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## Two new endangered species of *Anomaloglossus* (Anura: Aromobatidae) from Roraima State, northern Brazil

ANTOINE FOUQUET<sup>1,2,8</sup>, SERGIO MARQUES SOUZA<sup>2</sup>, PEDRO M. SALES NUNES<sup>2,3</sup>,  
PHILIPPE J. R. KOK<sup>4,5</sup>, FELIPE FRANCO CURCIO<sup>2,6</sup>, CELSO MORATO DE CARVALHO<sup>7</sup>,  
TARAN GRANT<sup>2</sup> & MIGUEL TREFAUT RODRIGUES<sup>2</sup>

<sup>1</sup>CNRS Guyane USR3456, Immeuble Le Relais, 2 Avenue Gustave Charlery, 97300, Cayenne, French Guiana

<sup>2</sup>Universidade de São Paulo, Instituto de Biociências, Departamento de Zoologia, Caixa Postal 11.461, CEP 05508-090, São Paulo, SP, Brazil

<sup>3</sup>Universidade Federal de Pernambuco, Centro de Ciências Biológicas, Departamento de Zoologia, Av. Professor Moraes Rego, s/n. Cidade Universitária CEP 50670-901, Recife, PE, Brazil

<sup>4</sup>Biology Department, Amphibian Evolution Lab, Vrije Universiteit Brussel, 2 Pleinlaan, B- 1050 Brussels, Belgium

<sup>5</sup>Department of Recent Vertebrates, Royal Belgian Institute of Natural Sciences, 29 rue Vautier, B- 1000 Brussels, Belgium

<sup>6</sup>Universidade Federal de Mato Grosso, Instituto de Biociências, Departamento de Biologia e Zoologia, CEP 78060-900, Cuiaba MT, Brazil

<sup>7</sup>INPA Núcleo de Pesquisas de Roraima (INPA/NPRR), Rua Coronel Pinto 315 – Centro, 69301-970, Boa Vista, RR, Brazil

<sup>8</sup>Corresponding author. E-mail: [fouquet.antoine@gmail.com](mailto:fouquet.antoine@gmail.com)

### Abstract

We describe two new species of *Anomaloglossus* from Roraima State, Brazil, that are likely endemic to single mountains currently isolated among lowland forest and savanna ecosystems. The first species, *Anomaloglossus tepequem* **sp. nov.** was collected in 1986 and 1992 along a single stream at >500 m elevation on a tepui-like mountain named Tepequém, but was not detected during recent investigations. It is mainly diagnosed from other *Anomaloglossus* species by its well developed foot webbing, immaculate cream abdomen colouration and small body size (males: 18.2–20.1 mm, females: 21.7–24.5). The second species, *Anomaloglossus apiaú* **sp. nov.** was found along several streams between 500 and 1400 m elevation on Serra do Apiaú, and is mainly diagnosed from congeners by its weakly webbed feet, males with swollen third finger and ventrolateral stripe formed by white dots, and its advertisement call; a long trill (up to almost 40 s) consisting of pairs of very short pulses. The discovery of these two apparently microendemic species suggests that additional *Anomaloglossus* species remain to be described in the Guiana Shield. Both species should be considered critically endangered given their seemingly reduced range size, association with highland habitat, and the anthropogenic pressure they currently face.

**Key words:** Amazonia, Amphibia, conservation, endemic, Guiana shield, taxonomy

### Resumo

Descrevemos aqui duas novas espécies de *Anomaloglossus* para o estado de Roraima, Brasil, provavelmente endêmicas de serras isoladas por florestas de baixada e ecossistemas savânicos. A primeira espécie, *Anomaloglossus tepequem* **sp. nov.** foi coletada na Serra do Tepequém entre 1986 e 1992 ao longo de um curso de água situado a >500 m de altitude, mas não foi registrada em trabalho de campo recente na mesma localidade. Esta nova espécie se distingue dos outros congêneres por apresentar membrana interdigital desenvolvida, abdomen de cor creme e imaculado, e tamanho pequeno (machos: 18.2–20.1 mm, fêmeas: 21.7–24.5). A segunda espécie, *Anomaloglossus apiaú* **sp. nov.** foi encontrada ao longo de diversos cursos de água entre 500 e 1400 m de altitude na Serra do Apiaú, e se distingue de seus congêneres por sua membrana interdigital pouco desenvolvida, machos com terceiro artelho volumoso faixa ventrolateral formada por pontos brancos, e por seu canto de anúncio um longo trinado (que pode chegar até 40 s) constituído de pares de pulsos muito curtos. A descoberta dessas duas espécies aparentemente microendêmicas sugere que outras espécies de *Anomaloglossus*

ainda restam por ser descritas no Escudo das Guianas. As duas espécies devem ser consideradas como criticamente ameaçadas, face à aparente distribuição restrita, associação com habitats de altitude e pressão antrópica que enfrentam.

**Palavras chaves:** Amazônia, Amphibia, conservação, endêmico, Escudo guianense, taxonomia

## Introduction

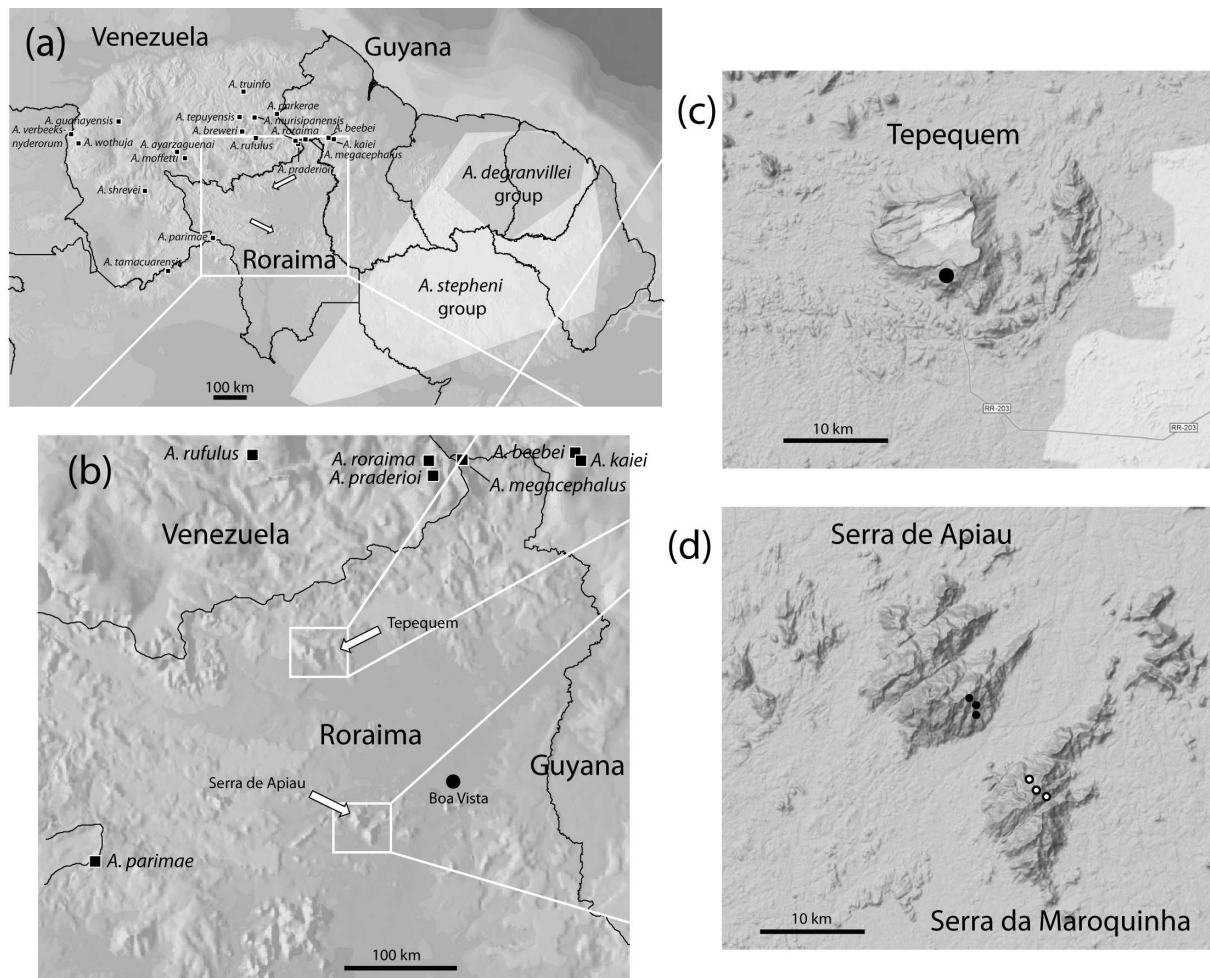
In recent decades amphibian declines have become a major concern and remain at the forefront of a global biodiversity crisis (Stuart *et al.* 2004; Wake & Vredenburg 2008). The main causes of this decline are habitat destruction (Laurance 2007; Laurance *et al.* 2012; da Silva *et al.* 2005), worldwide disease outbreaks (Pounds *et al.* 2006; Rodriguez *et al.* 2014) and the effects of climate change (Foden *et al.* 2013; Rull & Vegas-Vilarrúbia 2006). Some taxonomic groups and habitats appear to be more prone to rapid declines. This is particularly true for stream-associated frogs in the Andes and Central America (*e.g.*, *Atelopus*: La Marca 1996; *Hyloxalus*: Coloma 1995), Australian wet tropics (*e.g.*, *Rheobatrachus* and *Taudactylus*: Schloegel *et al.* 2006) or the Atlantic Forest (*e.g.*, *Cycloramphus*: Verdade *et al.* 2011). In tropical regions, this decline is often accompanied by a dearth of basic biological information on the biology and distribution of species, a factor which is further exasperated by increasing rate of species descriptions (Giam *et al.* 2012; Köhler *et al.* 2005), and a plethora of studies reveal large numbers of undescribed cryptic species (*e.g.* Fouquet *et al.* 2007; Funk *et al.* 2012; Gehara *et al.* 2014). Therefore, one can expect that many species will disappear, or have already disappeared, before the detection of their existence.

*Anomaloglossus* was erected by Grant *et al.* (2006) for the species of dendrobatoids that possess a median lingual process. Twenty-four nominal species of these diurnal, Neotropical frogs are endemic to the Guiana Shield (hereafter GS, area *sensu* Señaris & MacCulloch 2005) and are mostly associated with streams, uplands, and highlands. Five additional species that occur in the Chocó region from Ecuador to Panama are still provisionally placed in the genus but are not closely related to the *Anomaloglossus* of the Guiana Shield (Grant unpubl. data). Among the GS species, the majority of the nominal species (19) are found in the Pantepui region (*sensu* Kok 2013) and a few species (5) exist in the lowlands of the eastern GS. However, several undescribed species, based on molecular data, have been discovered in the GS lowlands and in the Pantepui region (Fouquet *et al.* 2012; Kok *et al.* 2012). As several species appear to be geographically restricted or microendemic—*i.e.* restricted to the upper parts of single mountain massifs—we can hypothesize that many other remain to be discovered in relatively unexplored regions of the GS.

Roraima State, in northern Brazil, is one of these poorly explored areas. It lies at the southeastern periphery of the Pantepui region but comprises mostly lowland habitats. These lowlands are heterogeneous, mainly composed of savannas (locally known as “lavrados”) and lowland rainforests, which are juxtaposed with scattered isolated mountains, often >1000 m in elevation. So far, no *Anomaloglossus* species have been recorded in Roraima State (although several species are known from close areas in Venezuela and Guyana, [Barrio Amorós *et al.* 2010; Kok *et al.* 2013]). A number of specimens collected during explorations of two massifs in the region were identified as belonging to two new species of this genus and are described herein.

## Materials and methods

One of the two new species described here was first collected in 1986 by Márcio Martins, with additional specimens collected in 1992 by Miguel T. Rodrigues, Celso Morato de Carvalho, Dante Pavan, and Gabriel Skuk, at a locality known as Tepequém (3.750866 N, 61.705084 W), a small tepui-like mountain, forested on its slopes and reaching 1100 m elevation (Fig. 1). Nine adults (five females and four males) and six juveniles were collected along a single stream in the upper part of the forested slopes at ~700 m elevation. This mountain is currently isolated by forested lowlands (<200 m elevation) from the core of Pantepui to the north and to the west. Fieldwork undertaken at the same locality in May 2011 by seven herpetologists (including three of the present authors: AF, SMS, MTR) failed to detect this species, whereas specimens were very abundant, easily collected and actively calling during daytime at the same period of the year in 1992 (MTR pers. obs.).



**FIGURE 1.** (a) Distribution map of *Anomaloglossus* species in the Guiana Shield. Type localities are depicted only for the Pantepui species, while for the lowland species we considered convex polygons for the entire species groups. (b) Northern Roraima State showing the areas where the new species were found. (c) Magnified view of Tepequem with the precise locality depicted as a black dot. (d) Magnified view of Serra do Apiaú and Serra da Maroquinha with occurrence localities depicted as black dots and localities without occurrence as white dots.

The second new species was collected in October 2011 and June 2012 at a locality known as Serra do Apiaú (2.430168 N, 61.411715 W), a forested massif reaching >1400 m elevation, also isolated by forested and pastured lowlands (<200 m elevation) from the closest mountains (Fig. 1). The species was found in association with streams running from the highest elevations on the top of the mountain to about 500 m elevation on the slopes. In total, 29 adults were collected (15 females and 14 males). The closest mountain, Serra da Maroquinha, is only separated from Serra do Apiaú by ~4 km of lowlands and was explored in June 2012 by AF, FFC and PMSN, but no *Anomaloglossus* was seen or heard, even though they were active at Serra do Apiaú.

Specimens of both species were encountered by active searching and collected during the day along rocky streams where males were calling. Specimens were anesthetized and killed using lidocaine, fixed in 10% formalin for 5–10 days, transferred to 70% ethanol, and later deposited at the Museu de Zoologia da Universidade de São Paulo (MZUSP). Preserved adult specimens were measured to the nearest 0.1 mm with a digital calliper with the aid of a dissecting microscope. Sex was determined by observation of vocal slits and/or gonads when no obvious sexual dimorphism was detected, or by calling activity before collection. We follow the terminology, diagnostic characters and measurements provided in Caldwell *et al.* (2002), with modifications by Grant & Rodríguez (2001) and Kok *et al.* (2010) to facilitate congeneric comparison. Seventeen standard measurements were recorded: (1) snout–vent length (SVL); (2) forearm length from proximal edge of palmar tubercle to outer edge of flexed elbow (FAL); (3) hand length from proximal edge of palmar tubercle to tip of Finger III (Ha); (4) tibia length from outer

edge of flexed knee to heel (TL); (5) foot length from proximal edge of inner metatarsal tubercle to tip of Toe IV (FL); (6) head width at level of angle of jaws (HW); (7) head length from corner of mouth to tip of snout (HL); (8) horizontal eye diameter (ED); (9) eye to naris distance from anterior edge of eye to centre of naris (EN); (10) internarial distance (IN); (11) snout length from anterior corner of eye to tip of snout (SL); (12) interorbital distance (IO); (13) diameter of tympanum (TYM); (14) width of disc on Finger III (WFD); (15) width of disc on Toe IV (WTD); (16) thigh length from vent opening to flexed knee (ThL); (17) length of Finger I from inner edge of thenar tubercle to tip of disc (1FiL). Webbing formulae follow Myers & Duellman (1982) as improved by Savage & Heyer (1997). Relative lengths of fingers (I–IV) were compared according to Kaplan (1997), using the distance from the proximal edge of the palmar tubercle to the tip of each finger, which in our opinion is the only way to accurately compare that character. Comparisons of external character states are based both on original descriptions and examination of museum specimens, including most type series (see Appendix for additional material examined). Examination of comparative type series sometimes revealed discrepancies (see Kok 2010; Kok *et al.* 2013) between type specimens and original descriptions, therefore our diagnoses may differ from those usually proposed.

Five uncollected calling males were recorded individually at a distance of less than 2 m at air temperature ranging between 21–23°C in Apiaú using an Olympus LS10 digital recorder with a built-in microphone, at a speed of 160 kbps. Recordings (5 min and 45 s total) were analysed at a sampling rate of 44.1 kHz using Raven Lite 1.0 and Audacity 2.0.3. Advertisement calls were not recorded at Tepequém. Temporal variables were measured following Kok & Kalamandeen (2008) and included: call duration, inter-call interval, pulse duration, and pulse rate. The dominant (emphasized) frequency was measured from a spectral slice taken through the portion of the note with the highest amplitude (using Blackman function; frequency resolution = 43 Hz).

## Results

### *Anomaloglossus tepequem* sp. nov.

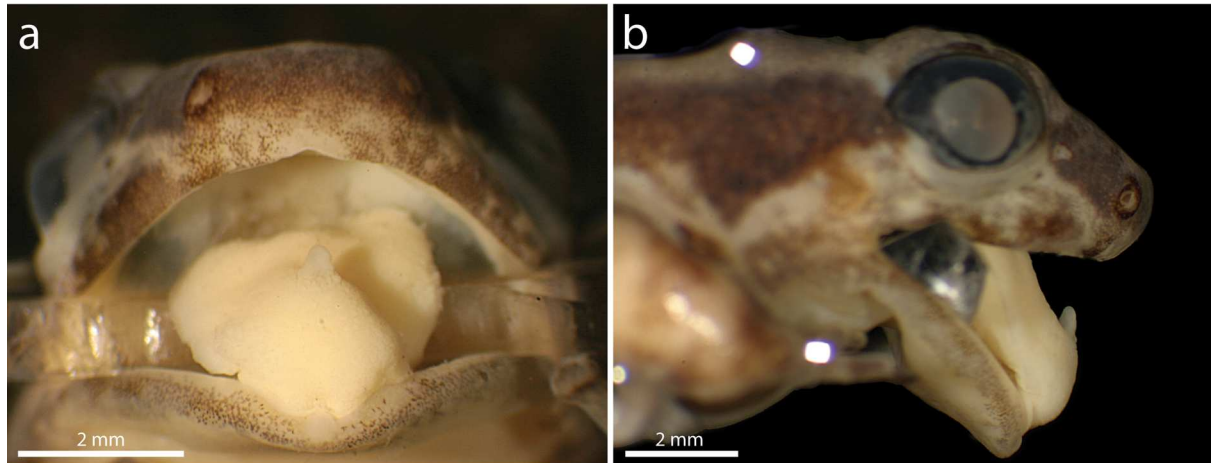
(Figs. 2–4; Table 1)

**Holotype.** MZUSP 63310, an adult female collected by Márcio Martins, 20 July 1986 at ~700 m elevation at Tepequém, Roraima State, Brazil (3.750866 N, 61.705084 W).

**Paratopotypes** (n = 14). MZUSP 63308–09, a female and a male, respectively, collected with the holotype by Márcio Martins. MZUSP 70692–95, 70701, 70703, six males, and MZUSP 70588, 70691, 70696–99, six females, collected by Miguel T. Rodrigues, Celso Morato de Carvalho, Dante Pavan, and Gabriel Skuk, 12 December 1992 (Table 1).

**Etymology.** The specific epithet is a noun in apposition and refers to the type locality (Tepequém, Roraima State, Brazil).

**Adult definition and diagnosis.** (1) medium-sized *Anomaloglossus* (average male SVL = 19.2 mm [18.2–20.1, n = 4], average female SVL = 22.9 mm [21.7–24.5, n = 5]) (Table 1); (2) body robust; (3) skin on dorsum and venter smooth; (4) Finger II appears shorter than I when fingers are appressed, but actually Finger I is slightly shorter than II (4.2 vs. 4.4 mm in holotype) using the method of Kaplan (1997); (5) tip of Finger IV surpassing the base of the distal subarticular tubercle on Finger III when fingers appressed; (6) distal subarticular tubercle on Finger III and IV indistinct; (7) Finger III not swollen in males; (8) fingers with fringes particularly developed on preaxial edges of Fingers II and III; (9) toes moderately webbed, with well developed folded, flapped fringing (*sensu* Myers & Donnelly 2008); (10) tarsal keel well defined, straight or very weakly curved, at most weakly elevated proximally, not forming tubercle; (11) black arm gland in males (*sensu* Grant & Castro 1998, see also Grant *et al.* 2006) and cloacal tubercles absent; (12) pale paracloacal mark present; (13) dorsolateral stripe absent; (15) ventrolateral stripe absent; (16) oblique lateral stripe present, short, extending from inguinal region to approximately mid-flank; (17) sexual dichromatism in throat colour pattern present, throat evenly covered with darker and larger patches in all males and in some females but almost no pigmentation in most females; (18) no sexual dichromatism in abdomen colour pattern, which is immaculate cream; (19) iris with metallic pigmentation and pupil ring; (20) median lingual process (Fig. 2) longer than wide, tapered, bluntly pointed, smooth (non-papillate), reclined in pit; (21) maxillary teeth present, small; (22) testes immaculate white, mature ova small (*ca.* 1 mm) yellowish brown.



**FIGURE 2.** The median lingual process of *Anomaloglossus tepequem* sp. nov. in anterior (a) and lateral (b) views (MZUSP 70691, adult female). Photographs by TG.

**Morphological comparisons with congeneric species.** *Anomaloglossus tepequem* is immediately distinguished from *A. baeobatrachus* (Boistel & de Massary 1999), *A. beebei* (Noble 1923), *A. degranvillei* (Lescure 1975), *A. kaiei* (Kok *et al.* 2006b), *A. leopardus* (Ouboter & Jairam 2012), *A. praderioi* (La Marca 1996), *A. rufulus* (Gorzula 1988), *A. roraima* (La Marca 1996, Kok *et al.* 2013), *A. stepheni* (Martins 1989), and *A. surinamensis* (Ouboter & Jairam 2012) in having moderate toe webbing (toe webbing absent or basal in the aforementioned species).

*Anomaloglossus tepequem* can be distinguished from *A. breweri* (Barrio-Amorós 2006), *A. murisipanensis* (La Marca 1996), *A. parimae* (La Marca 1996), *A. parkerae* (Meinhardt & Parmelee 1996), *A. tamacuarensis* (Myers & Donnelly 1997), *A. tepuyensis* (La Marca 1996), *A. triunfo* (Barrio-Amorós *et al.* 2004), *A. verbeeksnyderorum* (Barrio-Amorós *et al.* 2010), and *A. wothuja* (Barrio-Amorós *et al.* 2004) in having distinctly more developed toe webbing, particularly between Toes IV–V, with the webbing surpassing the distal subarticular tubercle on Toe V (toe webbing never surpasses the distal subarticular tubercle on Toe V in the aforementioned species).

*Anomaloglossus tepequem* can be distinguished from *A. ayarzaguenai* (La Marca 1996), *A. guanayensis* (La Marca 1996), and *A. moffetti* (Barrio-Amorós & Brewer-Carias 2008) by having less extensive toe webbing, especially between Toes I–III, and in always having an immaculate cream abdomen colouration in both sexes (at least covered by small melanophores, which sometimes form spots or even extensive marbling in *A. ayarzaguenai*, *A. guanayensis*, and *A. moffetti*).

*Anomaloglossus tepequem* mainly differs from *A. megacephalus* (Kok *et al.* 2010) by its smaller size (maximum SVL = 24.5 mm in *A. tepequem* vs. 28.3 mm in *A. megacephalus*), a relative shorter head (HW 108% of HL in *A. tepequem* vs. 90% in *A. megacephalus*), and in having an unpigmented ventral colouration in both sexes (at least covered by small melanophores, sometimes forming spots or even extensive marbling in female *A. megacephalus* [male unknown]).

Comparison with *Anomaloglossus shrevei* (Rivero 1961) is hindered by the brevity of the original description and the lack of comparative material from the type locality. However, Myers & Donnelly (1997) provided extensive additional information based on examination of the holotype and two additional specimens. *Anomaloglossus tepequem* can be distinguished from *A. shrevei* by a much smaller SVL in adult females (maximum female SVL = 24.5 mm in *A. tepequem*, 36.0 mm in *A. shrevei*) and an elongate, tapered median lingual process (Fig. 2; low, rounded bump or vertically aligned, blunt cone in *A. shrevei*; see Grant *et al.*, 1997: 15–16; Myers & Donnelly 1997: 26, fig. 17A–B).

**Description of holotype.** An adult female of 21.7 mm SVL. Dorsal skin entirely smooth; ventral skin smooth (Fig. 3). Cloacal tubercles absent. Head wider than long. Snout bluntly pointed in lateral view, extending past the lower jaw, bluntly pointed in ventral and dorsal views. Nares located close to snout tip (EN 60% of SL), directed posterolaterally; nares visible in frontal view, barely visible in dorsal and ventral view; IN 41% of HW. *Canthus rostralis* well defined; loreal region straight, sloping outward to lip. IO 64% of ED. SL 103% of ED, 49% of HL;

EN 61% of ED. Tympanic membrane inconspicuous, round, concealed posterodorsally by a diffuse supratympanic swelling; tympanic annulus visible; TYM 50% of ED. Maxillary teeth present, small. Median lingual process elongate, longer than wide, tapered, bluntly pointed, reclined in pit.

Hand moderate in size, 27% of SVL, 81% of HW. Relative length of fingers III > IV > I > II. Fingers unwebbed. Discs of fingers expanded, disc on Finger II, III, IV widest (state 2 *sensu* Grant *et al.* 2006), discs on Finger I correspond to state 1 (*sensu* Grant *et al.* 2006). Fingers with fringes [*sensu* Grant *et al.* (2006: 66–67); keel-like lateral folds *sensu* Myers & Donnelly (2008)], best developed on pre- and postaxial edges of Finger II and preaxial edge of Finger III (Fig. 3). Palmar tubercle large, rounded, slightly heart-shaped; thenar tubercle smaller, elliptical; one or two round to ovoid subarticular tubercles (one each on Fingers I and II, two each on Fingers III and IV, with distal tubercles on Finger III and IV inconspicuous). Tip of Finger IV distinctly surpassing the base of distal subarticular tubercle on Finger III when fingers appressed. No fleshy supracarpal fold atop wrist (Fig. 3).

Hind limbs robust, moderately long, TIL 51% of SVL. Relative lengths of appressed toes IV > III > V > II > I; Toe I short, slightly surpassing the base of subarticular tubercle of Toe II. Toe discs expanded, slightly larger than finger discs, largest on Toes II and IV. Feet moderately webbed; all toes with well developed folded, flapped fringing. Webbing formula I 0<sup>+</sup>–2<sup>-</sup> II 1<sup>-</sup>–2<sup>½</sup> III 2–3<sup>-</sup> IV 3–1<sup>½</sup>V (Fig. 3). Inner metatarsal tubercle small, elliptical; outer metatarsal tubercle small, round, about half the size of inner tubercle. One to three round to ovoid subarticular tubercles (one each on Toes I and II, two each on Toes III and V, and three on Toe IV, with distal tubercle on Toe IV the smallest and less conspicuous). A strong outer metatarsal fold is present, coextensive with the fringe (*sensu* Grant *et al.* 2006) on the postaxial edge of Toe V and almost reaching the outer metatarsal tubercle. Tarsal keel strong, continuous with fringe along the outer edge of the first toe, straight or very weakly curved at proximal end, lacking pronounced elevation or tubercle proximally (Fig. 3).

**Colour of holotype in preservative.** Dorsal ground colour brown with a dark brown interorbital bar followed by another dark brown “M-shaped” mark covering the scapular region. Dorsal surface of arm light brown with ill-defined dark brown transverse bands on forearm and wrist and a cream upper arm; upper surface of leg light brown with well defined dark brown transverse bands on thigh, shank, and foot. Flanks dark brown, with some irregular spots and a few whitish irregular blotches on the lower part. A few white spots (covering small tubercles) form a broken oblique lateral stripe that extends from the groin midway along flank. No dorsolateral stripe.

Upper lip brown, delimited by a clear line and with some whitish marks below eye; loreal region and side of head dark; small whitish stripe from arm insertion to tympanum. A dark brown stripe is present on the anterior edge of upper arm, tapering from arm insertion to forearm. Abdomen immaculate cream, throat with patches of melanophores. Ventral surface of upper arm whitish; ventral surface of forearm brown on postaxial side; ventral surface of thigh and shank whitish; rear of thigh and cloacal region brown. Paracloacal marks whitish. Palms and soles brown (Fig. 3).

**Measurements of holotype (in mm).** SVL = 21.7; FA = 4.7; Ha = 5.9; TL = 10.5; FL = 9.9; HW = 7.3; HL = 7.1; ED = 3.4; EN = 2.1; IN = 3.0; SL = 3.5; IO = 2.2; TD = 1.7; WFD = 0.8; WTD = 0.8; ThL = 10.8; 1FiL = 2.5.

**Variation.** The type series comprises five adult females, three juvenile females, four adult males, and three juvenile males (Table 1). Except for the sexual dimorphism in size and throat colour pattern (see above), dorsal colour varies from light brown to chestnut-brown; dorsal pattern varies slightly in shape and conspicuousness; brown transverse bands on shanks vary from four to three in number, and also vary in conspicuousness with sometimes only the central band being visible; ventral colour variation remains subtle (Fig. 4).

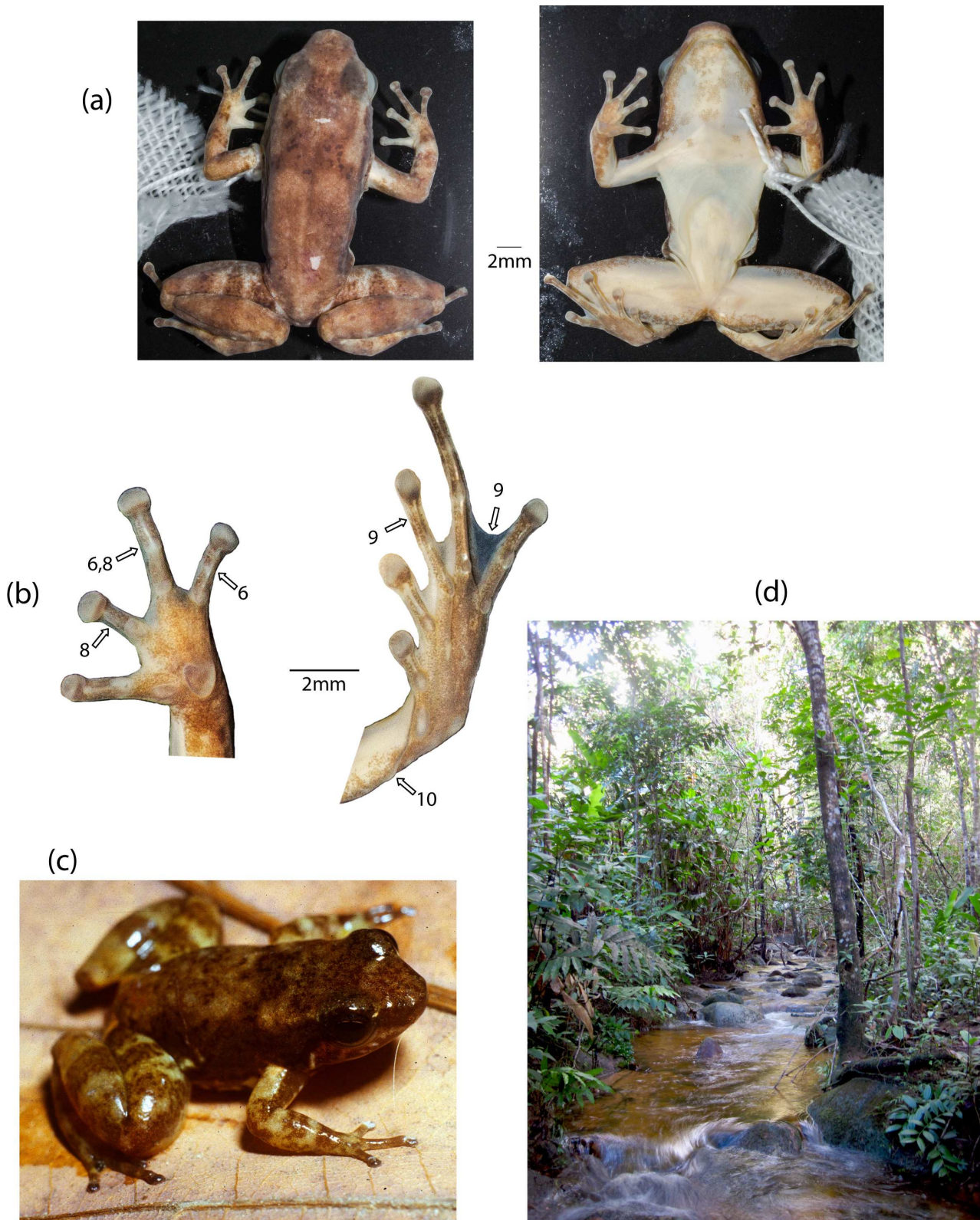
**Distribution and ecology.** *Anomaloglossus tepequem* was observed and collected only twice, once in 1986 and again in 1992. This is a diurnal species associated with fast flowing streams (Fig. 3d) and probably restricted to the slopes of Tepequém at >500 m elevation. In 1992, it was one of the most common frog species in the area. Dozens of males were seen actively calling from the banks and upon stones along streams, and were frequently spotted at night sleeping on rocks or leaves above or near water. Additional diurnal and nocturnal investigations performed during five days in May 2011 by seven herpetologists at the same sites where the species was previously found failed to detect it, despite the fact that the time of the year and the weather conditions were favorable.

**TABLE 1.** Morphometric data (in mm) of the type series of *Anomaloglossus tepequem* sp. nov. and *A. apiau* sp. nov. Abbreviations are defined in the text, except A and J used for adult and juvenile, respectively.

		SVL	FA	Ha	TL	FL	HW	HL	ED
<i>A. tepequem</i>	Females A (n=5)	22.90	4.86	6.06	11.10	10.02	7.54	7.06	3.26
	sd	1.05	0.18	0.21	0.42	0.39	0.39	0.30	0.17
	Females J (n=3)	18.87	4.40	5.33	10.30	9.20	6.70	6.37	2.83
	sd	1.15	0.10	0.29	0.44	0.36	0.46	0.38	0.29
	Males A (n=4)	19.20	4.63	5.53	10.30	9.48	6.88	6.30	3.15
	sd	0.86	0.36	0.36	0.22	0.45	0.22	0.16	0.10
	Males J (n=3)	16.43	3.80	4.37	8.87	7.93	6.10	5.57	2.57
	sd	0.15	0.17	0.25	0.25	0.45	0.10	0.32	0.06
<i>A. apiau</i>	Females A (n=15)	20.16	4.29	5.05	9.55	8.72	7.27	6.31	2.89
	sd	1.17	0.27	0.20	0.42	0.43	0.41	0.38	0.17
	Females J (n=4)	15.48	3.63	4.10	7.85	7.15	5.65	5.13	2.23
	sd	0.59	0.26	0.29	0.56	0.81	0.39	0.38	0.15
	Males A (n=14)	17.09	3.73	4.46	8.48	7.69	6.07	5.55	2.54
	sd	0.99	0.16	0.22	0.52	0.52	0.27	0.35	0.18
	Males J (n=3)	14.53	3.43	3.87	7.70	6.50	5.37	4.80	2.23
	sd	0.06	0.06	0.21	0.26	0.44	0.21	0.20	0.15

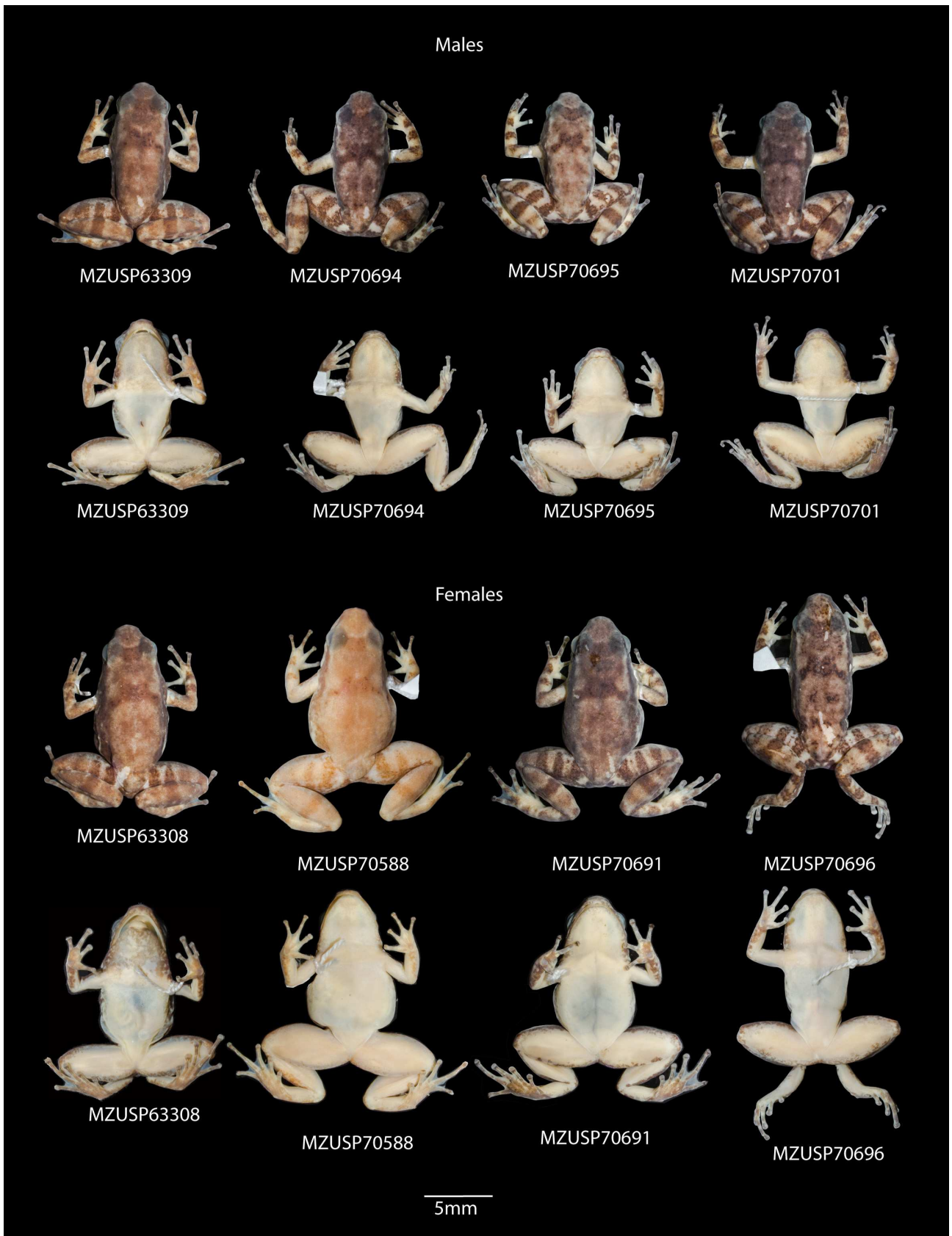
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		EN	IN	SL	IO	TD	WFD	WTD	ThL	IFiL
<i>A. tepequem</i>	Females A (n=5)	2.16	3.02	3.58	2.30	1.40	0.74	0.80	11.55	2.49
	sd	0.09	0.19	0.16	0.19	0.19	0.04	0.04	0.63	0.06
	Females J (n=3)	1.93	2.40	3.10	2.17	1.30	0.64	0.71	10.52	2.12
	sd	0.06	0.17	0.46	0.06	0.17	0.09	0.02	0.59	0.20
	Males A (n=4)	1.80	2.83	3.20	2.25	1.33	0.72	0.76	10.84	2.34
	sd	0.08	0.10	0.12	0.06	0.05	0.07	0.04	0.36	0.18
	Males J (n=3)	1.67	2.40	2.73	1.70	1.40	0.49	0.59	9.18	1.78
	sd	0.06	0.17	0.15	0.10	0.26	0.08	0.03	0.40	0.13
<i>A. apiau</i>	Females A (n=15)	1.73	2.80	3.09	2.21	1.07	0.82	0.91	10.31	2.16
	sd	0.08	0.17	0.27	0.13	0.10	0.08	0.10	0.39	0.18
	Females J (n=4)	1.35	2.20	2.40	1.78	0.85	0.59	0.66	8.70	1.75
	sd	0.06	0.12	0.14	0.10	0.10	0.10	0.07	0.75	0.20
	Males A (n=14)	1.54	2.44	2.67	1.90	0.97	0.67	0.79	9.06	1.91
	sd	0.13	0.15	0.17	0.15	0.08	0.08	0.07	0.47	0.18
	Males J (n=3)	1.30	2.20	2.27	1.70	0.77	0.56	0.67	7.49	1.55
	sd	0.10	0.10	0.12	0.10	0.06	0.05	0.02	0.43	0.04



**FIGURE 3.** (a) Holotype (MZUSP 63310) of *Anomaloglossus tepequem* sp. nov. in dorsal and ventral view. (b) Left hand and left foot in ventral view, numbers refer to the characters in the diagnosis. (c) Uncollected specimen in life photographed by MTR in December 1992 and (d) the stream were specimens were collected in 1992 (photograph by M. Teixeira) in May 2011. Other photographs by AF.





**FIGURE 4.** Eight paratypes (four females and four males) of *Anomaloglossus tepequem* sp. nov. in dorsal and ventral view. Photographs by AF.

***Anomaloglossus apiaiu* sp. nov.**

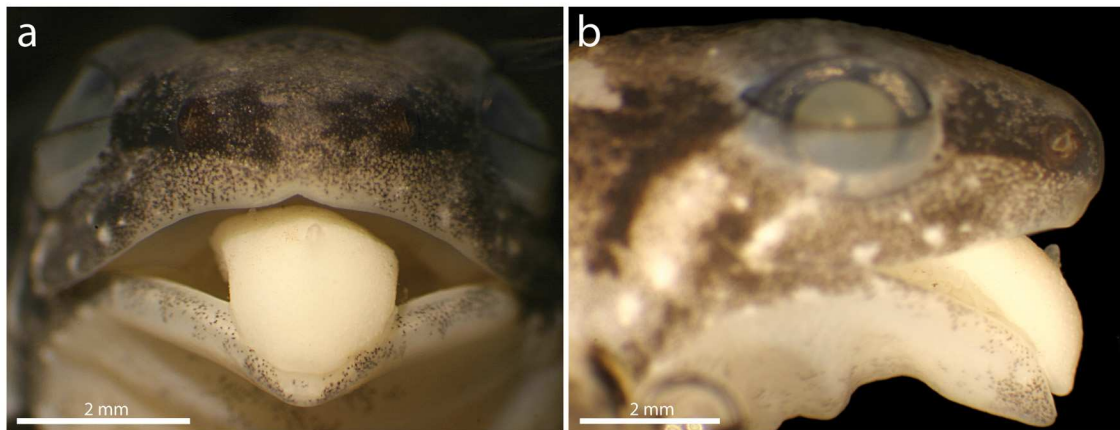
(Figs. 5–7; Table 1)

**Holotype.** MZUSP 155833 (SMS962), an adult male collected by Antoine Fouquet, Sergio Marques de Sousa and Pedro Murilo Sales Nunes in October 2011 at ~580 m at Serra do Apiaú, Roraima State, Brazil (2.430168 N, 61.411715 W).

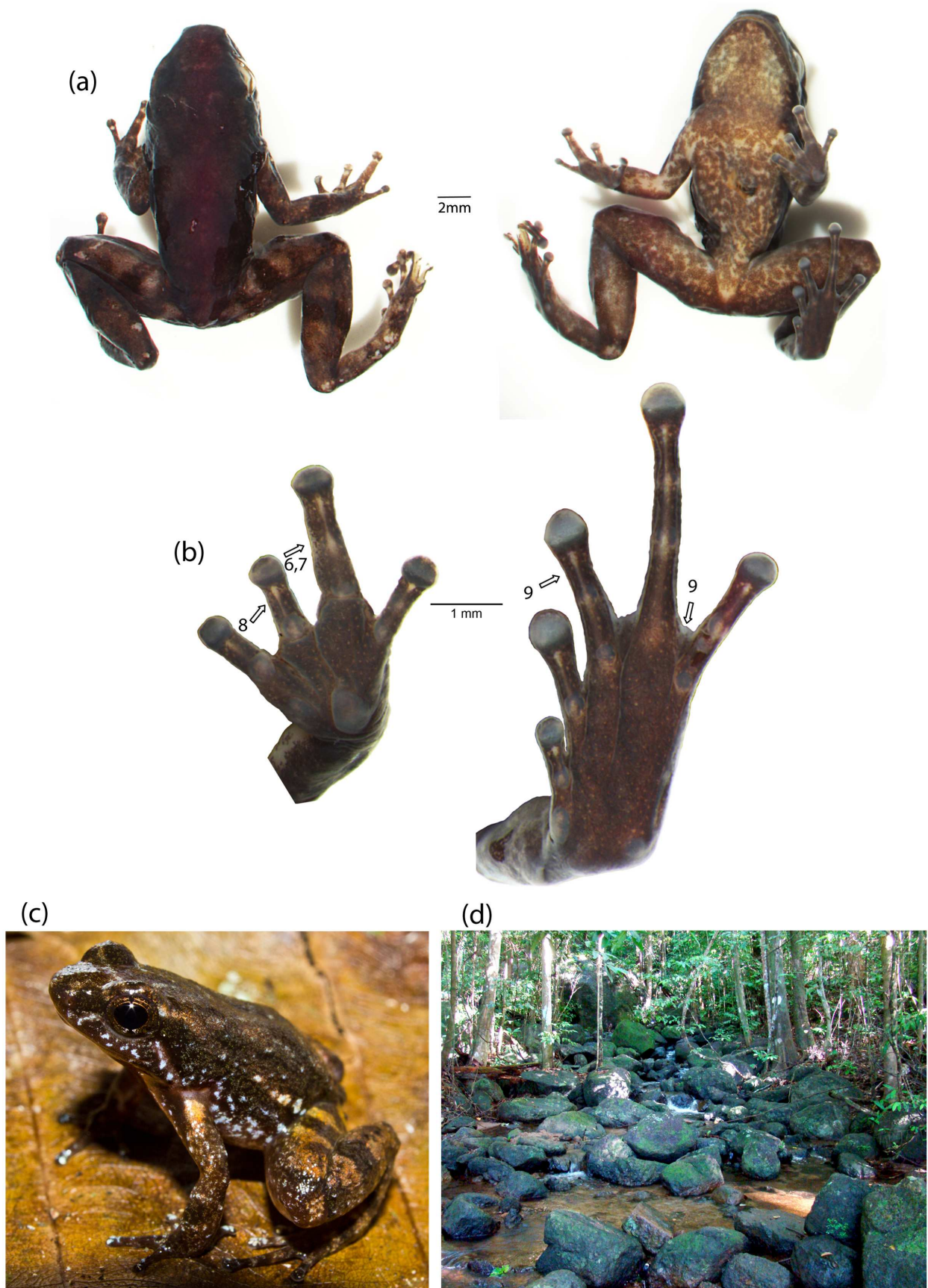
**Paratopotypes.** (n = 35): MZUSP 155814–15, 155818, 155826, 155828–29 155831–32, eight males, and MZUSP 155812–13, 155816–17, 155819–25, 11 females, collected in October 2011 by AF, SMS and PMSN, and MZUSP 155834, 155836, 155838, 155840, 155842–43, 155851–52, eight males, and MZUSP 155837, 155839, 155841, 155844–46, 155850, 155853, eight females, collected in June 2012 by AF and PMSN.

**Etymology.** The specific epithet is a noun in apposition and refers to the name of the region where the type locality lies (Serra do Apiaú, Roraima State, Brazil).

**Adult definition and diagnosis.** (1) a small *Anomaloglossus* (average male SVL = 17.1 mm [15.5–20.0, n = 14], average female SVL = 20.2 mm [18.4–21.8, n = 15]) (Table 1); (2) body robust; (3) skin on dorsum granular, especially posteriorly, venter smooth; (4) Finger II shorter than I when fingers are appressed, but Finger I shorter than II (3.3 vs. 3.5 mm in holotype) using the method of Kaplan (1997); (5) tip of Finger IV surpassing the base of the distal subarticular tubercle on Finger III when fingers appressed; (6) distal subarticular tubercle on Finger III indistinct; (7) Finger III distinctly swollen in males; (8) fingers with keel-like lateral folds particularly developed preaxially on Finger III; (9) toe webbing basal, with well developed fringes (*sensu* Grant *et al.* 2006; keel-like lateral folds *sensu* Myers & Donnelly 2008); (10) tarsal keel well defined, short, strongly curved, strongly elevated and tubercle-like proximally; (11) black arm gland in males (*sensu* Grant & Castro-Herrera 1998, see also Grant *et al.* 2006) and cloacal tubercles absent; (12) pale paracloacal mark present; (13) dorsolateral stripe absent; (14) ventrolateral stripe present in males as a series of more or less conspicuous white dots; (15) oblique lateral stripe present as conspicuous white dots extending from groin midway along flank and inconspicuous to the upper posterior edge of the orbit; (16) sexual dichromatism in throat and venter colour pattern present, with only a few scattered melanophores in females while males possess marbled ventral skin; (17) iris with metallic pigmentation and pupil ring; (18) median lingual process short, slightly longer than wide, tapered, bluntly pointed, smooth (non-papillate), reclined in pit (Fig. 5); (19) maxillary teeth present, small; (20) testes immaculate white, mature ova very large (3 mm in diameter), yellowish brown.

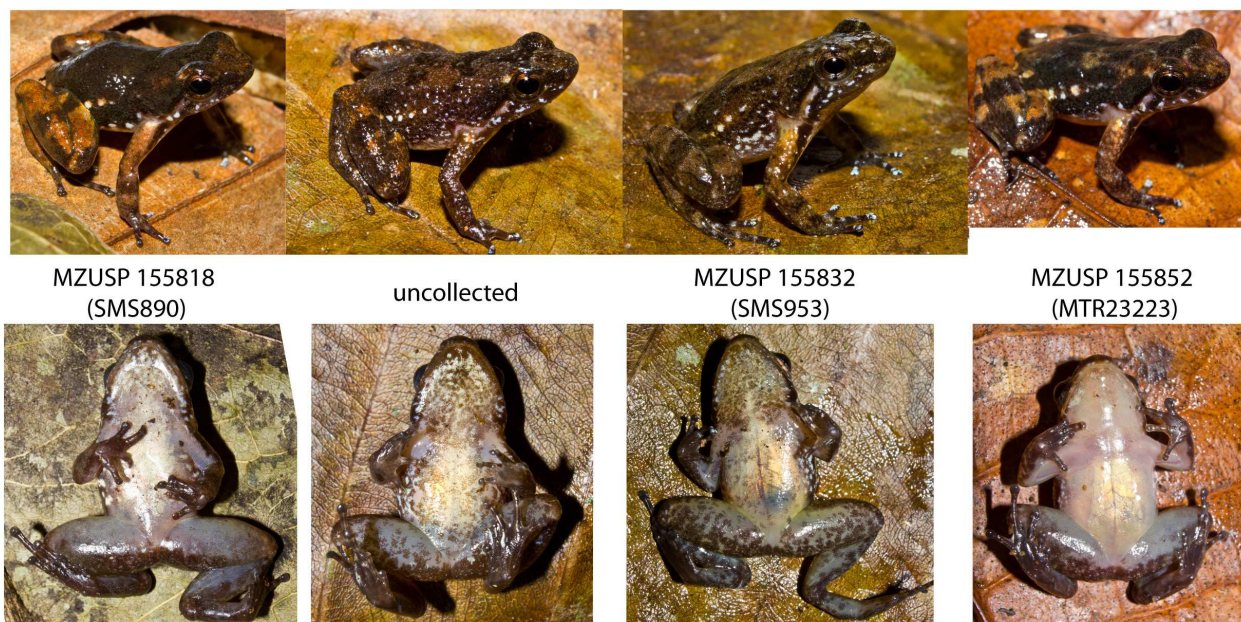


**FIGURE 5.** The median lingual process of *Anomaloglossus apiaiu* sp. nov. in anterior (a) and lateral (b) views (MZUSP 155853, subadult female). Photographs by TG.

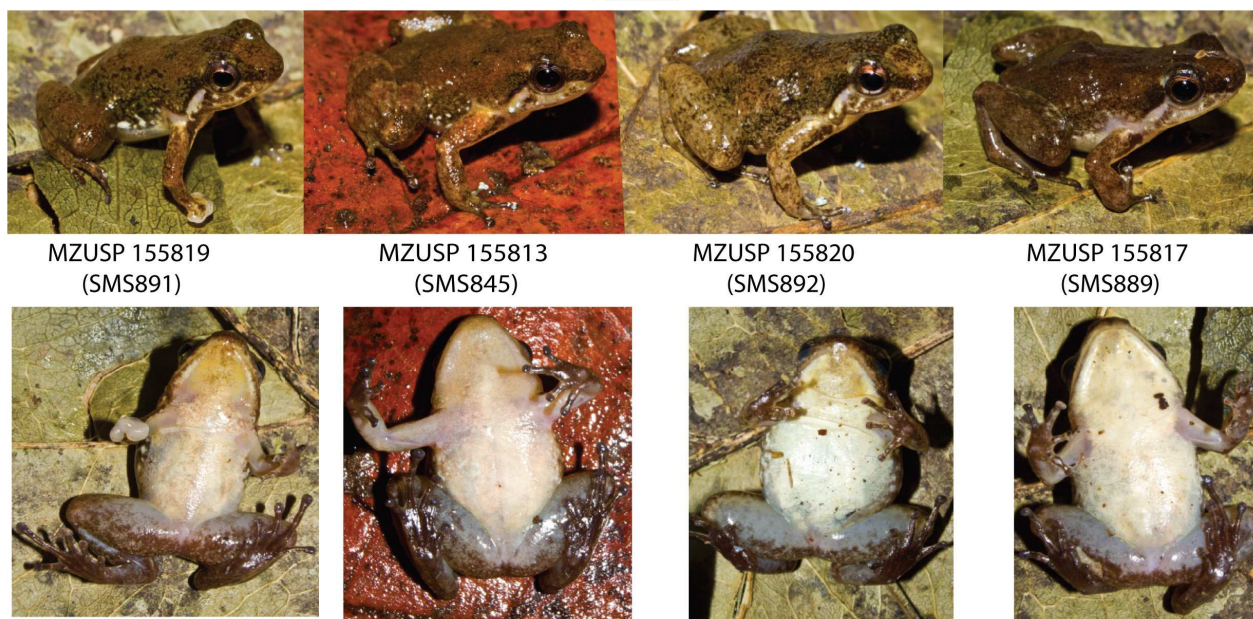


**FIGURE 6.** (a) Holotype (MZUSP 155833) of *Anomaloglossus apiau* sp. nov. in dorsal and ventral view. (b) Left hand and left foot in ventral view, numbers refer to the characters in the diagnosis. (c) Holotype in life and (d) the stream were specimens were collected in October 2011 and June 2012. Photographs by AF.

Males



Females



**FIGURE 7.** Eight paratypes (four females and four males) of *Anomaloglossus apiau* sp. nov. in profile and ventral view. Photographs by AF.

**Morphological comparisons with congeneric species.** *Anomaloglossus apiau* can easily be distinguished from *A. ayarzaguenai*, *A. breweri*, *A. guanayensis*, *A. megacephalus*, *A. moffetti*, *A. murisipanensis*, *A. parimae*, *A. parkerae*, *A. shrevei*, *A. tamacuarensis*, *A. tepequem*, *A. tepuyensis*, *A. triunfo*, *A. verbeeksnyderorum*, and *A. wothuja* in having basal toe webbing (moderate to extensive in the aforementioned species).

*Anomaloglossus apiau* can be readily distinguished from *A. beebei*, *A. kaiei*, *A. rufulus* and *A. roraima* in having folded fringes on fingers, best developed preaxially on Finger III (fringes barely distinct, not distinctly folded in the aforementioned species).

*Anomaloglossus apiau* can be distinguished from *A. baeobatrachus*, *A. leopardus*, and *A. stephensi* by its faint, discontinuous oblique ventrolateral stripe (conspicuous and continuous in *A. baeobatrachus*, *A. leopardus*, and *A.*

*stepheni*). *Anomaloglossus apiau* can be distinguished from *A. praderioi* by lacking a conspicuous light dorsolateral stripe (present in *A. praderioi*). *Anomaloglossus apiau* can be distinguished from *Anomaloglossus degranvillei*, *A. surinamensis* and *A. apiau* by its Finger II longer than Finger I (equal in size in *A. degranvillei* and *A. surinamensis*), and by a third finger swollen in male (not swollen in *A. degranvillei* and *A. surinamensis*). From all the other nominal species of *Anomaloglossus* it can be distinguished by its long advertisement call composed of pairs of short pulses (see below).

**Description of the holotype.** An adult male of 17.7 mm SVL. Dorsal skin granular on posterior dorsum, thighs, and shanks; ventral skin smooth (Fig. 6). Cloacal tubercles absent. Head wider than long. Snout bluntly pointed in lateral view, extending past the lower jaw, bluntly pointed in ventral and dorsal views. Nares located close to tip of snout, directed posterolaterally; nares visible in frontal view, barely visible in dorsal or ventral view; IN 39% of HW. Canthus rostralis well defined; loreal region straight, sloping outward to lip. IO 69% of ED. SL 96% of ED, 45% of HL; EN 62% of ED. Tympanic membrane inconspicuous, round, concealed posterodorsally by a diffuse supratympanic swelling; tympanic annulus not visible posterodorsally and partly unpigmented; TYM 35% of eye length. Maxillary teeth present, small. Median lingual process short, about as wide as long, tapered, bluntly pointed, smooth (non-papillate), reclined in lingual pit. Vocal sac and vocal slits visible.

Hand moderate in size, 27% of SVL, 79% of HW. Relative length of fingers III > IV > I > II. Fingers unwebbed. Discs of fingers expanded, disc on Finger III and IV widest (state 2 *sensu* Grant *et al.* 2006), discs on other fingers sub-equal (state 1 *sensu* Grant *et al.* 2006). Fingers with fringes, best developed preaxially on Finger II and III (Fig. 6). Palmar tubercle large, rounded, thenar tubercle smaller, elliptical; one or two round to ovoid subarticular tubercles (one each on Fingers I and II, two each on Fingers III and IV). Tip of Finger IV distinctly surpassing the base of distal subarticular tubercle on Finger III when fingers appressed. No fleshy supracarpal fold atop wrist (Fig. 6b). Finger III strongly swollen dorsally and preaxially, swelling extending from the wrist to the third subarticular tubercle [state 3 *sensu* Grant *et al.* (2006)].

Hind limbs robust, moderately long, TIL 49% of SVL. Relative lengths of appressed toes IV > III > V > II > I; Toe I short, not reaching the base of subarticular tubercle of Toe II. Toe discs expanded, distinctly larger than finger discs, largest on Toes II, III and IV. Feet weakly webbed; all toes with well-developed fringes. Webbing formula I 1<sup>½</sup>-2- II 2<sup>+</sup>-3- III 2<sup>½</sup>-4 IV 4-2-V (Fig. 6b). Inner metatarsal tubercle small, elliptical; outer metatarsal tubercle small, round, about half the size of the inner metatarsal tubercle. One to three round to ovoid subarticular tubercles (one each on Toes I and II, two each on Toes III and V, and three on Toe IV with proximal tubercle on Toe IV the smallest and least conspicuous). A strong outer metatarsal fold is present, coextensive with the fringe on Toe V and almost reaching the outer metatarsal tubercle. Tarsal keel weakly curved proximally, discontinuous with the fringe along the outer edge of the first toe, strongly elevated and tubercle-like proximally (Fig. 6b).

**Colour of holotype in life.** Dorsal ground colour brown with a light brown interorbital triangle (Fig. 6c). Upper surface of arm with a bright yellow mark with ill defined dark brown and white marks on forearm and wrist; upper surface of thigh yellow with well defined dark brown transverse bands, shank and foot light brown also with well defined dark brown transverse bands. Flanks dark brown, with some blue/whitish irregular iridescent blotches on the lower part, and a lateral stripe of yellowish spots from the inguinal region to the middle of the flank becoming conspicuous again with a short orange stripe on the upper posterior corner of the eye. Dorsolateral stripe absent.

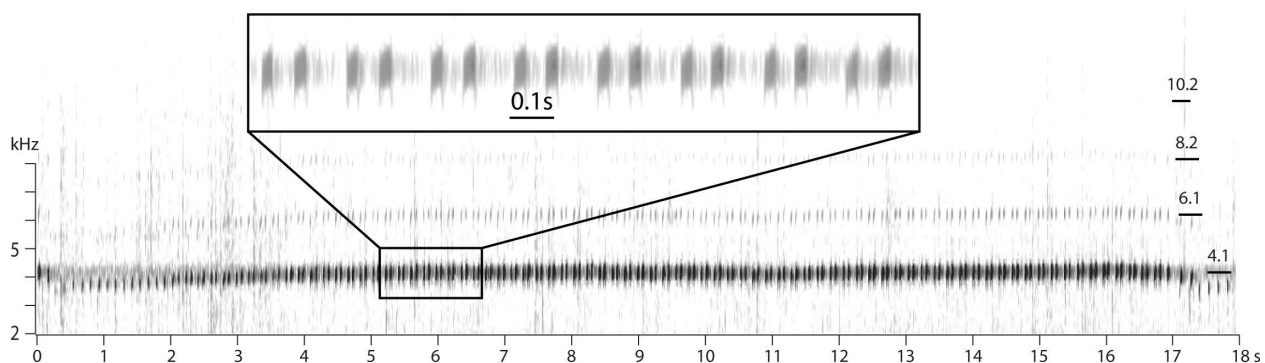
Upper lip brown with iridescent white marks below the eye; loreal region and side of head dark; a small whitish stripe is present from arm insertion to tympanum partly depigmented. A dark brown stripe is present on the anterior edge of upper arm, tapering from arm insertion to forearm. Throat, belly and undersurface of arm, thigh and shank marbled with patches of dark brown melanophores. Rear of thigh and cloacal region brown. Paracloacal marks orange. Palms and soles brown (Fig. 6c).

**Colour of holotype in preservative.** Dorsal ground colour dark brown with a thin light gray to light brown interorbital stripe and a similarly coloured small spot behind the eyes (Fig. 6a). Dorsal surface of arm brown with dark brown transverse bands on forearm and wrist, upper arm cream; dorsal surface of leg brown with well-defined dark brown transverse bands on thigh, shank, and foot. Flanks dark brown with some irregular spots and a few whitish irregular blotches ventrolaterally. A few white spots (covering small tubercles) form a dotted oblique lateral stripe that only extends from the inguinal region to the middle of the flanks. Throat, belly, and under-surface of arms and legs marbled with patches of melanophores; rear of thigh and cloacal region brown. Paracloacal marks whitish. Palms and soles dark brown (Fig. 6b).

**Variation.** Males are smaller than females (average male SVL = 17.1 mm 15.5–20.0 mm, n = 14; average female SVL = 20.2 mm, 17.7–21.8 mm, n = 15), usually with third Finger III distinctly swollen. There is marked sexual dichromatism (Fig. 7). Dorsal colouration of females is light to dark brown with small diffuse black marks and no lateral dotted stripe. Males, however, are generally darker with a highly variable and conspicuous pattern as well as a lateral stripe consisting of white, bluish and even sometimes orange spots. Whitish-blue marks also occur ventrally on flank, shoulder and lip in males, but found in one female only. Hind limbs are also generally markedly sexually dichromatic, being of similar colouration to the dorsum in females, but with orange markings of various extents in males (from inexistent to small patches, or even sometimes becoming the main background colour). Ventral colouration of females is immaculate white, sometimes with diffuse melanophores and a yellowish throat. Males, however, generally have extensively pigmented ventral surfaces (with one exception; Fig. 7, MZUSP 155836, SVL 16.8 mm, despite conspicuous dorsal colouration and swollen third finger) giving a marbled aspect, especially on throat.

In addition to sexual dimorphism in size and colour pattern, variation is extensive within sexes. Among females, dorsal colouration varies from light to dark brown and from immaculate to vermiculate with dark patches. The dark bands on thigh and shank vary from conspicuous to very faint. Lip pattern varies from almost immaculate cream to covered with dark brown marks. Shoulder is orange to light brown. In males, variation in colouration is even more striking and might depend partly on reproductive activity given that more conspicuously coloured males also have swollen third fingers. Dorsal colouration in males varies from immaculate dark brown to light brown with various different patterns of dark brown markings. The distribution of bluish white iridescent dots ranges from a few large ones on the ventral part of the flanks and lips to completely peppering flanks and lips. Limbs and ventral surface are also highly variable in colouration (see above).

**Advertisement calls.** The call is a long trill of 19.6 s on average (sd = 11.0, range = 7.0–39.4, n = 10) consisting of pairs of very short pulses (average duration of pulses = 0.03 s, sd = 0.005, 0.02–0.04, n = 50; inter-pulse interval within pair 0.03 s and between pairs 0.073 s on average) (Fig. 8). Pulse rate per second 11.3 on average (sd = 0.55). Four harmonics are visible, with the dominant frequency located in the lowest harmonic (= fundamental frequency). The dominant frequency increases during the first seconds of the call (~4 s) but reaches a plateau of 4.3 kHz on average (sd = 0.129, 4.147–4.526, n = 5; Fig. 8; Table 2).



**FIGURE 8.** Advertisement call of *Anomaloglossus apiau* (IND5) showing call length (>17 s) and spectral structure. Note the paired pulses (inset). The specimen was recorded in October 2011 around 11 am at the type locality (21°C).

The temporal structure of the call differs markedly from that of congeneric species in the duration of the call. *Anomaloglossus degranvillei* (Marty & Gaucher 1999), *A. surinamensis* (Ouboter & Jairam 2012) and *A. praderioi* (Kok 2010) emit a single note at rates between 50 and 100 calls/min; *A. beebei* (Kok *et al.* 2006a), *A. tamacuarensis* (Myers & Donnelly 1997) and *A. kaiei* (Kok *et al.* 2006b) emit short series of pulses (4–5, 2, and 1–2 pulses/call, respectively); *A. baeobatrachus* (Marty & Gaucher 1999) and *A. stepheni* (Lima *et al.* 2006; Martins 1989) emit short trills of 7–19 pulses and less than 1 s of duration. *Anomaloglossus rufulus* emits shorter (< 3 s) and regular trills with lower pulse rate (7 pulses/s) (Barrio-Amorós & Santos 2011). The only known *Anomaloglossus* call that has a similar temporal structure to the call of *A. apiau* is the one of *A. verbeeksnnyderorum* (Barrio-Amorós *et al.* 2010). However pulse rate of *A. apiau* is higher (11.27 pulses/s vs. 8.87 in *A. verbeeksnnyderorum*) and the pulses are paired (vs. regularly spaced in *A. verbeeksnnyderorum*).

**TABLE 2.** Acoustic parameters of six recordings of five uncollected males of *Anomaloglossus apiau* sp. nov. recorded in October 2011 from the same location as the holotype, except IND5 recorded at the top of the Apiaú mountain.

	MEAN	SD	IND1 REC1		IND2 REC1		IND3 REC1	
Recording duration (s), temperature (°C) and elevation (m)			97s (23°C)	580m asl	20s	580m asl	87s	580m asl
Call duration (s)	19.56	11.05	9.08	n=4	18.4	n=1	39.4	n=1
Inter-call interval (s)	11.17	7.24	13.7	n=3	NA		NA	
Pulse duration (s)	0.033	0.005	0.03	n=10	0.03	n=10	0.03	n=10
Inter-pulse interval (within pulse pair, in s)	0.03	0	0.03	n=10	0.03	n=10	0.03	n=10
Inter-pulse interval (between pulse pairs, in s)	0.073	0.005	0.07	n=10	0.07	n=10	0.08	n=10
Pulse rate (pulses/s)	11.27	0.55	11.67	70 pulses in 6s	11	66 pulses in 6s	11	66 pulses in 6s
Dominant frequency (Hz) bandwidth	4334	129.7	4257 (3980-4467)	n=4	4393 (4205-4617)	n=1	4526 (4242-4767)	n=1
Continued.								
	MEAN	SD	IND4 REC1		IND4 REC2		IND5 REC3	
Recording duration (s), temperature (°C) and elevation (m)			23s	580m asl	30	580m asl	88s (21°C)	1300m asl
Call duration (s)	19.56	11.05	9.4	n=1	20.5	n=1	20.6	n=2
Inter-call interval (s)	11.17	7.24	3	n=1	NA		16.8	n=1
Pulse duration (s)	0.033	0.005	0.04	n=10	0.04	n=10	0.03	n=10
Inter-pulse interval (within pulse pair, in s)	0.03	0	0.03	n=10	0.03	n=10	0.03	n=10
Inter-pulse interval (between pulse pairs, in s)	0.073	0.005	0.07	n=10	0.07	n=10	0.08	n=10
Pulse rate (pulses/s)	11.27	0.55	12	72 pulses in 6s	12	72 pulses in 6s	10.67	64 pulses in 6s
Dominant frequency (Hz) bandwidth	4334	129.7	4328 (4017-4579)	n=1	4353 (4017-4542)	n=1	4147 (3792-4429)	n=1

**Distribution and ecology.** *Anomaloglossus apiau* **sp. nov.** was observed exclusively along rocky streams (only a few meters away from water maximal level), on the slopes of Serra de Apiaú above 500 m elevation and up to the summit at ~1400 m. These streams are usually shallow, but they can be fast flowing and up to 15 m wide (but unlikely torrential) or reduced to rivulets with only a film of water running on the rocks (Fig. 6d). Males call from the stream banks or on rocks; they only call from the banks alongside larger streams. The species is locally abundant with one calling male found every ~5 m along the stream when calling activity is at its peak, *i.e.* during late afternoon or after rainfall.

## Discussion

**Affinities.** Based on morphological similarities (notably the foot webbing and the absence of a swollen third finger in males) the association of the species with rocky streams, and its occurrence on a low elevation tepui, we hypothesize that *Anomaloglossus tepequem* is related to one of the species groups from the Pantepui region (Kok *et al.* 2012), most likely to *A. tepuyensis*. Nevertheless, given (1) the lack of clarity on the polarity of these characters, (2) the overall difficulty to discriminate among *Anomaloglossus* species, especially from preserved material (Kok *et al.* 2010), (3) the scarcity of material at hand for this species, and particularly (4) the absence of additional data (especially DNA sequences), this hypothesis remains highly speculative.

Similarly, given the lack of toe webbing, presence of a swollen Finger III in males and trilled advertisement call, *Anomaloglossus apiau* might be related to the lowland species of the *A. stepheni* group. However, as for *A. tepequem*, this hypothesis should be taken with caution, especially given that *A. apiau* occurs *ca.* 500 km from the closest record of that group.

**Cryptic diversity and microendemism.** Despite a striking boost in amphibian species descriptions in the last decades (Köhler *et al.* 2005), many tropical regions still harbour vast numbers of undescribed species (Fouquet *et al.* 2007; Vieites *et al.* 2009). Some genera seem to be more prone to harbour cryptic species than others. *Anomaloglossus* seems to be such a genus with 11 species described since 2000 and many more remaining to be described (Fouquet *et al.* 2012; Kok *et al.* 2012). Most *Anomaloglossus* species display very restricted distributions, generally on isolated massifs. Many isolated mountains remain to be explored which likely harbour additional, and isolated, *Anomaloglossus* species (like in the Serra da Mocidade in Roraima State, the Kanuku mountains in central Guyana, and many others, notably in the Pantepui region). Such tendencies—*i.e.* association with highland and restricted distributions—make this group potentially sensitive to the deleterious effects of climate change (Fouquet *et al.* 2013) and disease outbreaks (Pounds *et al.* 2006; Verdade *et al.* 2011).

**Conservation.** *Anomaloglossus tepequem* might be one more example of a species described after being extinct (Coloma *et al.* 2010). It was found to be abundant and actively calling by day in the late 1980s and early 1990s, but was not detected at all in May 2011 (rainy season April–August), despite active searching at the same localities by seven herpetologists over five days. Gold mining intensity in Tepequém peaked between 1985–1990 and ended rapidly afterwards, which might be responsible for the decline of that species. Nevertheless, we cannot rule out the possibility that the species occurs on other slopes of Tepequém or even on other mountains nearby (>800 m massifs occur 20 km north). Fieldwork should be undertaken to answer this question. Human activity is now predominantly touristic on this massif, which might become a new conservation area.

Conversely, *Anomaloglossus apiau* remains locally abundant. However, its geographic range is extremely small. During field work (20 days, four herpetologists) on Serra da Maroquinha, the twin mountain of Serra do Apiaú, we failed to detect the presence of the species while it was conspicuously active on Serra do Apiaú during the same period (June). We assume that the species is a microendemic of Serra do Apiaú. Using a 500 m altitudinal boundary we estimate that its range could be less than 10 km<sup>2</sup>. Several threats could hamper the fate of the species. The consequences of future climate change are already troubling for species in similar situations (Fouquet *et al.* 2013), and epidemic disease outbreaks have wiped out comparable populations in many tropical highlands over the globe (Stuart *et al.* 2004). Additionally, this massif lies in the vicinity of recent agricultural planning and settlements. These activities continue to expand, along with wood extraction and periodic burning of the slopes of the mountains as a consequence. Last, but not least, there is still risk of mining in the region.

The IUCN Red List Categories are based on five criteria (IUCN 2014). One of them, B, considers geographic range size and fragmentation decline or fluctuations. With an entire geographic range (area of occupancy) smaller than 100 km<sup>2</sup>, an area of occupancy smaller than 10 km<sup>2</sup> ("B2"), a single known isolated population ("B2a") and



projected decline ("B2b"), both of these new species should be considered critically endangered and conservation measures should be taken urgently to preserve their habitat. Further, the entire genus should be the subject of conservation programs, given that most *Anomaloglossus* occur in highland areas and are closely associated with streams—two conditions known to increase extinction risk (Gillespie & Hines 1999; Woodhams & Alford 2005). Indeed, higher elevation populations (>400 m) have been shown to be more severely affected by chytridiomycosis (Pounds *et al.* 2006).

A recent case of potential extinction is that of the riparian species *Anomaloglossus parkerae*, a species described from the La Escalera area in southeastern Venezuela (Meinhardt & Parmelee 1996). The species was collected by W. E. Duellman during the early 1970s (Meinhardt & Parmelee 1996; Duellman 1997). PJRK and C. Barrio-Amorós visited the type locality together on two occasions, first in May 2009 and then in November 2010 (joined by D. B. Means), and could not detect a single individual. C. Barrio-Amorós had already visited the area five times without detecting a single specimen (C. Barrio-Amorós pers. comm.). The last sighting of the species might be that of K.-H. Jungfer in March 1993, who spotted two individuals at Salto El Danto (La Escalera region), but failed to find additional specimens in 2000 (K.-H. Jungfer pers. comm.).

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#### APPENDIX. Additional material examined.

- Anomaloglossus ayarzaguenai*: **Venezuela**, Estado Bolívar, Cerro Jaua, MHNLS 12949 (holotype), MHNLS 12950–51 (paratypes).
- Anomaloglossus baeobatrachus*: **French Guiana**, Municipality of Sinnamary, Piste St Elie, AF0590-91; **French Guiana**, Municipality of Sinnamary, AF0657-58; **French Guiana**, Municipality of Sinnamary, Paracou, AF0688, AF0718.
- Anomaloglossus beebei*: **Guyana**, Potaro-Siparuni District, Kaieteur National Park, IRSNB 13721–26, 13728–54, ULABG 6817 (ex IRSNB 13727), IRSNB 13779–81 (tadpoles).
- Anomaloglossus breweri*: **Venezuela**, Estado Bolívar, Aprada Tepui, Cueva del Fantasma, MHNLS 17044 (holotype), MHNLS 17045–46 (paratypes).
- Anomaloglossus degranvillei*: **French Guiana**, Municipality of Maripasoula, Atachi-Bacca (type locality) PG601-04, PG606-12, PG618-19, PG627-33
- Anomaloglossus guanayensis*: **Venezuela**, Estado Bolívar, Serranía de Guanay, MHNLS 10708 (holotype), MHNLS 10712–10714 (paratypes), 10716–10717 (paratypes), 10724–10725 (paratypes).
- Anomaloglossus kaiei*: **Guyana**, Potaro-Siparuni District, Kaieteur National Park, IRSNB 1938 (holotype), IRSNB 1939–64 (paratypes), IRSNB 14419 (2 specimens), IRSNB 14422–26, IRSNB 14433–35, IRSNB 14437–40, IRSNB 14443, IRSNB 14446–51, IRSNB 14454–57, IRSNB 13755–78 (tadpoles), IRSNB 14432 (tadpoles), IRSNB 14436 (tadpole), IRSNB 14444–45 (tadpoles), IRSNB 14452–53 (tadpoles), ROM 42999, Mount Wokomung, ROM 43321, ROM 43327, ROM 43330, ROM 43333; Cuyuni-Mazaruni District, Wayalayeng, IRSNB 14922–24, Maringma Tepui, IRSNB 14925–31.
- Anomaloglossus moffetti*: **Venezuela**, Estado Bolívar, Sarisariñama-tepui, EBRG 4645 (holotype), EBRG 4646–51 (paratypes).
- Anomaloglossus murisipanensis*: **Venezuela**, Estado Bolívar, Murisipan-Tepui, MHNLS 11385 (holotype).
- Anomaloglossus parimae*: **Venezuela**, Estado Amazonas, Cerro Delgado Chalbaud, ULABG 4221 (holotype), ULABG 4212–20 (paratypes), ULABG 4222–26 (paratypes).
- Anomaloglossus parkerae*: **Venezuela**, Estado Bolívar, Sierra de Lema, Salto El Danto, MHNLS 2901, MHNLS 11088–89 (topotypic specimens).
- Anomaloglossus praderioi*: **Guyana**, Cuyuni-Mazaruni District, Maringma Tepui, IRSNB 14403–13, IRSNB 14414–16 (tadpoles); **Venezuela**, Estado Bolívar, Mount Roraima ULABG 4196 (holotype), MHNLS 11272 (paratype), Sierra de Lema, EBRG 5569.
- Anomaloglossus roraima*: **Venezuela**, Estado Bolívar, Mount Roraima, ULABG 4197 (holotype).
- Anomaloglossus rufulus*: **Venezuela**, Estado Bolívar, Amuri-Tepui, Chimantá Massif, MHNLS 10361 (holotype).
- Anomaloglossus stepheni*: **Suriname**, Brokopondo district, Road to Apura, AF0093-96; **Brazil**, Amazonas, EE Anavilhanas, MSH10334, 10336; **Brazil**, Amazonas, **Brazil**, Amazonas, Igarape Araras, MTR10269-70.
- Anomaloglossus tamacuarensis*: **Venezuela**, Estado Amazonas, Sierra Tapirapecó, north base of Pico Tamacuari, MBUCV 6430–33 (paratypes).
- Anomaloglossus tepuyensis*: **Venezuela**, Estado Bolívar, Auyantepui, ULABG 2557 (holotype), Cucurital River, MHNLS 14404–05, Purumay River, MHNLS 14924–25, MHNLS 14940–41, MHNLS 15687, Quebrada Atapere, MHNLS 15924, MHNLS 17359–60, MHNLS 17383, Quebrada Tucutupan, MHNLS 17401, Quebrada Rutapa, MHNLS 17361.
- Anomaloglossus triunfo*: **Venezuela**, Estado Bolívar, Cerro Santa Rosa, Serranía del Supamo, EBRG 4756 (holotype), EBRG 4757–59 (paratypes).