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Description of the Tadpole of *Atelopus tricolor*

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Tadpoles of *Atelopus* belong to the gastromyzophorous guild of exotrophic larvae (Altig and Johnston, 1989), and are characterized by the presence of a conspicuous abdominal sucker and an expanded oral disc. The larvae of several *Atelopus* species have been described previously: *A. varius* (Starrett, 1967); *A. certus*, *A. ignescens*, and *A. spumarius* (Duellman and Lynch, 1969); *A. cruciger* (Mebs, 1980); *A. flavescens* (Lescure, 1981); *A. peruensis* (Gray and Cannatella, 1985); and *A. subornatus* (Lynch, 1986). These represent about 15% of the known species in the genus (Frost, 1985; Duellman, 1993). Although *Atelopus tricolor* was originally described at the beginning of the century (Boulenger, 1902), it is a poorly known species. It has been reported from only a few localities from southern Peru (type locality: Marcapata Valley, Departamento Cuzco), to Departamento Cochabamba, Bolivia (Fugler, 1984; De la Riva, 1990; Reynolds and Foster, 1992), at elevations of 600–2100 m (Duellman, 1979). Herein we characterize and illustrate the tadpole of *Atelopus tricolor*.

Materials and Methods.—Four series of tadpoles were examined: USNM 346225 (seven specimens) and USNM 346226 (36 specimens), collected at Paucartambo, 68 km (by road) NE of Puente Union on Río Tachila (=Bosque de las Nubes, km 150 on Paucartambo-Atalaya Road), 1700 m, 13°04'13"S – 71°34'00"W, Departamento Cuzco, Peru, 9 September 1991 (USNM 346225) and 17 September 1991 (USNM 346226); USNM 346415 (eight specimens), Paucartambo, 60 km (by road) NE (=km 142 on Paucartambo-Atalaya Road), Departamento Cuzco, Peru 21 June 1993; KU 222406, (five specimens) 40 km N Caranavi, Serrania Bellavista, 1450 m, Provincia Noryungas, Departamento La Paz, Bolivia, 7 July 1990. Larvae were preserved in 10% formalin and are deposited in the National Museum of Natural History, Washington D.C. (USNM) and the Museum of Natural History, University of Kansas (KU). Tadpoles were staged according to Gosner, 1960, and range from stages 25–40. Measurements were taken with a Mitutoyo dial caliper, recorded to the nearest 0.01 mm, and

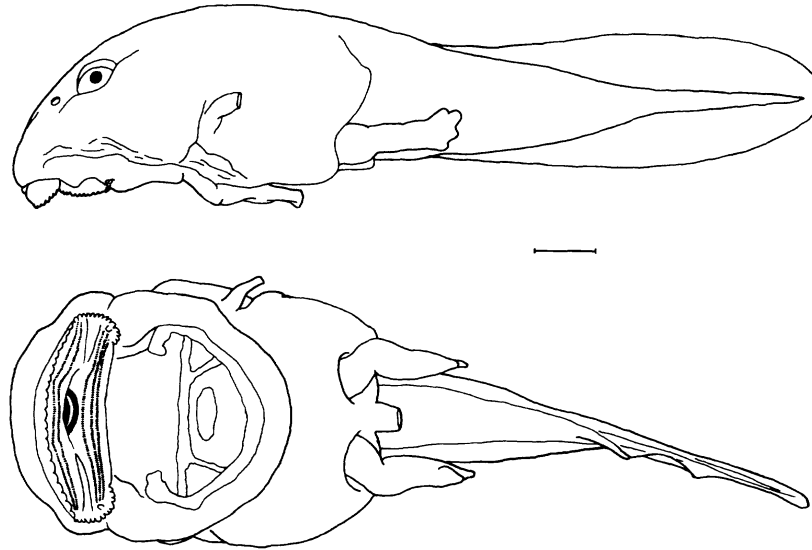


FIG. 1. Top = Lateral view and bottom = ventral view of *Atelopus tricolor* tadpole, USNM 346226, Gosner's Stage 34. Bar = 1.0 mm

with a micrometric ocular in a Wild M3C stereomicroscope. Values in the text correspond to mean values ($N = 10$). Morphometric descriptors follow those defined by Lavilla and Scrocchi (1986). These measurements are abbreviated as follow: TL (total length), BL (body length), TaL (tail length), BW (maximum body width), BWE (body width at eyes), BWN (body width at nostrils), BH (maximum body height), FH (fin height), TMH (height of tail muscle), RSD (rostrospiracular distance), FN (snout-nasal distance), NO (naso-ocular distance), N (nostril diameter), E (eye diameter), EN (extranarial distance), IN (internarial distance), EO (extraorbital distance), IO (interorbital distance), ODW (oral disc width), MG (mental gap width). Drawings were made with the aid of a camera lucida attached to the stereomicroscope.

Tadpole Description.—These tadpoles are assigned to *Atelopus tricolor* based on the collection of adults and tadpoles along the same streams; in the Bolivian locality adults were actively calling and the only other species found were *Eleutherodactylus platydactylus*, *Hyla armata*, and *H. callipleura*. Furthermore, *A. tricolor* is the only species of the genus that occurs in Bolivia (*A. willimani* is a junior synonym of *A. tricolor*, de la Riva and Lötters, pers. com.). The following description is based on ten specimens of *Atelopus tricolor* at stages equivalent to Gosner's Stages 33–34. Total length 13.7–16.3 mm; in dorsal view the body is ovoid with two pairs of lateral constrictions, one at level of eyes and one immediately anterior to spiracular tube; overall, body wider than high, height about 69% of maximum width; snout rounded in dorsal and lateral views; in lateral view (Fig 1), the body shape is disrupted ventrally by a large abdominal sucker. This abdominal sucker is circular and about as wide as the body; anteriorly the sucker is bordered by the oral disc and posteriorly it extends to the level of the distal tip of the spiracular tube; lateral and posterior edges of abdominal sucker free from body, representing about 11% of width of sucker. Tail about 56% of total length; caudal musculature well developed anteriorly; at about midlength of tail, the musculature abruptly

compressed and becoming progressively thinner caudally; both tail fins lower than tail musculature (FH/BH: 0.66), fins tapering to rounded tip; anterior one-quarter of tail free of dorsal and ventral fins. Nostrils small, oval, and dorsolateral (EN/BWN: 0.42), poorly visible in dorsal view, slightly recessed below surface of snout having fringed edge; nostrils closer to eyes than to tip of snout (FN/NO: 3.53); eyes small (E/BWE: 0.20) and dorsolateral (EO/BWE: 0.64). Spiracle single and sinistral, located on posterior third of body (RSD/BL: 0.58), and clearly visible as a tube attached only basally to body. Vent short, medial, wide and almost rectangular in ventral view wide. Oral disc well developed, ventral (not visible in dorsal view), lacking lateral fold; maximum width of oral disc about 79% of body width; single row of medium-sized marginal papillae bordering the oral disc; rostral papillae slightly larger with wider base than more conical and better defined lateral ones; row of marginal papillae lacking rostral gap, but having large mental gap representing about 66% of the oral disc width; only one submarginal papilla on either side, at the level of posterior lower tooth rows. Upper beak convex, longer than higher, poorly keratinized (as indicated by pigmentation), weakly serrated; lower beak V-shaped, poorly keratinized, weakly serrated; labial tooth row formula 2/3 with all rows about equal in length.

Coloration.—In preservative, dorsum and flanks dark brown with darker dots uniformly distributed over body surface with nonpigmented areas on flanks anterior to level of spiracle; nonpigmented areas ranging from isolated spots to almost complete postocular band. In life, these markings were recorded as yellow-gold in the collector's field notes. Ventrally body almost transparent with dark dots uniformly dispersed throughout; abdominal sucker almost transparent with a few scattered dots in some specimens; tail similar with some nonpigmented areas of variable size, shape, and position; musculature is darkly pigmented with a nonpigmented stripe along entire length of ventral edge; fins transparent with a few scattered dark dots, numerous anteriorly.

Tadpole Comparisons.—The tadpole of *Atelopus tricolor* could be confused with the gastromyzophorus larvae of *Bufo veraguensis* which also occurs in southern Peru and eastern Bolivia. However, the following characteristics of *B. veraguensis* tadpoles (Cadle and Altig, 1991) easily separate them from *A. tricolor* larvae: (1) marginal papillae with rostral gap and mental gaps, (2) several submarginal papillae on each side of oral disc, (3) dextral vent, (4) dorsal and ventral fins originating at tail-body junction, (5) lateral and posterior edges of abdominal sucker not free from body.

The following characteristics are diagnostic for the genus (present in all previously described *Atelopus* larvae and in *A. tricolor*): (1) large and laterally expanded oral disc, (2) oral disc with a single row of marginal papillae with mental, but no rostral, gap, (3) labial tooth formula 2/3, (4) presence of a large abdominal sucker, (5) low and posteriorly displaced tail fins, and (6) medial vent.

Tadpoles of only about 15% of the recognized species of *Atelopus* have been described; but these characters are diagnostic for the genus insofar as larvae are known. This is supported by the fact that taxa that once were considered *Atelopus*, but in which the larvae did not exhibit the above combination of characters, have been placed in other genera—*Frostius pernambucensis* (da Cruz and Peixoto, 1982; Cannatella, 1986) and *Dendrophryniscus minutus* (Duellman and Lynch, 1969; McDiarmid, 1971).

The morphological homogeneity exhibited by *Atelopus* larvae makes interspecific differences difficult to identify; however, several characteristics allow us to distinguish *A. tricolor* from other known *Atelopus* larvae. The single submarginal papilla on either side of the oral disc seems to be uniquely present in *A. tricolor*. Furthermore, in *A. tricolor* the maximum body height is two-thirds of the maximum width, and the internarial distance is twice the eye diameter, characteristics that differentiate *A. tricolor* from *A. ignescens* and *A. certus*, (body height three-quarters of the body width; internarial distance about three times the eye diameter). The rostral-spiracular distance/total length ratio in *A. tricolor* is three-fourths while in *A. spumarius* this ratio is three-fifths. The almost transparent lateral border of the abdominal sucker distinguishes *A. tricolor* from *A. peruensis* in which this border is pigmented. Both *A. tricolor* and *A. subornatus* exhibit large rostral marginal papillae relative to the lateral ones, but they differ in the pattern of tail coloration. *Atelopus subornatus* has a dark band across the middle of the tail; nothing comparable is present in *A. tricolor*. The margins of the oral disc in *A. flavescens* have a lateral projection (Lescure, 1981, Fig. 2); a lateral projection is absent in *A. tricolor*. The description of the tadpole of *A. cruciger* (Mebs, 1980) is too vague to allow for detailed comparisons; according to this description, *A. cruciger* tadpoles have diagnostic characters 1 and 3–6, but the condition of character 2 is doubtful. Larvae of *A. tricolor* are unique in possessing a single submarginal papilla on each side of the oral disc. In addition, morphometric and coloration characteristics distinguish *A. tricolor* tadpole from other known *Atelopus* larvae.

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