

Description of the tadpoles of *Hypsiboas aguilari* and *H. melanopleura* (Anura: Hylidae: *Hypsiboas pulchellus* group)

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Abstract. We describe the tadpoles of *Hypsiboas melanopleura* and *H. aguilari* and compare them with the tadpoles of other species in the *Hypsiboas pulchellus* group. The description of the tadpole of *H. aguilari* is based on an individual at GOSNER Stage 29 and that of *H. melanopleura* on an individual at GOSNER Stage 28. Both tadpoles have a labial tooth row formula of 2(2)/4(1). At Stage 35, the tadpole of *H. aguilari* had a total length of 52.2 mm, at Stage 37, the tadpole of *H. melanopleura* had a total length of 60.7 mm. In life, the tadpole of *H. aguilari* has a brownish olive body with dark brown spots; fins transparent with dark brown reticulations, anterior half of tail muscle brown laterally, its posterior half pale brown with dark brown reticulations, and iris gold with black reticulations. In life, the tadpole of *H. melanopleura* has a pale beige ground coloration with brown flecks; tail laterally and ventrally whitish with grey flecks, and a beige iris. The tadpole morphology in *Hypsiboas aguilari*, *H. melanopleura*, and *H. palaestes* is similar, but tadpoles differ by their species-specific coloration patterns.

Key words. Amphibia, Andes, *Hypsiboas aguilari*, *Hypsiboas melanopleura*, *Hypsiboas pulchellus* group, Peru, tadpole morphology.

Introduction

The genus *Hypsiboas* WAGLER, 1830 contains 83 species (updated from FROST, 2010, with the addition of *Hypsiboas aguilari* and *H. gladiator*, and the synonymy of *H. andinus* with *H. riojanus*), most of which are included in seven species groups. One of them is the *Hypsiboas pulchellus* group, which currently contains 36 species that are distributed in Andean Peru, Bolivia, and Argentina at elevations of 500 to 3416 m a.s.l., as well as in the lowlands and mountain regions of Argentina, Paraguay, Brazil, and Uruguay (FROST 2010). Field work in the eastern Andes of central Peru in 2003 led to the rediscovery of *Hypsiboas melanopleura* at its type locality (LEHR & VON MAY 2004) and to the discovery of its tadpole in July 2004, whereas *Hypsiboas aguilari* and its tadpoles were found in February 2003 at nearby localities but at higher elevations. LEHR et al. (2010) described *Hypsiboas aguilari*, assigned it to the *Hypsiboas pulchellus* group and compared it with the sympatric *H. melanopleura* based on morphological, molecular, and bioacoustic characters. Herein, we describe the tadpoles of both species as announced by LEHR et al. (2010) and compare them to tadpoles of other species in the *Hypsiboas pulchellus* group.

Materials and methods

Species affiliations of the tadpoles were confirmed genetically (see LEHR et al. 2010). The format of the tadpole description follows that of ANTUNES et al. (2008). Tadpoles were preserved in 10% formalin. In our descriptions, we use the terminology of ALTIG (1970) and MCDIARMID & ALTIG (1999). Tadpoles were staged with GOSNER'S (1960) developmental table. Most measurements were taken to the nearest 0.1 mm using a stereomicroscope equipped with an ocular micrometer, although tail length, body length, and body width were measured with digital callipers. Recorded measurements include: body length (distance from the tip of the snout to the body terminus, which is the junction of the posterior body wall with the tail axis); tail length (distance from the body terminus to the absolute tip of tail); total length (sum of body and tail lengths); body width (measured at the widest point right behind the eyes); body height (at level of eye); eye diameter; interorbital distance (measured between the centres of the pupils); internarial distance (measured between the centres of the nostrils indicated by reduced pigmentation when closed); distance between tip of snout and naris (from centre of naris to middle of snout); and distance between nostril and eye

(from the centre of nostril to the anterior edge of the eye); spiracle length (medially to opening); and spiracle tube width (at level of opening). Natural history observations of tadpoles were recorded by E. LEHR and C. AGUILAR. Comparative data were taken from original tadpole descriptions, and the specimens examined (Appendix I). Museum acronyms are: KU = Natural History Museum, University of Kansas, Lawrence, Kansas, USA; MUSM = Museo de Historia Natural Universidad Nacional Mayor de San Marcos, Lima, Peru; MTD = Museum für Tierkunde Dresden, Dresden, Germany.

Results

Tadpole of *Hypsiboas aguilari*

The following description is based on a Stage-29 individual (Figs. 1A–D, MTD 46557, series of 10 tadpoles, GOSNER Stages 25–29). Measurements (mm): body length 15.7, body width 10.1, body height 8.5, total length 48.1, eye diameter 1.6, interorbital distance 6.1, internarial distance 3.7, snout–nostril distance 2.6, nostril–eye distance 1.9, spiracle length 2.0, spiracle tube width 1.4, width spiracle opening 0.8, tail muscle height at its beginning: 5.1, tail muscle height

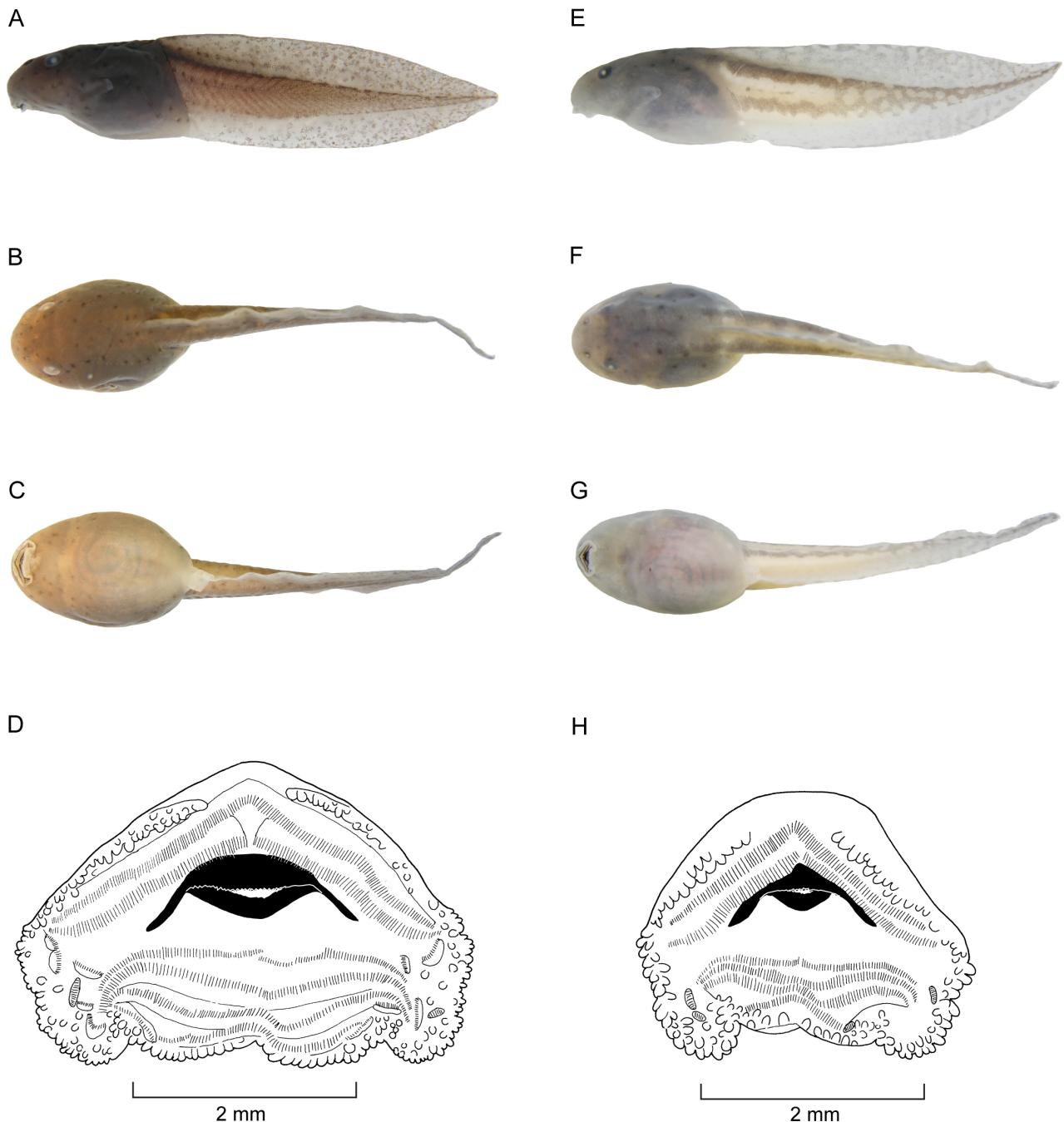


Figure 1. Tadpole of *Hypsiboas aguilari* (MTD 46557, Stage 29, total length 48.1 mm) in lateral (a), dorsal (b), and ventral views (c), and oral disc (d) in ventral view. Tadpole of *Hypsiboas melanopleura* (MTD 46350, Stage 28, total length 44.8 mm) in lateral (e), dorsal (f), and ventral views (g), and oral disc (h) in ventral view. Photos and drawings by E. LEHR.

Table 1. Morphometric measurements of selected tadpoles of *Hypsiboas aguilari* and *H. melanopleura*.

	<i>Hypsiboas aguilari</i>					<i>Hypsiboas melanopleura</i>				
	MTD 46326	MTD 46557	MTD 46557	MTD 46557	MTD 46557	MTD 46350	MTD 46350	MTD 46350	MTD 46350	MTD 46350
GOSNER stage	35	29	28	27	26	37	28	28	28	27
Body length	14.6	15.7	15.3	11.0	11.4	18.8	14.2	15.0	13.1	15.7
Tail length	37.6	32.4	30.6	24.1	20.5	41.9	28.1	29.8	29.9	22.5
Total length	52.2	48.1	45.9	35.1	31.9	60.7	42.3	44.8	43.0	38.2
Body width	10.8	10.1	9.2	6.7	6.4	14.0	8.8	8.7	9.1	9.6
Body height	9.6	8.5	6.8	5.2	5.9	11.3	8.5	8.5	8.6	8.3
Eye diameter	2.3	1.6	1.5	1.1	1.2	2.3	1.4	1.3	1.4	1.3
Interorbital distance	6.9	6.1	5.7	4.5	4.3	7.4	5.3	6.0	5.3	6.0
Internarial distance	4.1	3.7	3.5	2.7	2.7	4.0	3.3	3.0	3.2	3.3
Distance snout–naris	3.5	2.6	3.0	2.3	2.1	3.1	2.3	2.8	2.5	2.1
Distance naris–eye	2.1	1.9	1.6	1.3	1.3	2.2	1.7	1.9	1.8	1.9
Spiracle length	2.3	2.0	1.9	1.5	1.1	3.2	2.4	2.0	2.1	1.9
Spiracle width	1.6	1.4	1.5	1.2	1.0	2.3	1.6	1.4	1.5	1.4
Spiracle opening width	0.9	0.8	0.7	0.5	0.3	0.8	0.6	0.5	0.5	0.5
Distance snout–spiracle	12.6	11.3	8.1	7.1	6.9	13.8	10.5	9.1	10.5	11.3
Tail muscle height (at its beginning)	7.3	5.1	4.8	3.5	3.3	8.2	5.6	5.2	4.9	5.5
Tail muscle height (at mid-length of tail)	4.9	3.7	3.1	2.3	2.1	6.1	4.1	3.5	4.0	4.3
Tail height (greatest), at mid-length of tail	12.1	10.4	9.9	7.6	7.1	13.8	9.4	9.4	9.2	10.2

at tail mid-length: 3.7, greatest tail height 10.4, tail length 32.4. Body ovoid in dorsal and lateral aspects (Figs. 1A, B), body length 33% of total length of tadpole; body wider than high; greatest body height and width at mid-length of body; snout rounded in lateral and dorsal views; eyes large and positioned dorsolaterally, its diameter 10.2% of body length; nostrils oval with a small elliptical projection on its inner margin; lateral line system visible; tail length 67.4% of total length; tail height 32.1% of tail length; greatest tail height at mid-length of tail; tail musculature well developed throughout anterior half of length; in posterior half, musculature gradually diminishing, slightly curving upward to slender tip, tail tip narrowly rounded; tail muscle height at its beginning 59% of tail height; height of ventral fin at mid-length of tail about 81.8% of dorsal fin; dorsal fin originating at tail musculature; spiracle of medium size, longer than wide, sinistral, and directed postero-dorsally, its inner wall fused to body except for its distal end; cloacal tube large and opening laterally on the right side of ventral fin with aperture directed downward; oral disc well developed, anteroventral (Fig. 1C), not visible in dorsal view, and about 41.4% of body width; marginal papillae surrounding the oral disc, except for a rostral gap (about 17% of oral disc); labial tooth row formula is 2(2)/4(1) (Fig. 1D), being P(4) shorter than other rows and located near the border of marginal papillae; small flaps with labial teeth on the lateral areas of the oral disc; free margins of both jaw sheaths serrated, anterior one larger than the posterior one. In preservative, dorsal and lateral faces of body dark greyish brown with dark brown spots, ventral side of body grey with few dark brown spots on its anterior half. Tail musculature brown laterally, its posteri-

or half covered with dark brown reticulations, dark brown interrupted narrow stripe dorsolaterally on both sides of tail, tail muscle tan ventrally. Dorsal and ventral fins (except for area of cloacal tube) covered with dark brown reticulations, more dense on dorsal than on ventral fin. In life, body brownish olive with dark brown spots; fins transparent with dark brown reticulations; anterior half of tail muscle brown laterally, its posterior half pale brown with dark brown reticulations; iris gold with black reticulations. See Table 1 for measurements of selected tadpoles of *Hypsiboas aguilari*.

Tadpole of *Hypsiboas melanopleura*

The following description is based on a Stage-28 individual (Figs. 1E–H, MTD 46350, series of five tadpoles, GOSNER Stages 25–37). Measurements (mm): body length 15.0, body width 8.7, body height 8.5, total length 44.8, eye diameter 1.3, interorbital distance 6.0, internarial distance 3.0, snout–nostril distance 2.8, nostril–eye distance 1.9, spiracle length 2.0, spiracle tube width 1.4, width spiracle opening 0.5, tail muscle height at its beginning: 5.2, tail muscle height at tail mid-length: 3.5, greatest tail height 9.4, tail length 29.8. Body ovoid in dorsal and lateral aspects (Figs. 1E, F), body length 33.5% of total length of tadpole; body slightly wider than high; greatest body height and width at mid-length of body; snout rounded in lateral and dorsal views; eyes large and positioned dorsolaterally, its diameter 8.7% of body length; nostrils oval with a small elliptical projection on its inner margin; lateral line system visible; tail length 66.5% of total length; tail height 31.5%

of tail length; greatest tail height at mid-length of tail; tail musculature robust, well developed throughout three quarters of length; musculature gradually diminishing in posterior quarter of length, curving upward to slender tip, tail tip pointed; tail muscle height at its beginning 67.1% of tail height; height of ventral fin at mid-length of tail about 65.7% of dorsal fin; dorsal fin originating at tail musculature; spiracle of medium size, longer than wide, sinistral, and directed posterodorsally, its inner wall fused to body except for its distal end; cloacal tube large and opening laterally on the right side of ventral fin with aperture directed downward; oral disc well developed, anteroventral (Fig. 1G), not visible in dorsal view, and about 36.8% of body width; marginal papillae surrounding the oral disc, except for a rostral gap (about 26.7% of oral disc); labial tooth row formula is 2(2)/4(1) (Fig. 1H), being P(4) shorter than other rows and located near the border of marginal papillae; few small flaps with labial teeth on the lateral areas of the oral disc; free margin of both jaw sheaths serrated, anterior one larger than the posterior one. In preservative, body grey dorsally and laterally, dorsally with few dark brown spots, body pale grey ventrally. Tail musculature cream laterally with a brown longitudinal streak each near the upper and lower margins over one third of its length, tail musculature greyish brown with pale cream blotches over two thirds of its length; tail musculature pale cream ventrally. Dorsal and ventral fins covered with dark brown reticulations, leaving transparent areas open along upper margin of dorsal fin, ventral fin paler with fewer brown reticulations. In life, ground coloration pale beige with brown flecks, tail whitish with grey flecks laterally and ventrally, iris beige. See Table 1 for measurements of selected tadpoles of *Hypsiboas melanopleura*.

Distribution and ecology

Hypsiboas aguilari is known from several localities in the central Peruvian regions of Pasco and Junín at 1225–2080 m a.s.l., where it is commonly found in open areas of secondary forests and in agriculturally used habitats (LEHR et al. 2010). Tadpoles of *H. aguilari* were found during the rainy season (on 12 February) and during the dry season (between 10 and 17 July) in a swampy, slow-flowing creek on a cattle pasture together with adults of *H. aguilari* (Fig. 2). At Llamaquizu (Pasco), tadpoles of *H. aguilari* and *Scinax oreites* were found syntopically on 10 and 17 July in a small pond of approximately 60 cm in diameter and 40 cm in depth. Small rocks on the bottom of the pond were used by the tadpoles to hide under. The pond is connected to a small rivulet. Tadpoles of *H. melanopleura* were found on 29 April and 17 July. Close to the type locality of *H. melanopleura*, tadpoles of *H. melanopleura* and tadpoles of *Cochranella* sp. were found syntopically in a slow-flowing stream next to a road passing through a secondary forest (Fig. 3). The stream was vegetated, had a muddy bottom, and housed dragonfly larvae as potential predators.

Captive tadpoles of both *H. aguilari* and *H. melanopleura* were predominantly benthic. When grazing, the tadpoles of both species frequently emerged from the water with the anterior three quarters of their bodies on oblique or vertical surfaces.



Figure 2. Habitat (type locality) of tadpoles of *Hypsiboas aguilari* on 12 February 2003. Photo by E. LEHR.



Figure 3. Habitat of tadpoles of *Hypsiboas melanopleura* on 17 July 2004. Water turbidity as seen in the background was the result of catching activities. Photo by E. LEHR.

Discussion

KOLENC et al. (2008) summarized larval characters for 23 species of the *Hypsiboas pulchellus* group. The external morphology of the tadpoles of *H. aguilari* and *H. melanopleura* in general is similar to that of the other known larvae of the group. Having a labial tooth row formula of 2/4 *H. aguilari* differs from *H. bischoffi*, *H. caingua*, *H. cipoensis*, *H. cordobae*, *H. goianus*, *H. latistriatus*, *H. leptolineatus*, *H. polytaenius*, *H. prasinus*, and *H. pulchellus* (all with 2/3 or variations within these numbers of rows; BOTH et al. 2007, ETEROVICK & BRANDÃO 2002, GALLARDO 1961, HEYER et al. 1990, KOLENC et al. 2008, ORRICO et al. 2007, SPIRANDELLI-CRUZ 1991), *H. curupi* (3 (1,3)/5(1)); FAIVOVICH 1996), and *H. poaju* (2(2)/5(1)); GARCIA et al. 2008); all remaining species of the group have variable tooth row formulae, amongst which 2/4 occurs with some frequency (see KOLENC et al. 2008).

The tadpoles of *Hypsiboas aguilari*, *H. melanopleura*, and *H. palaestes* are similar but differ in their colour patterns. The tadpoles of *H. aguilari* and *H. palaestes* differ as follows (condition of *H. palaestes* in parentheses follows DUELLMAN et al. 1997): in preservative, the tadpole of *H. aguilari* has the body marked with distinct dark brown

spots dorsally and laterally (uniformly pigmented with brown chromatophores), tail musculature is brown laterally, with dark brown reticulations in its posterior half (tail musculature opaque yellowish brown laterally with discrete brown blotches), dorsal and ventral fins covered with dark brown reticulations (dorsal fin with scattered discrete brown blotches in its anterior part, ventral fin transparent). The tadpoles of *H. aguilari* and *H. melanopleura* differ from *H. gladiator* (= *H. balzani* in DUELLMAN et al. 1997) as follows: labial tooth row formula of *H. aguilari* and *H. melanopleura* is 2(2)/4(1), whereas in *H. gladiator* it is 3(1,3)/4(1) with variation that coincides with development (e.g., 2(2)/3(1) at Stage 25, DUELLMAN et al. 1997), tail tip is narrowly rounded in *H. aguilari*, pointed in *H. melanopleura*, and broadly rounded in *H. gladiator*. The tadpoles of *H. aguilari* and *H. melanopleura* differ as follows (condition of *H. melanopleura* in parentheses): in preservative, the tadpole of *H. aguilari* has the body marked with distinct dark brown spots dorsally and laterally (with few dark brown spots dorsally), tail musculature is brown laterally, with dark brown reticulations in its posterior half (tail musculature cream laterally with brown longitudinal streaks near the upper and lower margins over one third of its length, tail musculature greyish brown with pale cream blotches over two thirds of its length), dorsal and ventral fins covered with dark brown reticulations (dorsal and ventral fins covered with dark brown reticulations, ventral fin much paler with fewer brown reticulations).

In a molecular phylogenetic analysis of 27 species of the *H. pulchellus* group, *H. aguilari* and *H. melanopleura* presented themselves as sister species, forming a second, independent, Andean clade within the group (LEHR et al. 2010). In the molecular phylogenetic analysis by KÖHLER et al. (2010), the most basal species were *H. palaestes* and *H. gladiator*. Since both author teams used different species, it remains unknown if *H. aguilari*, *H. gladiator*, *H. melanopleura*, and *H. palaestes* belong to the same clade, but we consider it quite likely on the basis of their morphological similarity.

Larvae are now known from the Andean species *H. aguilari* (this paper), *H. riojanus* (CEI 1980, LAVILLA 1984, DUELLMAN et al. 1997 [the latter three papers using the name *H. andinus*]; KOLENC et al. 2008), *H. marianitae* (LÖTTTERS et al. 1999), *H. melanopleura* (this paper), *H. palaestes* (DUELLMAN et al. 1997), and *H. gladiator* (tadpole described as that of *H. balzani* by DUELLMAN et al. 1997, but this population is likely to represent *H. gladiator* according to KÖHLER et al. 2010). Of these, *H. callipleura*, *H. marianitae*, and *H. riojanus* belong to one of the Andean clades, while *H. aguilari* and *H. melanopleura* belong to the other Andean clade; we consider it very likely that *H. palaestes* is associated with the latter clade as well. KOLENC et al. (2008) noticed that larvae of the then only known Andean clade and a few others from the Atlantic forest share an LTRF of at least 2/4 (regardless of the 2/3 in some *H. riojanus*), the presence of lateral flaps bearing labial teeth, the last posterior row usually much shorter than the other, and P₄, when present, is usually fragmented. While larvae of *H. aguilari*, *H. melanopleura*, and *H. palaestes* do have the former three character states, P₄ is not fragmented. KOLENC et al. (2008) noticed that there is occasionally a divided A₃ in *H. riojanus*, *H. marianitae* and *H. gladiator*.

Large series of tadpoles of *H. aguilari*, *H. melanopleura*, and *H. palaestes* would be necessary to check if this polymorphism occurs there as well.

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Appendix

Larval specimens examined

Hypsiboas aguilari: PERU: Pasco: San Alberto, 10°32'53.4" S, 75°22'16.6" W, 2200 m a.s.l., on 12 February 2003, collected by E. LEHR and C. AGUILAR, MTD 46557 (series of 10, GOSNER Stages 25–29); km 2.65 near road from Llamaquizu to radio antenna, 10°37'17.8" S, 75°21'53.8" W, 2000 m a.s.l., MTD 46326 (series of 15, GOSNER Stages 25–35, on 10 July 2004 by M. LUNDBERG), 46347 (one tadpole, Stage 30, on 17 July 2004 by E. LEHR and M. LUNDBERG).

Hypsiboas melanopleura: PERU: Pasco: Huancabamba/PROSOYA, 10°25'09.5" S, 75°31'08.9" W, 1780 m a.s.l., in a pond near road from PROSOYA to Yanachaga–Chemillén National Park, slow current, vegetation and muddy bottom, syntopic with *Cochranella* tadpoles and dragonfly larvae, on 17 July 2004, coll. by E. LEHR and C. RAMIREZ, MTD 46350 (series of five, GOSNER Stages 25–37); Huancabamba/PROSOYA, 10°25'08.7" S, 75°31'08.1" W, 1780 m a.s.l., on 29 April 2004, coll. by M. LUNDBERG, MTD 46328 (series of 23 with damaged fins, GOSNER Stages 25–35), 46329 (one tadpole of GOSNER Stages 28), 46331 (one tadpole of GOSNER Stages 27).

Hypsiboas palaestes: PERU: San José, Rio Santa Rosa, 1005 m: KU 164051.