

## THE TADPOLE OF *ATELOPUS BALIOS* (ANURA: BUFONIDAE) FROM THE PACIFIC LOWLANDS OF ECUADOR

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**ABSTRACT:** The tadpole of *Atelopus balios* Peters from the Pacific lowlands in southern Ecuador is described. Its morphology is similar to other larvae of lowland species of *Atelopus*. Tadpoles of *Atelopus balios* were found in low-gradient streams.

**Key words:** Anura; Bufonidae; *Atelopus balios*; Tadpoles; Natural History; Ecuador

PETERS (1973) described *Atelopus balios* from the Río Pescado in the coastal lowlands in southwestern Ecuador. *Atelopus balios* occurs at elevations of 350–650 m between the Río Pescado and Río Patul in southwestern Ecuador (Almendáriz and Carr, 1992). Knowledge concerning this species is limited and the tadpole has not been described.

During field work in 1991–1993 in southwestern Ecuador, we found adults of *Atelopus balios* and several gastromyzophorous tadpoles. Some of the tadpoles were maintained in captivity until they metamorphosed and their identity as *A. balios* could be confirmed. The region where *A. balios* is found is one of the last refugia for the southwestern Humid Premontane Forest; however, we witnessed partial destruction of this relictual forest, emphasizing the need for enhanced protection efforts.

Duellman and Lynch (1969) suggested that larval features may be useful in defining species groups of *Atelopus*. They reported differences in tail shape and size of the oral discs between tadpoles of *A. ignescens*, which lives in the highlands, and lowland species of *Atelopus*. Furthermore, coloration seems to be useful for distinguishing species and assessing phylogenetic relationships; however, too few species have been described. The discovery of the tadpole of *A. balios* brings the total number of known tadpoles of *Atelopus* to 10.

### MATERIAL AND METHODS

This description is based on three series of tadpoles and recently metamorphosed individuals in eight stages between stages 29–46 fide Gosner (1960). These series (QCAZ 2670, 3331, 5035) are deposited in the Pontificia Universidad Católica del Ecuador, Museo de Zoología (QCAZ). Specimens were collected at the Río Patul (2 km south of Manta Real) at the border of provincias Azuay and Cañar, approximately 350 m above sea level. Tadpoles were fixed in 10% formalin. Terminology of larval features follows Altig and Johnston (1989). Measurements of tadpoles and recently metamorphosed individuals were taken to the nearest 0.1 mm with a Max-Cal caliper. Data and measurements for tadpoles of other species of *Atelopus* were taken from the literature and are cited when discussed. Water chemistry was analyzed with a Dupla Aquaristik Analytic System.

### RESULTS

#### *Description*

Measurements (mm) of developmental stages (Gosner, 1960) of a series of 38 larvae and recently metamorphosed individuals (QCAZ 2670, 3331) are given in Table 1.

The following description is based on an individual at stage 34 (QCAZ 2670) (Fig. 1). Type-IV tadpole of Orton (1953). Tadpoles belong to the gastromyzophorous ecomorphological guild defined by Altig

and Johnston (1989). Body length (tip of snout-base of vent tube) 6.1 mm, total length 12.8 mm. Body elongately ovoid, depressed, about two-thirds as high as wide; greatest width in posterior half of body. Snout bluntly rounded in dorsal view and in profile; body constricted slightly at level of eyes and just anterior to spiracle; nostrils small, about one-third distance from eyes 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, elongate, ventral to horizontal body axis, directed posterodorsally, originating at midpoint of body; diameter of opening about half length of free tube; vent tube short, medial. Caudal musculature robust anteriorly, narrowing abruptly just posterior to midlength of tail, terminating just anterior to end of tail; dorsal fin highest posterior to midlength of tail; tail length 52% of total length; dorsal and ventral fin height 1 mm at midlength of tail, dorsal fin beginning well posterior to body, ventral fin beginning posterior to vent tube, tip of tail rounded.

Mouth ventral, surrounded by labia forming complete oral disc 3.2 mm wide; one row of marginal papillae anteriorly; no papillae posteriorly; submarginal papillae lateral on upper labium. Labial tooth row formula 2/3, rows complete, about equal in length; jaw sheaths about equal in length, serrate, upper jaw sheath narrow, but slightly wider medially; lower jaw sheath V-shaped. Large belly sucker extending from posterior labium posteriorly for half body length, forming a complete, round sucker with raised edge; sucker broadened at juncture with labium; minute papillae not present on the roof of belly sucker.

*Color in preservative.*—Dorsum and sides of body brown; pale mark behind eye; posterior to latter, one middorsal mark and two white marks distally on body; white marks extending onto tail musculature; six white marks spaced along periphery of snout; spiracle unpigmented; tail musculature brown with white marks; fins with scattered brown flecks; oral disc and belly sucker translucent, except for scat-

TABLE 1.—Mean measurements of developmental stages fide Gosner (1960) of tadpoles and recently metamorphosed juveniles (\*) of *Atelopus baltos*.

Stage	n	Body length (mm)	Total length (mm)
29	1	3.7	10.1
31	5	4.1 (4.0–4.2)	10.5 (10.2–10.9)
32	1	4.2	10.7
33	4	4.4 (4.1–4.7)	10.6 (10.4–10.8)
34	12	4.8 (4.1–6.1)	11.7 (10.4–12.8)
41	8	5.5 (4.6–6.1)	12.4 (11.3–13.2)
42	4	5.8 (5.1–6.5)	12.6 (11.5–13.6)
46 (*)	3	6.2 (6.0–6.4)	

tered, isolated flecks; venter brown; gut barely visible.

*Color in life.*—Dark brown with symmetrical yellowish-brown marks on dorsum and tail musculature. Metamorphosing individuals in stage 42 brown, mottled with diffuse pale brown and distinctive creamy-yellow dorsolateral stripes; flanks dark brown. Recently metamorphosed juveniles in stage 46 dark-brown, mottled with diffuse golden marks; palmar and plantar regions pale orange; dorsolateral stripes yellow.

*Comments.*—In general, the series of tadpoles is morphologically homogeneous, although there is some variation in the labial teeth. One individual in stage 33 has poorly keratinized tooth rows; an individual at stage-34 has a medial gap in the second upper row, and an individual at stage-34 has a medial gap in the first lower row. An individual in early stage 42 (right forelimb emerged) possesses complete tooth rows, whereas another individual in late stage 42 lacks teeth.

One series (QCAZ 2670) was collected during August 1991 in a relatively low-gradient, clear-water stream connected to, and running parallel to the Río Patul, separated by several meters from it. The stream was about 0.5–1.0 m wide and 0.1–0.3 m deep, and lacked boulders or other obstructions. Between the Río Patul and the stream, the land was swampy and flooded during the rainy season. A steep slope with old secondary growth including bananas formed the other side of the stream. The loamy stream bank was flat and sparsely vegetated. The tadpoles were cryptically concealed above the stream bed,

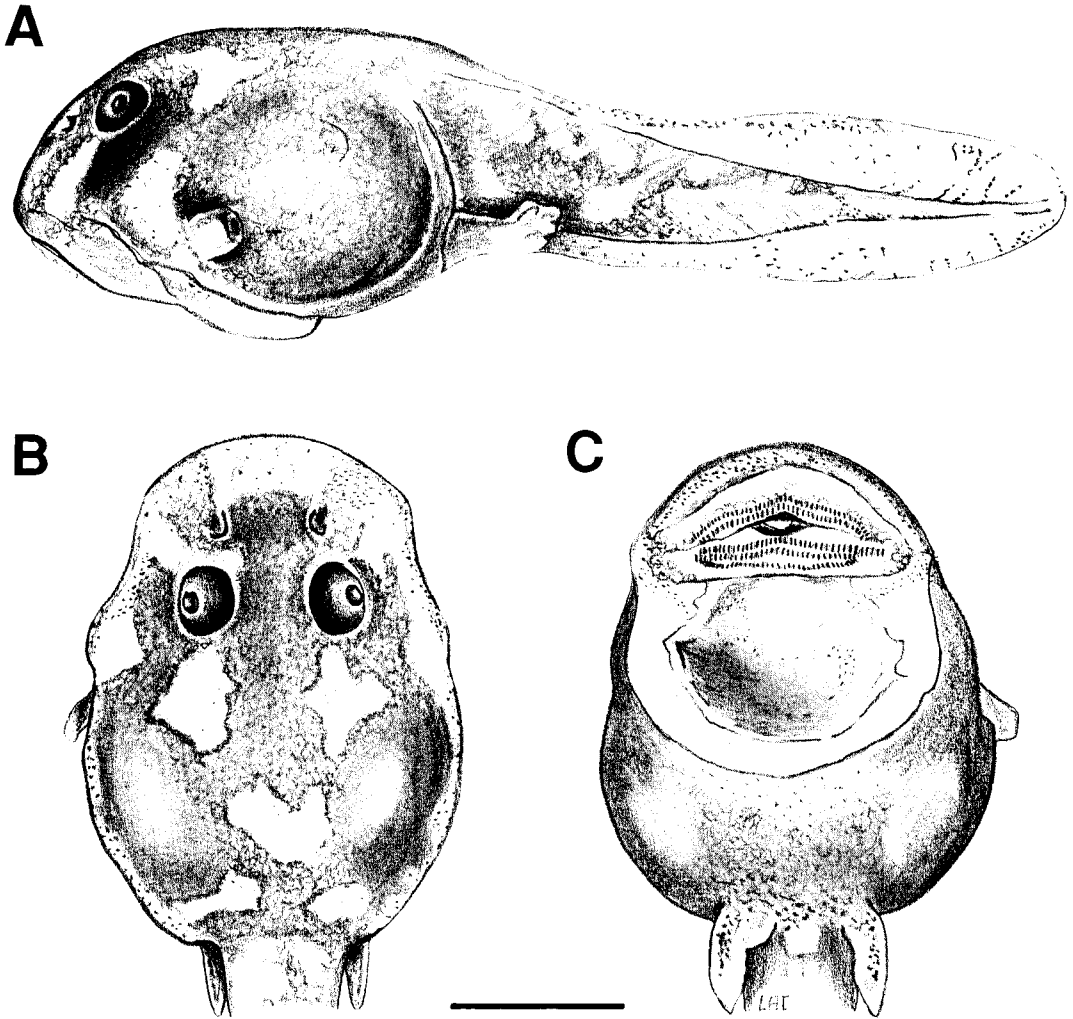


FIG. 1.—Tadpole of *Atelopus balios* in stage 34 (of series QCAZ 2670) in (A) lateral, (B) dorsal, and (C) ventral views. Scale = 2 mm.

which was composed of small gravel, sand, and smooth pebbles. The tadpoles adhered to the substrate and moved along while rasping. Several areas were covered by green algae, but no tadpoles were obtained there.

We found QCAZ 3331 ( $n = 19$ ) in August 1992 in the stream described above, also in a slow-flowing puddle about 1 m in diameter in the river bank of Río Patul. We found QCAZ 5035 ( $n = 5$ ) in October 1993 in a stream 1–2 m wide that flows into the Río Patul.

Data from water analysis are as follows: (5 August 1991, 1500 h) temperature 19.0 C; total hardness 0.54 mol/m<sup>3</sup>; carbonate hardness 1.25 mol/m<sup>3</sup>; pH 7.7; O<sub>2</sub> 4.0–5.0 mg/l; Fe < 0.05 mg/l; NH<sub>4</sub>, NO<sub>2</sub>, NO<sub>3</sub>, and PO<sub>4</sub> 0.0 mg/l. A comparison of these data with the data obtained for *Atelopus flavescens* by Lescure (1981) in a lowland site in French Guyana reveals noticeable differences in pH and dissolved oxygen (pH 5.0; O<sub>2</sub> 7.5 mg/l for *A. flavescens*).

Other animals present in the river and stream included a crustacean, which may

be a predator, and a few insect larvae. Characid fish were observed in the Río Patul and in a water reservoir connected to the stream.

Tadpoles of *Atelopus balios* are easily distinguished from those of *A. ignescens* (Duellman and Lynch, 1969), *A. peruensis* (Gray and Cannatella, 1985), and *A. subornatus* (Lynch, 1986) by having a shorter and higher tail with a different color pattern, and lacking black color in life. The larvae of *A. balios*, however, do resemble other lowland species of *Atelopus*, including *A. certus* (Duellman and Lynch 1969), *A. cruciger* (Mebs, 1980), *A. flavescens* (Lescure, 1981), *A. pulcher* (Gascon, 1989), *A. spumarius* (Duellman and Lynch, 1969), and *A. varius* (Starrett, 1967). These taxa can be distinguished from *A. balios* as follows. Tadpoles of *A. certus* are black with golden bronze flecks. Those of *A. varius* have uniform dark brown bodies, whereas the bodies of larval *A. balios* are dark brown with yellowish-brown marks. Tadpoles of *A. spumarius* have vertical, irregular cream and black bands on the caudal musculature, whereas those of *A. balios* have irregular yellowish-brown marks on the tail musculature. The tadpoles of *A. flavescens* and *A. cruciger* have longer tails than those of *A. balios* (tail length 61%, 57–59% versus 52% of body length, respectively). Larvae of *A. pulcher* have an unusually short upper beak and long lower lip (Gascon, 1989:238).

#### DISCUSSION

Lynch (1986) stated that at least in cloud forests with short and long dry seasons, species of *Atelopus* initiate oviposition during the onset of the short dry season. Our observations of tadpoles of *Atelopus balios* during August and October (dry season according to Cañadas-Cruz, 1983) confirm Lynch's speculation for at least one lowland species.

In the lowlands, with the exception of tadpoles of *A. pulcher*, larval *Atelopus* occur in swiftly flowing, rocky streams or under cascades (Duellman and Lynch, 1969; Lescure, 1981). The habitat of tadpoles of *A. balios* is slightly different, including slowly flowing water. This habitat

resembles that described for tadpoles of *A. pulcher* by Gascon (1989). The habitat conditions of cascades or swift flow guarantee a high concentration of dissolved oxygen in the water, which is assumed to be important for tadpoles of *Atelopus* (Lescure, 1981). Therefore, the oxygen measured in the habitat of larval *A. balios* (4.0–5.0 mg/l) is relatively low, compared with the data of Lescure (1981) who measured 7.5 mg/l under a cascade (the only place where tadpoles of *Atelopus* occurred) in a lowland stream in French Guyana.

The gastromyzophorous larva is assumed to be a uniquely derived feature of *Atelopus* (Cannatella, 1986; Lamotte and Lescure, 1989). McCranie et al. (1989) described the tadpole of the bufonid *Atelophryniscus chrysophorous*, which is remarkably similar in general morphology and coloration to tadpoles of *Atelopus*. However, they considered the similarity of these taxa to be convergent adaptations to similar environments and noted differences in papillae arrangement, lateral folds of the oral disc, and size. Recently metamorphosed juveniles of *A. balios* resemble those of *Atelophryniscus chrysophorous* in having a pale yellowish lateral stripe. The suggestion that the resemblance between tadpoles of *Atelophryniscus* and *Atelopus* is convergent is unwarranted in the absence of a detailed analysis of bufonid relationships, but the similarity of species of *Atelopus* and *Atelophryniscus* in tadpole and juvenile characters may be evidence that they are plesiomorphic for *Atelopus*.

#### RESUMEN

Se describe el renacuajo de *Atelopus balios* de las tierras bajas de la región Pacífica del sur de Ecuador. La morfología del renacuajo es similar a la de otras especies de *Atelopus* de tierras bajas. Los renacuajos de *A. balios* se encontraron en habitats de agua poco corriente.

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