1 mm, body width 4.2 mm. Body ovoid, flattened (about two-thirds as high as wide). Snout broadly rounded in dorsal view and profile; body slightly constricted at posterior level of eyes and anterior to spiracle; nostrils small, at about one-third the distance from eye to tip of snout; eyes dorsal directed dorsolaterally, diameter 0.8 mm, interocular distance 1.1 mm (taken from the medial edges of the corneas). Spiracle sinistral, two-thirds free, directed posterodorsally, originating at midpoint of body; diameter of opening less than

TABLE 1. MEAN MEASUREMENTS (AND RANGE) OF 11 DEVELOPMENT STAGES FIDE GOSNER (1960) OF 33 TADPOLES OF *Atelopus mindoensis* (KU 180277).

Stage	n	Body length (mm)	Total length (mm)
25	2	3.3 (3.2–3.4)	7.5 (7.3–7.6)
26	4	4.1 (3.6–4.6)	9.3 (8.6–10.2)
28	3	4.2 (3.9–4.3)	10.4 (9.8–11.1)
29	3	4.8 (4.3–5.2)	10.9 (10.4–11.4)
30	3	4.7 (4.0–5.5)	11.4 (10.6–12.1)
31	2	4.9 (4.7–5.0)	11.2 (11.1–11.2)
32	2	5.8 (5.6–6.0)	12.5 (12.4–12.6)
33	1	4.9	11.6
34	2	5.3 (5.0–5.5)	11.9 (11.8–11.9)
35	4	5.8 (5.1–6.8)	12.7 (12.4–13.0)
36	7	6.2 (5.0–7.6)	13.4 (12.6–14.3)

half the length of free tube; vent tube short, medial. Caudal musculature robust anteriorly, narrowing abruptly posterior to midlength of tail, terminating just anterior to end of rounded tail; dorsal fin highest at about two-thirds of tail; tail length 60% of total length; dorsal and ventral fin height approximately 0.6 mm at midlength of tail; dorsal fin beginning posterior to body, ventral fin beginning posterior to vent tube. Mouth ventral, surrounded by labia forming complete oral disc 3.0 mm wide; complete row of marginal, blunt papillae anteriorly, no papillae posteriorly; submarginal papillae absent. Labial tooth row formula 2/3, rows complete, about equal in length; jaw sheath about equal in length, serrate; upper beak narrow, but slightly wider medially, lower beak V-shaped. Large belly sucker extending from posterior labium posteriorly for about half the body length, forming a complete, round sucker without papillae.

In preservative, dorsum and sides of body uniform brownish orange with minute brown spots, anteriorly becoming lighter, edges of body translucent with numerous scattered brown spots; eyes black; posterior side of body dark brown; hind limbs proximally brownish orange, distally tan; spiracle unpigmented; one-third of caudal musculature dorsally dark brown and dorsolaterally brownish orange, remaining two-thirds of caudal musculature tan (fleshy) with brown flecks on dorsal and ventral edges; both fins transparent with minute brown spots, at posterior portion of tail spots may be replaced by brown reticulation; oral disc and belly sucker translucent; venter tan to translucent (gut well visible). According to the collector's field notes, in life, minor stages of tadpoles were black and white, whereas, major stages were dull orange and dirty green with cream bands.

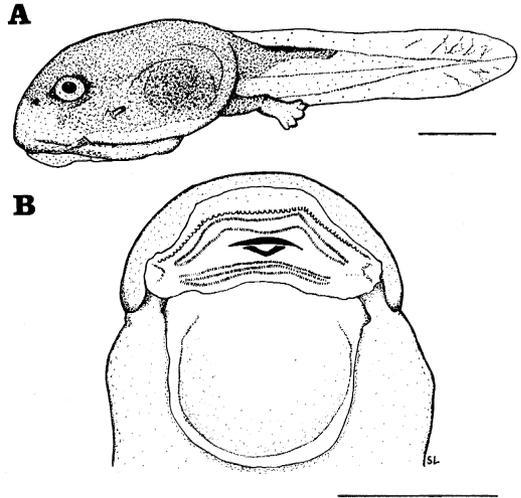


Fig. 1. Tadpole of *Atelopus mindoensis* (from KU 180277) in developmental stage 36 fide Gosner (1960) in lateral (A) and ventral (B) views. Scales = 2 mm.

DISCUSSION

Duellman and Lynch (1969), and subsequent authors (e.g., Coloma and Löters, 1996), found that tadpoles of the Andean species of *Atelopus* have proportionally larger oral suckers and longer, shallower tails than those of lowland species. A large oral sucker with a long, shallow tail can be interpreted to be advantageous in fast running water. Because the latter is usually found at higher altitudes, the above-mentioned differences between Andean and lowland larvae probably reflect morphological adaptations to different habitats. When trying to approach phylogenetic relationships among *Atelopus* spp. based on tadpole characters, I suggest not simply grouping them according to oral disc size and tail shape.

Coloma and Löters (1996) suggested that larval coloration may be useful for distinguishing *Atelopus* species and assessing phylogenetic relationships. Recently, Vélez-Rodríguez and Ruiz-Carranza (1997) discussed the phylogenetic significance of basic larval color patterns among Colombian species of *Atelopus*. They recognized a pattern of multiple symmetrical or asymmetrical light marks (in life) in several taxa and hypothesized that it represents a synapomorphy (vs an inconspicuous uniform brownish coloration in other tadpoles of the genus). Because data on larval coloration are available for 32 species of *Atelopus* only (i.e., approximately 50% of the described taxa), currently the hypothesis by Vélez-Rodríguez and Ruiz-Carranza (1997) cannot be tested adequately. However,

tentatively adopting their hypothesis, *A. mindoensis* is assigned to the tadpoles characterized by multiple symmetrical or asymmetrical light marks in life. These are (sources in parentheses) *A. spumarius* (Duellman and Lynch, 1969), *Atelopus* sp. (Gascon, 1989, as *A. pulcher*), *A. balios* (Coloma and Lötters, 1996), *A. varius* (Lötters, 1996: color plates 44–53, 56), *A. tricolor* (Lavilla et al., 1997), *A. elegans*, *A. eusebianus*, *A. famelicus*, *A. farci*, *A. pictiventris*, *A. simulatus*, *A. sonsonensis*, *A. subornatus* (Vélez-Rodríguez and Ruiz-Carranza, 1997), *A. bomolochos* (Coloma, 1997), and *A. exiguus* (Coloma et al., 2000). Detailed morphological data are available only for some of these tadpoles. *Atelopus mindoensis* can be distinguished as follows (data taken from references cited above): larvae of *A. bomolochos*, *A. exiguus*, and *A. subornatus* have longer, shallower tails; those of *A. balios* and *A. tricolor* exhibit submarginal papillae (absent in *A. mindoensis*), and tadpoles of *Atelopus* sp. have an unusually short upper beak and a long lower lip (not noticeable in *A. mindoensis*).

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