



A new, riparian, species of *Allobates* Zimmermann and Zimmermann, 1988 (Anura: Aromobatidae) from southwestern Amazonia

PAULO ROBERTO MELO-SAMPAIO^{1,3}, MOISÉS BARBOSA DE SOUZA¹ &
PEDRO LUIZ VIEIRA PELOSO²

¹Universidade Federal do Acre – Laboratório de Herpetologia (HerPet) – BR-364 km 04 – Distrito Industrial. CEP: 69.915-900. Rio Branco, Acre, Brazil

²Division of Vertebrate Zoology (Herpetology) and Richard Gilder Graduate School, American Museum of Natural History, Central Park West at 79th Street, 10024, New York, NY, USA. E-mail: pedropeloso@gmail.com

³Corresponding author. E-mail: prmelosampaio@gmail.com

Abstract

We describe *Allobates flaviventris* **sp. nov.**, a medium-sized (SVL 16.7–19.7 mm in males; 19.3–21.1 mm in females) aromobatid frog with Finger III not swollen in adult males from eastern state of Acre, Brazil. It inhabits open forests with bamboo, usually along small streams and rivers. It has golden-yellow belly and a unique advertisement call as a distinctive character. Notes on natural history are also provided.

Key words: *Allobates*, bamboo forest, taxonomy, morphology, riparian species

Resumo

Descrevemos *Allobates flaviventris* **sp. nov.**, de tamanho mediano (CRC 16.7–19.7 mm em machos; 19.3–21.1 mm em fêmeas), com dedo III não expandido nos machos, do leste do estado do Acre, Brasil. Ocorre em florestas abertas com bambu ao longo de pequenos córregos e rios, possui ventre amarelo-dourado e um canto de anúncio diferenciado bem característicos. Notas de história natural também são fornecidas.

Palavras chave: *Allobates*, floresta com bambu, taxonomia, morfologia, espécie ripária

Resumen

Describimos *Allobates flaviventris* **sp. nov.**, de tamaño mediano (LHC 16.7–19.7 mm en los machos; 19.3–21.1 mm en las hembras), con el dedo III no dilatado en los machos adultos, de este del Acre, Brasil. Habita en los bosques abiertos con el bambú, al largo de quebradas y ríos, tiene el vientre amarillo dorado y un canto de anuncio único como carácter distinto. También se incluyen notas sobre historia natural.

Palabras clave: *Allobates*, bosque de bambú, taxonomía, morfología, especie riparia

Introduction

Allobates Zimmermann and Zimmermann contains approximately 50 species, distributed throughout the Pacific lowlands of Colombia and Ecuador; north and west in Central America to Nicaragua; the Guyanan region; and the Amazonian drainage in Brazil, Bolivia, Peru, Ecuador, Colombia, Venezuela, Guyana, Surinam and French Guiana, and Martinique (Frost 2013). Most Amazonian *Allobates* have restricted distributions (Simões *et al.* 2010, 2013) but a few are apparently widespread (Lima *et al.* 2010). Nonetheless, recent studies show that many seemingly widespread Amazonian frog species are in fact species complexes, including some *Allobates* (Morales

1994, 2000 "2002"; Grant *et al.* 2006; Simões *et al.* 2010) and many species have only recently been named. In Brazil, 20 species of *Allobates* have been reported in the literature (Segalla *et al.* 2012; Simões *et al.* 2013). There is consensus that some populations referred to as *Allobates marchesianus*, *A. trilineatus*, and *A. brunneus* in different regions of the Amazon may actually represent species complexes (Morales 1994; Caldwell *et al.* 2002a; Lima *et al.* 2009).

Several species of *Allobates* occur sympatrically in many localities throughout their range (Lima *et al.* 2007; Souza *et al.* 2008; Souza 2009; Caldwell & Araújo 2005), but similar morphology and difficulty in distinguishing species after preservation has for a long time obscured a potentially astonishing cryptic diversity (Duellman 2004; Simões *et al.* 2013). Analyses of advertisement calls and tadpoles can be helpful in identification and diagnosis of species, but unfortunately such data is unavailable for many species (Caldwell *et al.* 2002b; Simões *et al.* 2013).

During fieldwork in scattered localities in the state of Acre, Brazil, we discovered an unnamed species of *Allobates*, distinguishable from other congeners in morphology and advertisement call. Here, we describe and name this species.

Material and methods

Adults of the new species were collected and observed from August 2009 to June 2010. Localities sampled were Fazenda Experimental Catuaba (10°04'56" S, 67°37'33" W) and Fazenda Bonal (09°53'45.1"S; 67°18'14.8"W), hereafter FEC and FB respectively. Adults were killed in a solution of lidocaine hydrochloride and subsequently fixed in 10% formalin for 24 hours and transferred to 70% ethanol for permanent storage. We also searched the material housed at Coleção Herpetológica da Universidade Federal do Acre, Rio Branco, Acre, Brazil (**UFAC-RB**) for additional specimens of the new taxon. In total, we analyzed 14 males and 16 females of the new species. Specimens examined for comparisons are deposited at the American Museum of Natural History, New York, USA (**AMNH**), Museu Paraense Emílio Goeldi, Belém, Pará, Brazil (**MPEG**), and Smithsonian Institution, National Museum of Natural History, Washington, District of Columbia, USA (**USNM**).

The following measurements were taken from adult specimens: snout-vent length (SVL); head length, from corner of mouth to the tip of the snout (HL); head width, at the angle of the jaw (HW); interorbital distance (IOD); eye–nostril distance, from the corner of the eye to the center of the nostril (END); internarial distance (IND); eye diameter (ED); forearm length (FaL); length of the proximal edge of palmar tubercle to tip of finger III (HandIII); width disc of finger III (WDFIII); tibia length (TL); foot length, from the proximal border of the metatarsal tubercle to the tip of toe IV (FL); width disc of toe IV (WDTIV). Measurements were taken with a digital caliper to the nearest 0.1 mm. Color in life was taken from field notes and digital photographs. Sex was confirmed by observing calling activity of males or by subsequent dissection. Student t-tests were performed with Statistica® 7.0 to examine differences in sexual dimorphism of SVL, HW, and HL.

Advertisement calls of three individuals (two recordings of UFAC-RB 4650, holotype; one of UFAC-RB 4678; and one from a specimen not collected) were recorded with a Sony® ICX-50 digital recorder (locality, dates, and time given in Results). The local temperature was not recorded but the mean is 28°C approximately. The call of the unvouchered specimen is, unfortunately, unsuitable for a detailed acoustic analyses but is clearly assignable to the new species. Temporal and spectral variables of recordings were analyzed in the software Raven Pro 1.3 (Charif *et al.* 2008). Spectral analyses were performed based on Fast Fourier transformations with a resolution of 256 points. For temporal analyses we measured call duration (s), interval between calls (s), number of notes per call, note duration (s), interval between notes (s) and call rate (calls per minute). Spectral variables scored were restricted to dominant frequency (Hz; where energy of the note is highest), presence or absence of harmonics, and whether the dominant frequency is also the fundamental frequency.

Results

Allobates flaviventris sp. nov.

Figures 1–2

Colostethus marchesianus (Cardoso & Souza, 1996 part)

Colostethus sp. A—(Köhler & Lötters, 1999 part p. 263)

Colostethus sp. 4—(Amézquita *et al.* 2006 p. 1878, 1881)

Allobates sp.—(Souza *et al.* 2008 part p. 53)

Portuguese name: rãzinha ripária de barriga amarela

English name: yellow-bellied stream frog

Spanish name: rana de quebrada de barriga amarilla

Holotype. UFAC-RB 4650 an adult male, collected on May 16, 2010 by Paulo R. Melo-Sampaio and Auristo da Conceição Melo, at Colocação Olho D'água, Fazenda Bonal, Senador Guimard, state of Acre, Brazil (09°53'45.1"S; 67°18'14.8"W), approximately 150 m.a.s.l.

Paratypes. UFAC-RB 4599–4601, females (FEC on January 3, 2010); UFAC-RB 4603, female (type–locality on April 2, 2010); UFAC-RB 4633–4635 (type locality on May 08, 2010); UFAC-RB 4640–4641 (FEC on January 23, 2010); UFAC-RB 4649 (same data as holotype); UFAC-RB 4657, 4659–4660, 4670 (all from type locality on June 4, 2010); UFAC-RB 4675–4677; UFAC 4602, 4604, 4631–4632, males, (type locality on May 8, 2010); UFAC-RB 4658, 4661–4666, 4669 (all from type locality on June 4, 2010); UFAC-RB 4671 (FEC on June 6, 2010); UFAC-RB 4678 (FEC on June 12, 2010). All specimens were collected by the senior author and field assistants (see acknowledgements).

Diagnosis. The new species is diagnosed by the following combination of characteristics: median lingual process absent; canthus rostralis rounded in both lateral and dorsal profile. Medium-sized species, mean SVL of males 18.8 mm (range 16.7–19.7); mean SVL of females 20.4 mm (range 19.3–21.1). Dorsolateral stripe absent in both sexes; ventrolateral stripe represented by irregular spots in males, but present in females; short, diffuse oblique lateral stripe present only in inguinal region in both sexes. Males with gray to violet-gray throat and golden-yellow belly; females with yellow throat and golden-yellow belly. Finger III of males not swollen in both sexes (Fig. 1 and 2), disc on finger III wider than diameter of finger; basal webbing absent on hands. Webbing absent between toes III and IV; relative toe length $IV > III > V > II > I$. Advertisement call consists of groups of 2–10 notes separated by irregular intervals; dominant frequency 3617.6–4651.2 Hz.

Comparison with other species. The new species is compared here with all *Allobates* species. The new species differs from putatively aposematic species in the genus, i.e., with red, yellow or orange color in thighs or inguinal blotches or white stripes by lacking such color patterns (vs. presence in *A. femoralis*, *A. hodli*, *A. myersi*, *A. rubriventris* and *A. zaparo*). From non-Amazonian species, the species differs, by presence of yellow venter (vs. absence) from *A. alessandroi*, *A. algorei*, *A. bromelicola*, *A. caribe*, *A. chalcopis*, *A. craspedocephalus*, *A. fratisenescus*, *A. goianus*, *A. granti*, *A. humilis*, *A. ignotus*, *A. juanii*, *A. mandelorum*, *A. mediarmedi*, *A. picachos*, *A. pittieri*, *A. olfersioides*, *A. sanmartini* and *A. spumaponens*; from *Allobates insperatus* and *A. niputidea*, two non-aposematic species, by larger body size (13.6–18.4 and 15.7–18.0 mm vs. 16.7–21.1 mm respectively); from *A. kingsburyi* by smaller size (16.7–21.1 mm vs. 22.3–26.2 mm); from the remaining non-aposematic species, by third finger of males swollen in *A. humilis*, *niputidea*, *mandelorum*, *ornatus*, *picachos*, and *wayuu* (non-swollen in the new species). Because most species of *Allobates* are known to be microendemic and their ranges do not normally appear to extend beyond biogeographic boundaries (Simões *et al.* 2013), a more detailed comparison is here presented only for non-aposematic species from the Amazon region. *Allobates flaviventris* differs from *A. brunneus* by its larger SVL in females, the absence of a gray to violet-gray throat (light color in *A. brunneus*) and advertisement call (long trains of single notes emitted in bouts in *A. flaviventris*); *A. caeruleodactylus* in not having sky blue digits on males, and larger size (SVL 14.9–17.4 mm; uniform dorsum and sky blue digits on *A. caeruleodactylus*). *A. cepedai* in having finger I longer than finger II, by not having swollen third fingers in males and dorsal pattern (same size of fingers I and II, and swollen third finger in males *A. cepedai*); *A. conspicuus* by its larger SVL in both sexes (16.5 mm in males and 17.2 mm in females of *A. conspicuus* vs. mean 18.8 mm in males and 20.4 mm in females of *A. flaviventris*), and by the absence of dorsolateral stripes (present in *A. conspicuus*); from *A. crombiei* its coloration in life (venter, including throat, of males entirely yellow in *A. crombiei* Lima *et al.* 2012), and by its advertisement call (a long series of notes—25–59—in *Allobates crombiei* with frequency modulation, dominant frequency 4522–5383 Hz, emitted at a high and regular rate: Lima *et al.* 2012); *A. fuscillus* by the absence of a swollen third finger (swollen in *A. fuscillus*); *Allobates gasconi* by the absence of a swollen third finger (swollen in *A. gasconi*); *Allobates grilissimilis* by its dorsal pattern (uniform in *A. grilissimilis*), and by its advertisement call (trills of short pulses emitted in a variable number in *A. grilissimilis*); *Allobates marchesianus* by its advertisement call (number of notes per calls, dominant frequency and note duration consisting in thrill of notes in *A. marchesianus*); *A. masniger* by the absence of dorsolateral stripes (present in *A. masniger*) and throat color (black in *A. masniger*); *A. melanolaemus* by its smaller SVL and advertisement call (1–6 notes with

frequency ranging 3840–4560 Hz in *A. melanolaemus* Grant & Rodriguez 2001); *A. nidicola* by absence of dorsolateral stripes (present in *A. nidicola*), throat color (black in *A. nidicola*), in their advertisement call (long trains of single notes emitted in bouts, dominant frequency of 3440–5010Hz) and by its free-swimming tadpole (nidicolous tadpole in *A. nidicola*); *A. paleovarzensis* by absence of swollen third finger (swollen third finger in *A. paleovarzensis*) and transparent egg capsules in clutches (opaque gelatinous capsules in *Allobates paleovarzensis*); *A. subfolionidificans* by the presence of hour-glass on dorsum, larger SVL, throat coloration (dorsolateral and ventrolateral stripes absent, males uniform white venter and females cream uniform venter), and calls (call structure with continuous and similar notes in *A. subfolionidificans*); *Allobates sumtuosus* by not having swollen in third finger (swollen in *A. sumtuosus*), ventral coloration dark throat in males *A. flaviventris* (light in *A. sumtuosus*); *A. trilineatus* in not having swollen fingers (third and sometimes second finger swollen in adult males of *A. trilineatus*; see Figure 4) and by its advertisement call (multipulsed call, 9–13 pulses/call, dominant frequency 4920–6040Hz); *A. vanzolinius* by smaller SVL and by absence of swollen third finger (swollen in *A. vanzolinius*). At the type locality another unnamed species (*Allobates* aff. *conspicuous*) is distinguished from *Allobates flaviventris* by the absence of an hourglass pattern on the dorsum, light yellow throat, uniform belly, and a smaller SVL.

TABLE 1. Measurements (in mm) of adult females and males of *Allobates flaviventris* sp. nov. Abbreviations are defined in the text. Values are means \pm standard deviation (in brackets); maximum and minimum values are in bold.

Character	Holotype	Females (n= 16)	Males (n= 14)
SVL	18.1	20.4 (\pm 0.51) 19.3–21.1	18.8 (\pm 0.88) 16.7–19.7
HL	5.7	6.1 (\pm 0.32) 5.7–6.5	5.7 (\pm 0.20) 5.4–6.1
HW	5.7	6.4 (\pm 0.18) 6.1–6.7	5.8 (\pm 0.15) 5.5–6.1
IOD	3.9	4.1 (\pm 0.07) 4.0–4.2	3.9 (\pm 0.18) 3.6–4.2
ESD	3.0	3.40 (\pm 0.23) 2.9–3.7	3.1 (\pm 0.22) 2.7–3.5
IND	2.9	2.89 (\pm 0.16) 2.5–3.1	2.6 (\pm 0.15) 2.4–2.9
ED	2.4	2.80 (\pm 0.09) 2.6–2.9	2.5 (\pm 0.18) 2.2–2.8
TYM	1.1	1.23 (\pm 0.17) 1.0–1.5	1.1 (\pm 0.08) 1.0–1.3
ARM	3.9	4.64 (\pm 0.33) 4.0–5.0	4.4 (\pm 0.38) 3.6–4.9
HAND	4.9	4.85 (\pm 0.22) 4.3–5.1	4.8 (\pm 0.14) 4.6–5.1
WDFIII	0.4	0.53 (\pm 0.03) 0.5–0.6	0.4 (\pm 0.04) 0.4–0.5
TL	9.0	9.89 (\pm 0.14) 9.6–10.0	9.4 (\pm 0.28) 8.7–9.7
FL	8.7	9.30 (\pm 0.45) 8.4–9.7	9.0 (\pm 0.35) 8.4–9.5
WDTIV	0.6	0.65 (\pm 0.07) 0.5–0.8	0.6 (\pm 0.04) 0.5–0.7

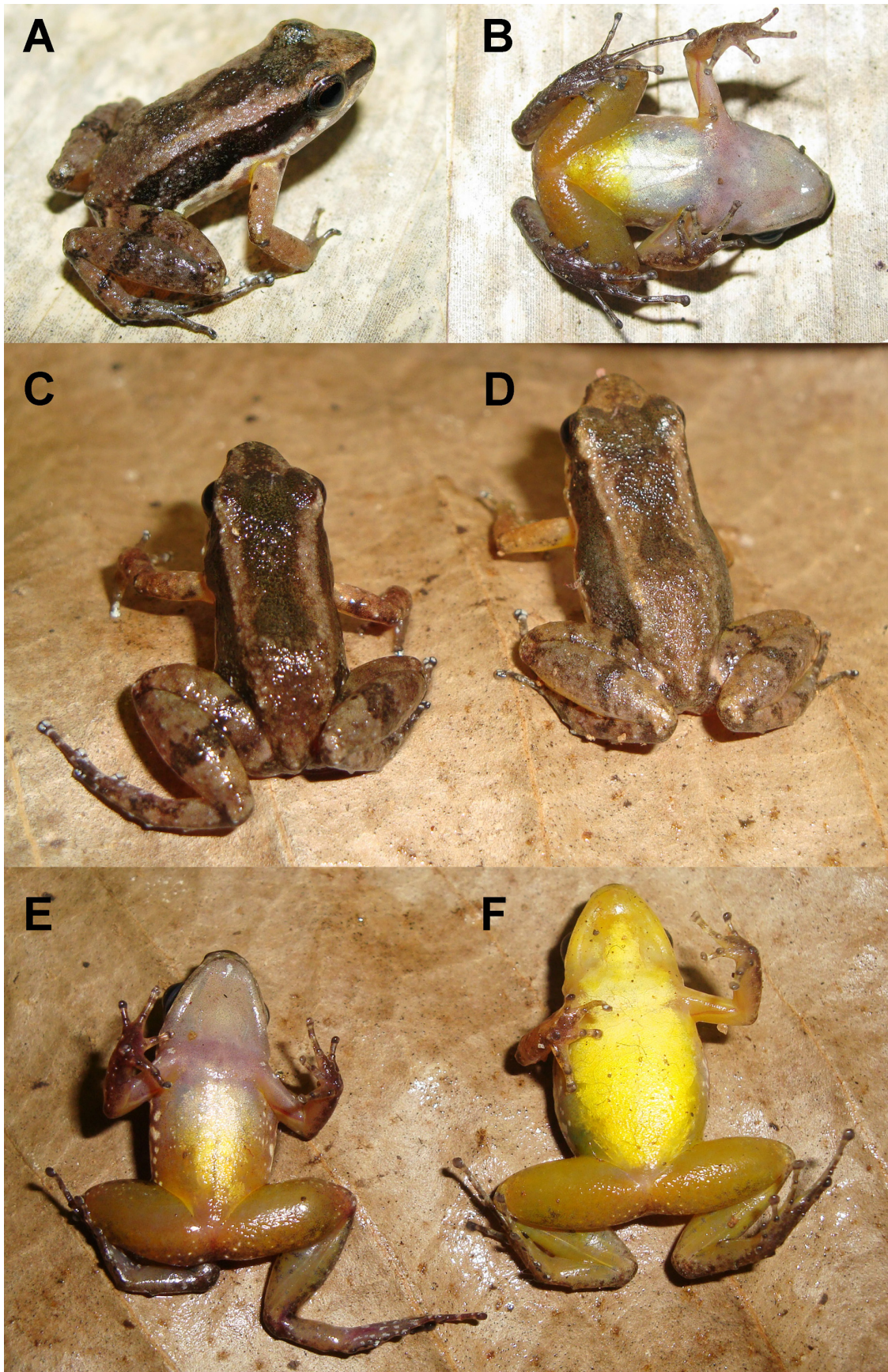


FIGURE 1. *Allobates flaviventris*, in life. (A, B) male specimen, UFAC 4631; (C, E) male, UFAC 4671; and (D, F) female, UFAC 4675. All specimens from the type locality, Fazenda Bonal, Acre, Brazil.



FIGURE 2. Right hand of males *Allobates flaviventris* (UFAC-RB 4669, 4670, 4675 and 4676) showing third finger not swollen (not to scale).



FIGURE 3. Ventral view of hand (left) and foot (right) of holotype of *Allobates flaviventris* (scale bar 5 mm).



FIGURE 4. Ventral view of hand of *Allobates trilineatus* UFAC-RB 4703 showing Finger III swollen (scale bar 5 mm).

Description of holotype. An adult male, 18.1 mm SVL (additional measurements in Table 1), slender body, head width equal to head length, head width 31.4% of SVL; snout blunt, broadly rounded to nearly truncate in dorsal view (Figs. 1C) and acutely rounded in lateral view (Fig. 1A); snout 21.5% of HL; internarial distance 50% of head width, END 1.25 times greater than ED. Nostrils lateral, slightly protuberant, opening posterolateral. Iris tan with black reticulations. Tympanum round, posterolaterally directed; tympanic membrane inconspicuous, tympanic annuli 46.9% of ED. Tongue nearly twice as long as wide, attached anteriorly, fringed along posterior margin; median lingual process absent; vocal sac and vocal slits present; choanae small placed anteriorly; maxillary teeth present.

Skin on dorsum granular, granulation weaker on head than dorsum; skin granular on dorsal surface of legs; skin smooth on ventral surfaces. Dorsolateral stripe absent; ventrolateral stripe diffuse consisting of small spots near upper lip and becoming more intense posterior to tympanum and reaching the groin. Forearm slender, 88.3% of upper arm; ulnar fold absent; finger I longer than finger II when appressed; relative finger length III>I>II>IV (Fig. 3); basal webbing between fingers absent; subarticular tubercle in finger III absent; finger III not swollen; disc width of finger III 0.5 mm (Fig. 3).

Hindlimbs relatively robust; tibia length (49.7%) of SVL; foot length (47.9%) of SVL length. Webbing between toes absent. Relative toe length IV> III> V> II> I (Fig. 2). Toes without fringes; small fold between the first subarticular tubercle of 5th toe and outer metatarsal tubercle. Subarticular tubercles of 3rd toe almost imperceptible (Fig. 3). Outer tarsal tubercle round. Inner tarsal tubercle ovoid; discs of all toes expanded; Discs of all toes expanded except Toe V (slightly enlarged). One subarticular tubercle on Toes I and II; two on Toes III and V; three on Toe IV. Basal subarticular tubercle on Toe IV absent (Figure 3).

Color of adults in life. Color of dorsum usually varies from light grayish brown to brown with pale cream (Fig. 1A, 1C and 1D). Hourglass markings brown, sometimes diffuse, diamond, or triangular, extending from between orbits to sacral region. Surface of upper arm pale cream-tan; upper surfaces of legs light brown with dark brown cross bands on thigh, legs, and feet in many specimens. Adult males with throat violet-gray with evenly dispersed melanophores on vocal sac; chest and belly golden yellow; dark line sometimes present on lower lip; adult female with center part of throat and chest pale yellow; belly cream, yellow, or golden yellow. Lateral and ventral surface of thigh golden yellow; posterior surface of legs and feet light gray, internal surface of the arm

golden yellow. Oblique lateral stripe pale gray to pale brown, forming several diffuse areas extending from groin to middle of body or sometimes insertion of arm; ventrolateral band consists of series of white spots, irregular, elongated, extending from anterior corner of eye to groin. Iris bronze centrally with metallic gold edges with black reticulations; pupil uniform black.

Specimen UFAC-RB 4671 has bad-defined hourglass pattern on the dorsum. The dorsum had a greenish color that formed a continuous design that began in the interorbital region and reached the sacral region, where it became faded. All males have dark spots in the axilla. All specimens have a “W” between the orbits formed by the anterior edge of the hourglass pattern. In some individuals the hourglass pattern is almost imperceptible, but have dorsolateral stripes that bifurcate on the head toward laterally to center forming reentrance that continues as stripes and end in the sacrum. The hourglass shape is observed only with colors in life in these specimens.

Color of adults in preservative. Dorsum light brown with darker brown hourglass pattern that ends at the level of sacrum; lateral portion of body dark chocolate. Dorsal surfaces of the forearm ranging from cream to brown. Throat and chest gray in males and cream in females. The limbs are lighter than body. Forelimbs lighter than hindlimbs. Small dark spots on the knee and elbow. Belly and forelimbs light cream. Dark brown transverse stripe present on the tibia and thighs in all specimens. Lower lip with dark spots in males. Cloacal area dark chocolate in all males, and sometimes restricted to inferior portion in any females (UFAC-RB 4649, 4675). White ventrolateral stripe diffuse in males, absent in females. Oblique lateral stripe present in all females, most perceptible in lighter specimens.

Variation in the type series: In preservative, specimens UFAC-RB 4601, 4671, 4664 and 4650 have a nearly uniform brown dorsum except for a slight darkening in the central region of the back where the hourglass pattern is present in live specimens. Specimens UFAC-RB 4665, 4632, 4659, 4675, 4678, 4669, 4657, 4670, 4635, 4649, 4631 and 4663 have light cream stripes on the body. All examined males of new species show third finger not swollen (see Fig. 2). Specimens UFAC-RB 4666, 4600, 4634, 4677, 4632, 4658 and 4670 have the typical hourglass pattern. Sexual dimorphism is present in many characters with females slightly larger than males [Table 3 ($t = 5.22$, $df = 28$, $P = 0.000015$)]. Average female SVL is 1.4 mm greater than male SVL, and females have relatively wider heads [head wider than long; male HW 31.1% of SVL in males, 31.4% of SVL in females ($t = 5.09$, $df = 28$, $P = 0.000021$) see Table 2]. Snout blunt, broadly rounded to nearly truncate in dorsal view and acutely rounded in lateral view, extending past lower jaw (Figs. 1B and 1E). Male SL 54.2% and female END 55.3% of HL; IND in males 45.5% and females 43.7% of HW; END in males 53.1% and in females 73% of HW; tympanic membrane inconspicuous, round, TYM 45% of ED in both sexes.

Advertisement call. Call description is based on three recordings (two of the holotype UFAC-RB 4650, recorded 7 minutes apart from each other; and one of a paratype UFAC-RB 4678). The call of *Allobates flaviventris* consists of groups of 2–10 notes separated by irregular intervals, both between notes in the same call (0.034–0.250 s), and between calls (0.2–11.4 s). Call rate varied among the three recordings from 18 to 37 calls / min. Although our observations in the field suggest a difference between warm-up calls and “regular” calls, at least in some individuals, it is difficult to ascertain differences in these calls. Two recordings of the same individual (UFAC-RB 4650; taken 7 minutes apart) show conflicting evidence on whether the calls are consistently emitted in bouts or if they are emitted sporadically. The first recording (UFAC-RB 4650-A) show calls were emitted with irregular intervals, while the second recording (UFAC-RB 4650-B) shows well structured bouts (Fig. 5) with two bouts consisting of warm-up calls with fewer notes (2–4 notes) and several “regular” calls (4–6 notes). Duration of bouts was respectively 19.4 s and 17.0 s for the first and second recorded bouts. UFAC-RB 4678 does not show evident bouts (although it is a very short recording, 22 s total).

The call of a specimen from Catuaba (not collected) also showed a clear bout structure, with two bouts, 14.8 and 13.2 s of duration. Different from what was observed in the other recordings, most calls (96.3%) have only two notes, whereas the other calls have either three or four notes.

Since most calls are apparently unstructured regarding bouts, summary statistics (Fig. 5) for the calls are all calculated as if there is no bout structure. This certainly affected temporal parameters such as interval between calls, but was judged to be the best fit for the data in hand. Additional calls recorded for longer intervals will help clarify this issue. Spectral parameters show some variation among and within individuals, with dominant frequency values ranging from 3617.6–4651.2 Hz. A large number of harmonics are detectable in the two recordings of the holotype (UFAC-RB 4650; up to 9 harmonics) but fewer are detectable in UFAC-RB 4678 (up to 6 harmonics). Dominant frequency varied from 3617.6–4651.2 Hz. In the two recordings of UFAC-RB 4650 the dominant

frequency is not the fundamental frequency, whereas the same pattern was not detected in UFAC-RB 4678. Summary of acoustic parameters are given in Fig. 5. See also additional detail in Amézquita *et al.* (2006) [Fig. 3 p. 1878] who comments on the call of the species, labeled there as *Colostethus* sp. 4.

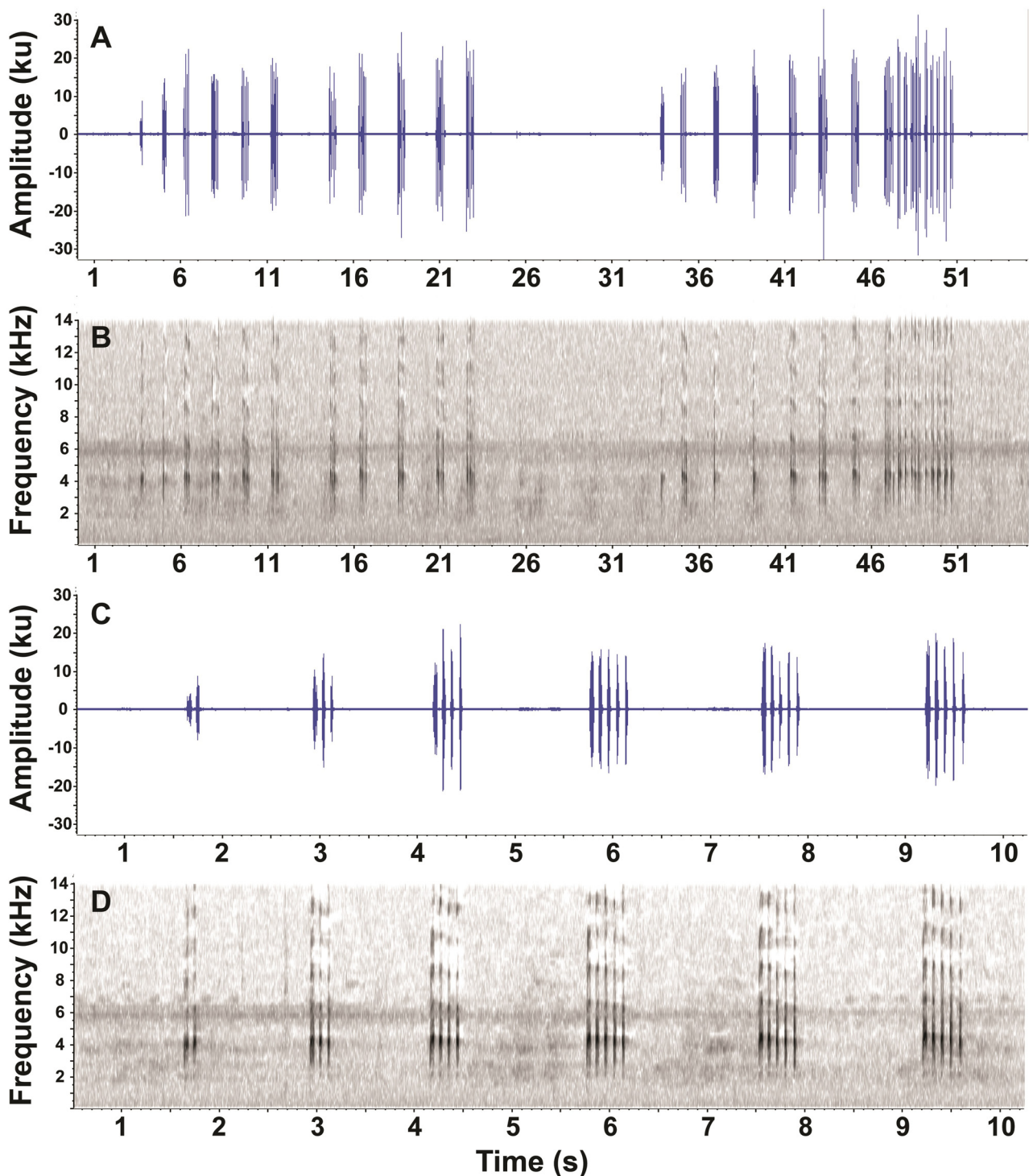


FIGURE 5. Advertisement call of *Allobates flaviventris* from Fazenda Bonal, Acre, Brazil (UFAC 4650, holotype). (A, B) Waveform and spectrogram, respectively, of two bouts. (C, D) Waveform and spectrogram, respectively, of a single bout, evidencing multi-pulsed notes.

Etymology. From the Latin *flavo* meaning yellow and *ventris* meaning ventral surface or belly. The specific name refers to the golden-yellow bellies in both sexes.

Natural history. *Allobates flaviventris* inhabits open forest with bamboo near streams. Similar to other

Allobates in the region, individuals are most active early in the morning and late afternoon. Males usually call between 0630–0930 h, and again from 1630 h until dusk (GMT-5h). On cloudy days, the males can be heard calling throughout the day. The males usually call from leaf litter on the forest floor (Fig. 6), or sometimes elevated a few centimeters from the ground. Vocalization and reproductive activity occur throughout the rainy season. At the type locality and vicinities, the rainy season extends from November to May with annual average precipitation of 2000 mm.

During sampling at the type locality a single clutch containing 13 embryos surrounded by transparent gelatinous capsules was found on the forest floor in high humidity conditions (Fig. 6) into ferns patches. A calling male inspected the clutch, suggesting multiple mating during the breeding season. At FEC we found a male with seven tadpoles on its back (also in a moist place). This species uses small ponds on the forest floor for tadpole deposition, sometimes these ponds has connectivity with streams One of us (PRMS) checked husks of Brazil nuts for tadpoles, but they were not found. In the FEC site, husks of Brazil nuts are used by *Allobates hodli*, *Ameerega hahneli*, and *A. trivittata* for tadpole deposition.

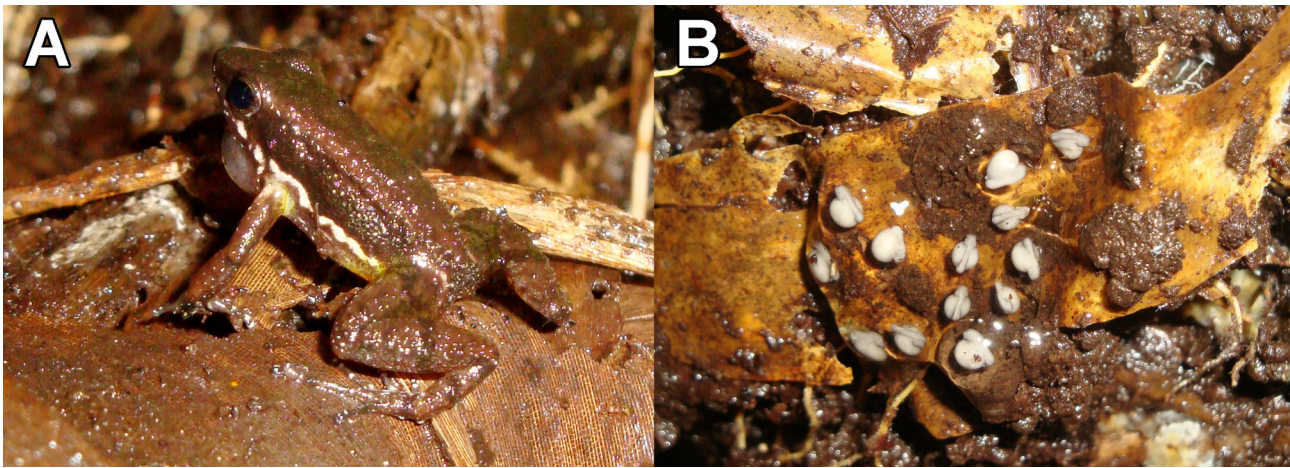


FIGURE 6. Reproductive behavior of *Allobates flaviventris*. (A) Calling male, UFAC 4658 (note the presence of dark throat), and (B) gelatinous egg mass attached to fallen leaves in the forest floor at Fazenda Bonal, Acre, Brazil.

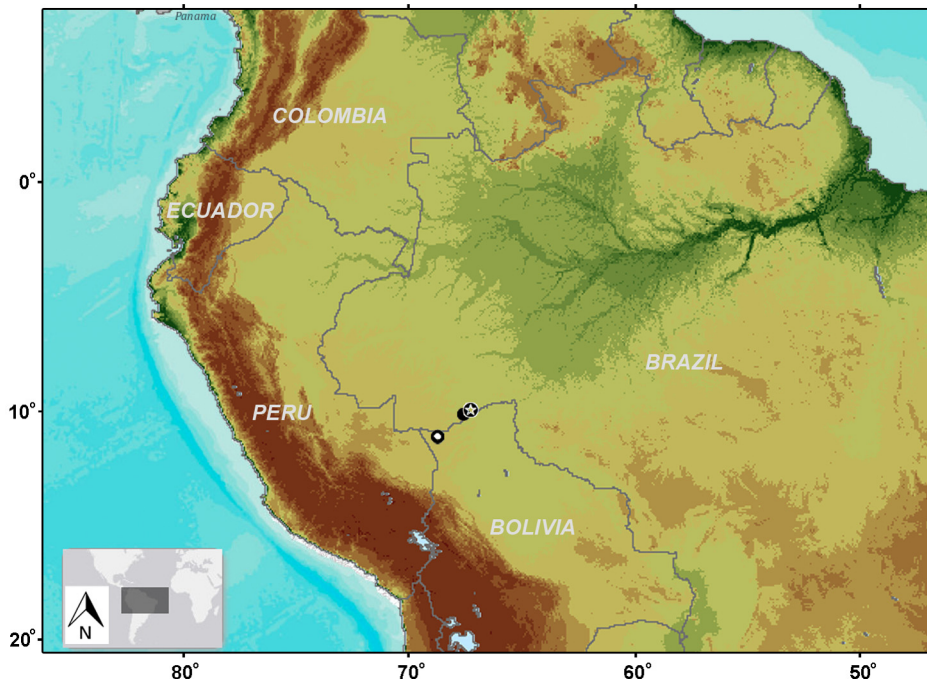


FIGURE 7. Distribution of *Allobates flaviventris*. Star = type locality of *A. flaviventris*. Closed circle = Fazenda Experimental Catuaba. Open circle = literature record of *A. flaviventris* (as *Allobates* sp. A; Köhler & Lötters 1999).

Distribution. *Allobates flaviventris* is known from southwestern Amazonia (see Fig. 7), in the states of Acre and Amazonas, Brazil. The northern limit reach the basin of Purus River near Boca do Acre city, state of Amazonas. The site of the westernmost occurrence of *A. flaviventris* is located near the city of Rio Branco, Acre, ca. 5 km on BR-364 highway (10° 00' 58" S, 67° 44' 05" W). The species is known to occur on the both banks of the Iquiri River. Thus, this river does not represent a barrier to the distribution of this species. Therefore, the distribution of this species may extend south to Departamento Pando in Bolivia. Köhler & Lötters (1999 p. 264) noted the occurrence of this unnamed species, (= *Colostethus* sp. A) in the region of Cobija, Bolivia, near the border with Brazil. The morphological features of the species in that area are similar to those found for the populations described here. The habitat used and call parameters reported by Köhler and Lötters (4450 Hz, 36.7 ms intervals) are similar to those found by us (see call analysis) and their photograph is assignable to *Allobates flaviventris* by lack ventrolateral stripes, having white marks instead, and by having dorsolateral stripes in hourglass pattern.

Discussion

Taxonomy of *Allobates* is challenging and problematic in many aspects. The lack of reliable diagnostic features in adults and standardized descriptions of calls certainly does not help the cause. Several species of *Allobates* are indistinguishable morphologically and descriptions of advertisement calls are, in many cases, not accurate or directly comparable with other descriptions (Tsuji-Nishikido *et al.* 2012). However, good morphological descriptions still are needed (e.g. Barrio-Amorós *et al.* 2006; Barrio-Amorós & Santos 2009; Anganoy-Criollo 2012). Reproductive behavior, color in life, and larval characteristics are useful tools used by *Allobates* taxonomists to help in species diagnosis and identification. We present a series of characters useful to diagnose *Allobates flaviventris* from the remaining Amazonian congeners, but acknowledge the lack of detailed ecological description and limitations in the description of potential morphological and acoustic variation (we are constrained by sample size). Even extra-amazonian species can be easily distinguishable to *A. flaviventris* (e.g. Verdade & Rodrigues 2007 for Atlantic Forest species and Anganoy-Criollo 2012 for Serrania de Perijá) with morphological data presented here.

Morales (2000 "2002") described 11 new species based only on morphology for diagnosis; no data on calls was presented, and the tadpoles of many of those species remain unknown (Lima *et al.* 2012; Simões & Lima 2012). On top of that, descriptions are not much detailed and several important features neglected. This makes comparisons with the species described by Morales, difficult if based solely on the literature. We have examined several of the types described by Morales (see appendix) to attenuate the effects of that.

The lack of detailed knowledge on taxonomy and geographical distribution of many species of *Allobates* is a serious impediment to an adequate assessment of species's conservation status (Angulo & Icochea 2010; Peloso 2010; Barrio-Amorós & Santos 2011; Simões *et al.* 2013). By demonstrating that the populations from Acre, herein named as a new species, are in fact distinct from *A. marchesianus* which is thought to have a widespread distribution we only strengthen this point of view. *Allobates flaviventris* occurs in areas of legal reserve and settlement projects and in one research area of the Universidade Federal do Acre, making it in some ways protected from habitat loss. However, given the limited number of locations studied, we suggest allocating the species in the category Data Deficient (DD) of the International Union for Conservation of Nature (2012). The recent discovery of several unnamed and recognition of hidden lineages within the Amazon Basin species shows that we are still far from understanding the biogeographic patterns of the region.

Acknowledgments

Roy McDiarmid and Ron Heyer (USNM) provided access to specimens under their care, and working space for PLVP during a visit to the USNM collection. We are grateful to W.E. Duellman for help in choosing the specific epithet. Evan Twomey, Miguel Vences, Cesar Luis Barrio-Amorós and two anonymous reviewers provided comments on earlier versions of the manuscript. We thank João Tucano and Francisco Brito (Chico) and their families for their collaboration during observations at Fazenda Bonal; Talisson Ruy Batista da Silva, Bruno Luiz Alencar de Souza Melo, Jailini da Silva Araújo, and Thays de Andrade Farias for field assistance; Auristo da

Conceição Melo for invaluable companionship and help in the field. PLVP is supported by fellowships from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior / Fulbright Commission (CAPES/IE, process number BEX 2806/09-6) and the Richard Gilder Graduate School at the American Museum of Natural History.

References

- Anganoy-Criollo, M. (2012) A new species of *Allobates* (Anura, Dendrobatidae) from the western flank of the Serranía de Perijá, Colombia. *Zootaxa*, 3308, 49–62.
- Amézquita, A., Hödl, W., Lima, A.P., Castellanos, L., Erdtmann, L. & Araújo, M.C. (2006) Masking interference and the evolution of the acoustic communication system in the amazonian dendrobatid frog *Allobates femoralis*. *Evolution*, 60, 1874–1887.
<http://dx.doi.org/10.1111/j.0014-3820.2006.tb00531.x>
- Angulo, A. & Icochea, J. (2010) Cryptic species complexes, widespread species and conservation: lessons from Amazonian frogs of the *Leptodactylus marmoratus* group (Anura: Leptodactylidae). *Systematics and Biodiversity*, 8, 357–370.
<http://dx.doi.org/10.1080/14772000.2010.507264>
- Barrio-Amorós, C.L., Rivas, G. & Kaiser, H. (2006) New species of *Colostethus* (Anura, Dendrobatidae) from the Península de Paria, Venezuela. *Journal of Herpetology*, 40, 371–377.
[http://dx.doi.org/10.1670/0022-1511\(2006\)40\[371:nsocad\]2.0.co;2](http://dx.doi.org/10.1670/0022-1511(2006)40[371:nsocad]2.0.co;2)
- Barrio-Amorós, C.L. & Santos, J.C. (2009) Description of a new *Allobates* (Anura, Dendrobatidae) from the eastern Andean piedmont, Venezuela. *Phyllomedusa*, 8, 89–104.
- Barrio-Amorós, C.L. & Santos, J.C. (2011) Redescription and generic assignation of *Dendrobates rufulus* Gorzula, 1990 (Anura: Dendrobatidae) from the Chimantá Massif, Venezuela. *Salamandra*, 47, 155–160.
- Caldwell, J.P., Lima, A.P. & Keller, C. (2002a) Redescription of *Colostethus marchesianus* (Melin, 1941) from its type locality. *Copeia*, 2002, 157–165.
[http://dx.doi.org/10.1643/0045-8511\(2002\)002\[0157:rocmmf\]2.0.co;2](http://dx.doi.org/10.1643/0045-8511(2002)002[0157:rocmmf]2.0.co;2)
- Caldwell, J.P., Lima, A.P. & Biavati, G.M. (2002b) Descriptions of tadpoles of *Colostethus marchesianus* and *Colostethus caeruleodactylus* (Anura: Dendrobatidae) from their type localities. *Copeia*, 2002, 166–172.
[http://dx.doi.org/10.1643/0045-8511\(2002\)002\[0166:dotocm\]2.0.co;2](http://dx.doi.org/10.1643/0045-8511(2002)002[0166:dotocm]2.0.co;2)
- Caldwell, J.P. & Araújo, M.C. (2005) Amphibian faunas of two eastern Amazonian rainforest sites in Pará, Brazil. *Occasional Papers of the Sam Noble Oklahoma Museum of Natural History*, 16, 1–41.
- Cardoso, A.J. & Souza, M.B. (1996) Distribuição temporal e espacial de anfíbios anuros no Seringal Catuaba, Estado do Acre-Brasil. In: Perfaus, J.E. (Ed.), *Herpetological Neotropical*. Venezuela, Universidade dos Andes, Actas 2º Congresso Latino Americano de Herpetologia. pp. 271–292.
- Charif, R.A., Waack, A.M. & Strickman, L.M. (2008) *Raven Pro 1.3 User's Manual*. Ithaca, New York. 313 pp.
- Duellman, W.E. (2004) Frogs of genus *Colostethus* (Anura: Dendrobatidae) in the Andes of Northern Peru. *Scientific Papers Natural History Museum University of Kansas*, 35, 1–49.
<http://dx.doi.org/10.5962/bhl.title.8467>
- Frost, D.R. (2013) Amphibian Species of the World: an Online Reference. Version 5.6 (09 January, 2013). American Museum of Natural History, New York, USA. Electronic Database. Available from: <http://research.amnh.org/vz/herpetology/amphibia/> (Accessed 14 May 2013)
- Grant, T. & Rodríguez, L.O. (2001) Two new species of frogs of the genus *Colostethus* (Dendrobatidae) from Peru and a redescription of *C. trilineatus* (Boulenger, 1883). *American Museum Novitates*, 3355, 1–24.
[http://dx.doi.org/10.1206/0003-0082\(2001\)355<0001:tnsofo>2.0.co;2](http://dx.doi.org/10.1206/0003-0082(2001)355<0001:tnsofo>2.0.co;2)
- Grant, T., Frost, D.F., Caldwell, J.P., Gagliardo, R., Haddad, C.F.B., Kok, P.J.R., Means, B.D., Noonan, B.P., Schargel, W. & Wheeler, W.C. (2006) Phylogenetic systematics of dart-poison frogs and their relatives (Anura: Athesphatanura: Dendrobatidae). *Bulletin of the American Museum of Natural History*, 299, 1–262.
[http://dx.doi.org/10.1206/0003-0090\(2006\)299\[1:psodfa\]2.0.co;2](http://dx.doi.org/10.1206/0003-0090(2006)299[1:psodfa]2.0.co;2)
- IUCN (2012) The IUCN Red List of Threatened Species. Version 2012.2. Available from: <http://www.iucnredlist.org> (Accessed 25 May 2013)
- Köhler, J. & Lötters, S. (1999) Annotated list of amphibian records from the Departamento Pando, Bolivia, with description of some advertisement calls. *Bonner Zoologische Beiträge*, 48, 259–273.
- Lima, A.P., Sanchez, D.E.A. & Souza, J.R.D. (2007) A new Amazonian species of the frog genus *Colostethus* (Dendrobatidae) that lays its eggs on undersides of leaves. *Copeia*, 2007, 114–122.
[http://dx.doi.org/10.1643/0045-8511\(2007\)7\[114:anasot\]2.0.co;2](http://dx.doi.org/10.1643/0045-8511(2007)7[114:anasot]2.0.co;2)
- Lima, A.P., Caldwell, J.P. & Strussmann, C. (2009) Redescription of *Allobates brunneus* (Cope) 1887 (Anura: Aromobatidae: Allobatinae), with a description of the tadpole, call, and reproductive behavior. *Zootaxa*, 1988, 1–16.
- Lima, A.P., Caldwell, J.P., Biavati, G. & Montanarin, A. (2010) A new species of *Allobates* (Anura: Aromobatidae) from Paleovárzea Forest in Amazonas, Brazil. *Zootaxa*, 2337, 1–17.

- Lima, A.P., Erdtmann, L.K. & Amézquita, A. (2012) Advertisement call and colour in life of *Allobates crombiei* (Morales) “2000” [2002] (Anura: Aromobatidae) from the type Locality (Cachoeira do Espelho), Xingu River, Brazil. *Zootaxa*, 3475, 86–88.
- Morales, V.R. (1994) Taxonomía de algunos *Colostethus* (Anura: Dendrobatidae) de Sudamérica, con descripción de dos especies nuevas. *Revista Española de Herpetología*, 8, 95–103.
- Morales, V.R. (2000 “2002”) Sistemática y biogeografía del grupo *trilineatus* (Amphibia, Anura, Dendrobatidae, *Colostethus*), con descripción de once nuevas especies. *Publicaciones de la Asociación de Amigos Doñana*, 13, 1–59.
- Peloso, P.L.V. (2010) A safe place for amphibians? A cautionary tale on the taxonomy and conservation of frogs, caecilians, and salamanders in the Brazilian Amazonia. *Zoologia*, 27, 667–673.
<http://dx.doi.org/10.1590/s1984-46702010000500001>
- Segalla, M.V., Caramaschi, U., Cruz, C.A.G., Garcia, P.C.A., Grant, T., Haddad, C.F.B & Langone, J.A. (2012) Brazilian amphibians – List of species. Sociedade Brasileira de Herpetologia. Available from: <http://www.sbherpetologia.org.br> (accessed 23 August 2012)
- Simões, P.I., Lima, A.P. & Farias, I.P. (2010) The description of a cryptic species related to the pan-Amazonian frog *Allobates femoralis* (Boulenger 1883) (Anura: Aromobatidae). *Zootaxa*, 2406, 1–28.
- Simões, P.I. & Lima, A.P. (2012) The tadpole of *Allobates sumtuosus* (Morales, ‘2000’ 2002) (Anura: Aromobatidae) from its type locality at Reserva Biológica do Rio Trombetas, Pará, Brazil. *Zootaxa*, 3499, 86–88.
- Simões, P.I., Sturaro, M.J., Peloso, P.L.V. & Lima, A.P. (2013) A new diminutive species of *Allobates* Zimmermann and Zimmermann, 1988 (Anura, Aromobatidae) from the northwestern Rio Madeira—Rio Tapajós interfluvium, Amazonas, Brazil. *Zootaxa*, 3609 (3), 251–273.
<http://dx.doi.org/10.11646/zootaxa.3609.3.1>
- Souza, V.M., Souza, M.B. & Morato, E.F. (2008) Efeitos da sucessão florestal sobre a anurofauna (Amphibia: Anura) da Reserva Catuaba e seu entorno, Acre, Amazônia sul-ocidental. *Revista Brasileira de Zoologia*, 25, 49–57.
<http://dx.doi.org/10.1590/s0101-81752008000100008>
- Souza, M.B. (2009) *Anfibios: Reserva Extrativista do Alto Juruá e Parque Nacional da Serra do Divisor, Acre*. IFCH, Campinas, 77 pp. + 32 il.
- Tsuji-Nishikido, B.M., Kaefer, I.L., Freitas, F.C., Menin, M. & Lima, A.P. (2012) Significant but not diagnostic: Differentiation through morphology and calls in the Amazonian frogs *Allobates nidicola* and *A. masniger*. *Herpetological Journal*, 22, 105–114.
- Verdade, V.K. & Rodrigues, M.T. (2007) Taxonomic review of *Allobates* (Anura, Aromobatidae) from the Atlantic Forest, Brazil. *Journal of Herpetology*, 41, 566–580.
<http://dx.doi.org/10.1670/06-094.1>

APPENDIX I. Examined specimens.

Allobates alessandroi: AMNH 157004 Paratype. Paucartambo, Cusco, Peru. *Allobates flaviventris*: UFAC-RB 0159–0167, 0349, 0401, 0520–0521, 0524, 0535, 0567: Fazenda Experimental Catuaba, Senador Guiomard, Acre. UFAC-RB 4627: BR-317 km 38 (Bode Preto), Boca do Acre, Amazonas. *Allobates grillisimilis*: Paratypes MPEG 28535–28536, 28538, 28540–28541, 28543, 28545. Floresta Nacional de Pau-Rosa, Municipality of Maués, Amazonas, Brazil. *Allobates masniger*: USNM 303585. Holotype: Itaituba, 75 km SW near of Parque Nacional da Amazônia Rio Tapajós, Estado do Pará, Brasil. Paratypes 303584, 303587, 303589–303590 Itaituba, between 65 and 66 km SW near of Parque Nacional da Amazônia Rio Tapajós, Estado do Pará, Brasil. *Allobates marchesianus*: UFAC-RB 4181. Topotype: Missão Taracua, Amazonas, Brasil. UFAC-RB 4812: São Gabriel da Cachoeira, Amazonas, Brasil (near type locality). *Allobates mcdiarmidi*: USNM 257805 Approximately 0.25 km E road to San Onofre, at a point 3.3 km by road N of the road from Cochabamba to Villa Tunari, at a point 97.5 km from Cochabamba, Chapare Province, Department of Cochabamba, Bolivia. Paratypes: USNM 257804, 257806 (same data of Holotype). *Allobates sumtuosus*: USNM 303591 Holotype: Igarapé Jacaré, Reserva Biológica Rio Trombetas, Pará, Brasil. 303592–303593. Paratypes (same data of holotype). *Allobates subfolionidificans*: UFAC-RB 4616–4617, 4682–4683, 4700–4701 Parque Zoobotânico of Universidade Federal do Acre (type locality). *Allobates* aff. *trilineatus* UFAC-RB 4703 Sena Madureira, Bairro Segundo Distrito, margem direita do Rio Iaco, UFAC-RB 5203 Parque Zoobotânico of Universidade Federal do Acre.