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Description of a new species of *Teratohyla* Taylor (Amphibia: Athesphatanura: Centrolenidae) from north-western Ecuador

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Abstract

We describe a new species of Glassfrog of the family Centrolenidae. This new taxon, *Terarohyla sornozai* **sp. nov.**, is diagnosed by having a protruding snout in lateral profile, uniform green dorsal colouration in life, concealed prepollex, extensive webbing between the outer fingers, fully webbed toes, and small body size. It inhabits the Non-Seasonal Evergreen Foothill and Lowland forests in the provinces of Esmeraldas, Imbabura, and Pichincha, north-western Ecuador.

Key words: Centrolenidae, new species, taxonomy, *Teratohyla sornozai* **sp. nov.**, Ecuador

Resumen

Describimos una nueva especie de rana de cristal de la familia Centrolenidae. Este nuevo taxón, *Teratohyla sornozai* **sp. nov.**, es diagnosticado por tener el hocico protuberante en perfil lateral, la coloración dorsal verde uniforme en vida, el prepolex oculto, membranas extensas entre los dedos externos de la mano, dedos del pie con membranas interdigitales completas y tamaño corporal pequeño. Esta especie habita en los bosques Siempreverdes No-Estacionales Piemontanos y de Tierras Bajas en las provincias de Esmeraldas, Imbabura y Pichincha en el noroccidente de Ecuador.

Palabras clave: Centrolenidae, nueva especie, taxonomía, *Teratohyla sornozai* **sp. nov.**, Ecuador

Introduction

The diversity of species of frogs of the family Centrolenidae is highest in Colombia and Ecuador, diminishing northward and southward. The number of species in Ecuador has increased significantly since Lynch & Duellman (1973) and Duellman & Burrowes (1989), with 10 species described as new since 2004; and currently 32% (48 spp.) of the known anuran species of the family Centrolenidae (glassfrogs) have been reported to inhabit in the Republic of Ecuador (see Cisneros-Heredia & McDiarmid, 2007 and subsequent publications: Cisneros-Heredia *et al.*, 2008; Cisneros-Heredia & Morales-Mite, 2008; Guayasamin *et al.*, 2008a; Yánez-Muñoz & Cisneros-Heredia, 2008; Yánez-Muñoz *et al.* 2009). Knowledge about the glassfrogs from Ecuador is still fragmented and its species richness is expected to increase with the study of unidentified

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museum specimens and the discovery of additional species with the exploration of previously uncollected areas (Cisneros-Heredia & McDiarmid 2006a, b, 2007).

Despite been explored since the second half of the 19th century, western Ecuador holds several undescribed or unreported amphibian species particularly on the Andean foothill forests and on the Cordillera de la Costa. The foothill forests along the western base of the Andes of Ecuador hold a species-rich amphibian fauna but have remained almost unstudied until recently. Various expeditions in the last years to the western Andean foothills resulted in several new country records as well as in the discovery of new species of frogs (e.g. Cisneros-Heredia & Yánez-Muñoz 2007; Yánez-Muñoz & Cisneros-Heredia 2008). Recent surveys conducted in foothill forests in the provinces of Esmeraldas, Imbabura, and Pichincha on north-western Ecuador by the Museo Ecuatoriano de Ciencias Naturales resulted in the collection of an undescribed species of glassfrog which we are pleased to describe herein.

Materials and methods

Characters, terminology, measurements, and organization of the sections are standardised following definitions provided by Cisneros-Heredia & McDiarmid (2007). Taxonomic arrangement follows Guayasamin *et al*. (2009). The following measurements (in millimetres) were taken with electronic digital callipers (0.05 mm accuracy, rounded to the nearest 0.1 mm): snout-vent length, SVL; head width, HW; head length, HL; horizontal eye diameter, ED; inter-orbital distance, IOD; eye-nostril distance, EN; inter-narial distance, IN; width of disc on the third finger, TD, horizontal tympanum diameter; 3DW; tibia length, TL; foot length, FL. For the webbing formulae, we use the notational device of Savage & Heyer (1967) as modified by Savage & Heyer (1997). We use the standardised numeration system that codes the fingers in order from innermost to outermost by Roman numerals from I to IV. Sex and sexual maturity was determined by direct examination of the condition of gonads and development of secondary sexual characters (vocal slits and nuptial pads). Specimens were fixed in 4% formalin and stored in 75% ethanol. We examined specimens (Appendix I and those cited in Cisneros-Heredia & McDiarmid 2007) deposited in the following collections: DHMECN—División de Herpetología, Museo Ecuatoriano de Ciencias Naturales, Quito; DFCH-USFQ—Universidad San Francisco de Quito, Quito; QCAZ—Museo de Zoología, Pontificia Universidad Católica del Ecuador, Quito; ICN—Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá; KU—The University of Kansas, Natural History Museum, Lawrence; USNM—National Museum of Natural History, Washington, D.C. Classifications of vegetation formations follow the definitions by Sierra (1999) and the zoogeographic regions and endemic areas follow the definitions by Albuja *et al.* (1980) with modifications by Cisneros-Heredia (2006, 2007).

Results

***Teratohyla sornozai* sp. nov.**
Figures 1–2

Holotype. DHMECN 3522, an adult female collected at a small stream tributary of Río Naranjal (00°21’05” N, 78°55’01” W, 750 m elevation), cantón Cotacachi, provincia de Imbabura, República del Ecuador, 01 May 2006 by H. M. Ortega-Andrade.

Paratypes. DHMECN 2634, adult male, Reserva Biológica Canandé (00°18’22.5” N, 79°08’17.6” W, 550 m elevation), cantón Quinindé, provincia de Esmeraldas, República del Ecuador, 21 August 2004, M. Yánez-Muñoz, P. Meza-Ramos, M. M. Reyes & A. Loaiza. DHMECN 4308, adult female, Bosque Protector Mashpi (00°10’2.34” N, 78°52’2.32” W, 1100 m), provincia de Pichincha, República del Ecuador, May 2007, M. H. Yánez-Muñoz y C. Castro.

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FIGURE 1. *Teratohyla sornozai* **sp. nov.**, adult female (paratype, DHMECN 4308) collected at Bosque Protector Mashpi, province of Pichincha, Ecuador. Photo by H. M. Ortega-Andrade.

Referred material. DHMECN 3521, a juvenile female with the same data of the holotype.

Diagnosis. A glassfrog species (Figs. 1, 2, 3E) diagnosed from all other Centrolenidae by the combination of the following characters: (1) vomerine teeth present; (2) snout truncate in dorsal view, protruding in profile; nostrils slightly elevated producing an slight depression in the internarial area; loreal region concave; (3) tympanic annulus evident, oriented dorsolaterally; very weak supratympanic fold above the tympanum; (4) dorsal skin slightly shagreen with minute granulations; (5) ventral skin coarsely areolate; subcloacal tubercles absent but subcloacal area granular; other cloacal ornamentation absent; (6) parietal peritoneum (condition P3), visceral peritoneum translucent except for pericardium covered by iridophores (condition V1); (7) liver tri-lobed (condition H0); (8) humeral *crista dorsalis* not forming a humeral spine in adult males; (9) webbing basal between fingers I and II; webbing formula for outer fingers II 1^{-}–3 III 2^{-}–1IV (Fig. 2); (10) webbing on feet I 1^{-}–1 II 1^{-}–1^{-} III 1^{-}–1^{-} IV 1–1 V (Fig. 2); (11) no dermal folds or tubercles on hands, upper arm or feet; ulnar and tarsal folds present (12) unpigmented nuptial pad Type I; concealed prepollex; (13) first finger longer than second, (14) eye diameter larger than width of disc on finger III; (15) colour in life, uniform bright green dorsum, green bones; (16) colour in preservative, dorsal surfaces deep grey-purple with few blurred cream spots; (17) iris golden copper with dark fine reticulations; (18) melanophores present on fingers and toes; (19) males call from upper side of leaves and ferns around smalls streams; call undescribed; (20, 21, 22) fighting behaviour, egg clutches, and tadpoles unknown; (23) snout-vent length in adult females 20.4–21.3 mm (n = 2); adult male paratype 19.0 mm.

Comparisons. *Teratohyla sornozai* (Fig. 1) is the only Glassfrog with protruding snout in profile, uniform green dorsal colouration, extensive webbing between outer fingers, and fully webbed toes. Extensive webbing between the outer fingers, humeral *crista ventralis* not developed into a humeral spine and uniform dorsal

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colouration also occurs in the following species: *Rulyrana adiazeta* (Ruiz-Carranza & Lynch), *Teratohyla amelie* (Cisneros-Heredia & Meza-Ramos), *Rulyrana orejuela* (Duellman & Burrowes), *T. spinosa* (Taylor), *R. susatamai* (Ruiz-Carranza & Lynch), and *Cochranella xanthocheridia* Ruiz-Carranza & Lynch. However, all differ from *T. sornozai* as follows: *Rurylana adiazeta* and *R. susatamai* have rounded to truncate snouts in lateral profile, less extensive webbing between the fingers and not fully webbed toes, abundant melanophores on hands and feet, a different iris colouration (brown with dark brown reticulations), and they inhabit the eastern slopes of Cordillera Oriental and Central of Colombia. *Teratohyla amelie* has a rounded snout in lateral profile, iridophores covering the visceral peritonea, transparent parietal peritoneum, and inhabits the central and southern lowlands and foothills of Amazonian Ecuador. *Rulyrana orejuela* has a truncate snout in lateral profile, less webbing between the outer fingers and not fully webbed toes, abundant melanophores on hands, feet, and ventral surfaces, different iris colouration (dark grey with yellow ring around pupil), and larger SVL in adult males (27.3–28.3 mm). *Teratohyla spinosa* has a truncate snout in lateral profile, less webbing between the outer fingers and not fully webbed toes, and adult males have a prepollical spine at the base of the thumb. *Cochranella xanthocheridia* has a rounded to truncate snout, less webbing between the outer fingers and not fully webbed toes, and it inhabits the northern portion of the Cordillera Occidental of Colombia. Further, in preservative, *T. sornozai* shows a deep grey-purple colouration, while all other species show a lavender colouration.

FIGURE 2. Ventral view of hand and foot of *Teratohyla sornozai* **sp. nov.** (adult female, holotype, DHMECN 3522).

Description of the holotype. Adult female, SVL = 21.3 mm (Fig. 20). Body slender. Head distinct, slightly wider than long, and wider than body; HW/HL = 1.05, HW/SVL = 0.37, HL/SVL = 0.35. Snout short, truncate in dorsal view, protruding in profile, EN/HL = 0.30; nostrils slightly elevated producing a slight depression in the internarial area; canthus rostralis indistinct; concave loreal region; lips flared. Eyes large, ED/HL = 0.35, directed anterolaterally at about 45° from midline, eyes can be seen when viewed from below,

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interorbital area wider than eye diameter, IOD/ED = 1.54, EN/ED = 0.87, EN/IOD = 0.56. Tympanic annulus evident, oriented dorsolaterally with dorsal inclination; weak supratympanic fold from behind the eye to the insertion of the arm, separated from orbit by a longer distance than the tympanum diameter. Dentigerous processes of vomers present, choanae moderately sized, rounded, near margin of mouth; tongue rounded, slightly notched behind, not indented posteriorly.

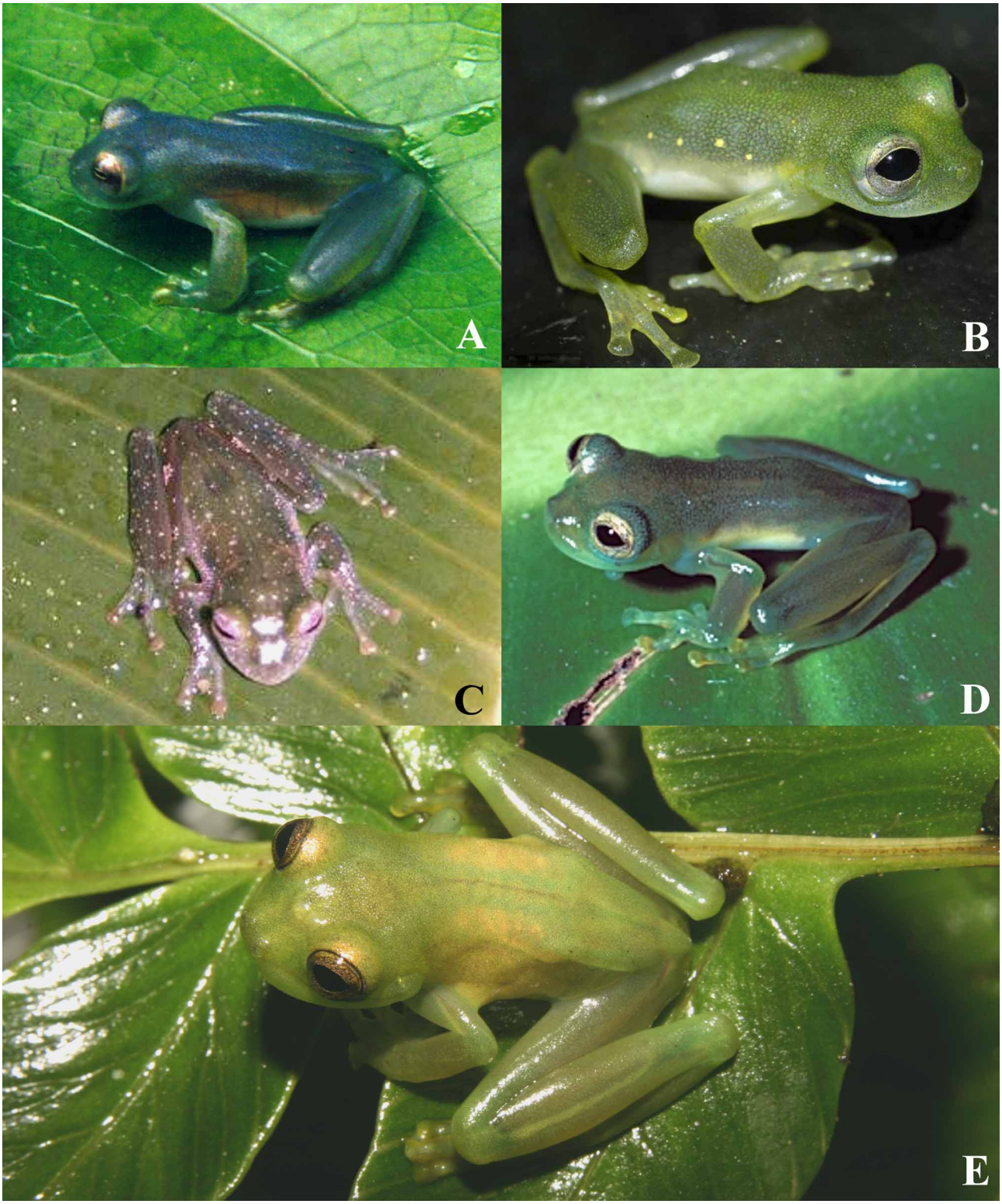

FIGURE 3. (A): *Teratohyla amelie*; (B): *Teratohyla midas*; (C): *Teratohyla pulverata*; (D): *Teratohyla spinosa*; (E): *Teratohyla sornozai* **sp. nov.** Photos by P. Meza-Ramos, A. Georges, M. H. Yánez-Muñoz, R. W. McDiarmid, and H. M. Ortega-Andrade, respectively.

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Skin of dorsal surfaces of head, body, and limbs slightly shagreened with minute granulations. Ventral surfaces coarsely areolate; cloacal opening directed posteriorly at upper level of thighs; no distinct cloacal sheath, some small low tubercles around the cloacal opening; subcloacal tubercles absent, other cloacal ornamentation absent.

Upper arm thin, forearm moderately robust, breadth of upper arm about half that of forearm. Humeral spine absent; ulnar fold present, tubercles absent. Relative lengths of fingers III > IV > I > II; webbing basal between fingers I and II, webbing formula for other fingers I 1–3 III 2⁻–1 IV; bulla absent; finger discs slightly wide, truncate; disc on third finger slightly larger than those on toes, and shorter than eye diameter, 3DW/ED = 0.62; all subarticular tubercles rounded and elevated; indistinct supernumerary tubercles present in fingers; palmar tubercle large, rounded, plane; thenar tubercle elliptic, rather indistinct.

Hind limbs slender; TL/SVL = 0.63, FL/SVL = 0.53. Tarsal fold present; inner metatarsal tubercle large and elliptical, flat; outer metatarsal tubercle indistinct. Subarticular tubercles rounded and low; supernumerary tubercles small, rather indistinct. Webbing on foot I 1⁻–1 II 1⁻–1⁻ III 1⁻–1⁻ IV 1–1 V; discs truncate on all toes, slightly expanded.

Measurements of the holotype. Snout-vent length, 21.3 mm; head width, 7.9 mm; head length, 7.5 mm; horizontal eye diameter, 2.6 mm; inter-orbital distance, 4.0 mm; eye-nostril distance, 2.3 mm; internarial distance between the nostrils, 1.8 mm; width of disc on the third finger, 1.6 mm; tibia length, 13.3 mm; foot length, 11.2 mm.

Colouration. In life (Fig. 1, 3E), dorsal surface uniform bright green, yellowish towards the flanks, without light or dark flecks, spots, or ocelli. Upper eyelids yellowish-green or bright green; tips of digits and interdigital webbing dull yellow to greenish-yellow. Throat and ventral surfaces of legs bluish-green. Parietal peritoneum white (condition P3). Bones pale green. Iris golden copper to golden brown with dark thin reticulations.

In preservative, dorsum deep grey-lavender with few blurred cream spots; dorsal surfaces of arms grey-lavender, hind limbs cream-greenish or lavender; upper eyelid dark blue; lips cream. All ventral surfaces cream. Parietal peritoneum white (condition P3); all visceral peritonea clear except for the white pericardium (condition V1).

TABLE 1. Variation of measurements (in mm) of adult *Teratohyla sornozai* **sp. nov.** See text for abbreviations.

Specimen	DHMECN 3522	DHMECN 4308	DHMECN 2634
	Holotype	Paratype	Paratype
Sex	Female	Female	Male
SVL	21.3	20.4	19.0
HW	7.9	7.3	6.5
HL	7.5	7.2	6.7
ED	2.6	2.8	2.3
IOD	4.0	2.6	3.5
EN	2.3	2.5	2.4
IN	1.8	1.7	1.7
TD	0.9	0.9	0.8
3DW	1.6	1.6	1.2
TL	13.3	13.7	11.2
FL	11.2	13.3	8.8

Variation. Variation of measurements and body proportions is presented in Tables 1 and 2. Photographs of specimens in life are shown in Figs. 1 and 3. Gross morphological and colouration features are fairly

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invariant; male paratype, adult female paratype, and juvenile female are similar to female holotype. Hand and foot webbing does not vary (Fig. 2). In preservative a few blurred cream irregular spots appear in some specimens (DHMECN 3521–22), while other remain uniform lavender. These spaces are produced by the absence of melanophores rather than by the presence of light pigmentation (iridophores or xanthophores). Humeral spine and prepollical spine absent in both sexes. Adult male is smaller than adult females (SVL male =19.0 mm; SVL females = 20.4–21.3 mm). Males have unpigmented nuptial pads Type–I.

TABLE 2. Variation of proportions of adult *Teratohyla sornozai* **sp. nov.** See text for abbreviations.

Specimen	DHMECN 3522	DHMECN 4308	DHMECN 2634
	Holotype	Paratype	Paratype
Sex	Female	Female	Male
HW/HL	1.01	1.05	0.97
HW/SVL	0.36	0.37	0.34
HL/SVL	0.35	0.35	0.35
EN/HL	0.34	0.30	0.35
EN/HW	0.34	0.29	0.36
EN/ED	0.88	0.87	1.02
EN/IOD	0.95	0.56	0.67
ED/HL	0.39	0.35	0.35
ED/HW	0.38	0.33	0.36
ED/3DW	1.79	1.63	1.92
IOD/ED	0.93	1.54	1.52
IOD/HW	0.36	0.51	0.54
IOD/HL	0.36	0.53	0.53
IN/IOD	0.66	0.44	0.49
TD/ED	0.32	0.33	0.35
TL/SVL	0.67	0.63	0.59
FL/SVL	0.65	0.53	0.46
TL/FL	1.03	1.19	1.27

Etymology. The specific name of this Glassfrog is a noun in the genitive case and a patronym for our friend Francisco (Pancho) Sornoza, Ecuadorian ornithologist and conservationist. He is president of Fundación Jocotoco, an Ecuadorian NGO that manages the Reserva Biológica Canandé, and has actively support the research activities of the Museo Ecuatoriano de Ciencias Naturales that resulted in the discovery of this new species.

Distribution and natural history. *Teratohyla sornozai* is known from three localities in the provinces of Esmeraldas, Imbabura, and Pichincha, northwestern Ecuador (Fig. 4). This species occur in Foothill Evergreen Forests (DHMECN 3521, 3522, 4308) and Lowland Evergreen Forests (DHMECN 2634), with an altitudinal range between 550 and 1100 m elevation. The female holotype and juvenile female were found sitting on leaves of herbs and ferns up to 2 meters above a small stream, Naranjal River. No egg clutches or tadpoles were seen in the area. At Naranjal, *T. sornozai* was found in sympatry with *Espadarana prosoblepon* (Boettger), *Pristimantis labiosus* (Lynch, Ruiz-Carranza & Ardila-Robayo), and *Hyloscirtus alytolylax* (Duellman). Although just females where found at Naranjal, males were calling in the surroundings but over 5 meters above the stream. At Canandé, the male was found calling from the upper surface of a leave and in sympatry with *E. prosoblepon*, *Sachatamia albomaculata* (Taylor), *S. ilex* (Savage), *Hyloscirtus palmeri* (Boulenger), *Hypsiboas boans* (Linnaeus), and *H. picturatus* (Boulenger). At Mashpi, the male was collected

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in sympatry with *Pristimantis labiosus* (Lynch, Ruiz-Carranza & Ardila-Robayo), *E. prosoblepon*, *Hyloscirtus palmeri*, and *H. picturatus*.

FIGURE 4. Schematic map showing the known localities of *Teratohyla sornozai* **sp. nov.** in Ecuador. Type-locality marked by an empty dot.

Remarks. *Teratohyla sornozai* is similar to *T. spinosa*, sharing a similar body form and size, uniform dorsal colouration, lobed liver, ventral parietal peritoneum covered by iridophores, and gastrointestinal and hepatic peritonea without iridophores. We hypothesise that both are sister taxa based on their high morphological similarity, but this remains to be tested. *Teratohyla sornozai* has not been found in sympatry with *T. spinosa*. It is possible that both occur together particularly on lowland areas. In contrast with *T. spinosa* that prefers low riverine vegetation along relatively quiet areas (Kubicki, 2007; pers. obs.); *T. sornozai* apparently prefers higher strata along riverine vegetation (over 1.5 m) especially in the splash zone of waterfalls.

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We have not found egg clutches of *Teratohyla sornozai* but we have observed egg clutches of *T. amelie*, *T. midas*, *T. pulverata*, and *T. spinosa*. Females of *T. amelie*, *T. midas*, and *T. pulverata* deposit their egg clutches on the upper side of leaves, while *T. spinosa* may use both sides of leaves. Eggs are laid in a laminar array (Altig and McDiarmid 2007) at different locations on the leave (centre or borders, showing intra-specific variation). The egg clutches of *T. amelie*, *T. midas* and *T. spinosa* keep the original arrangement and location where they were deposited, but the egg clutches of *T. pulverata* frequently absorb water and swell considerably, forming a 3-dimensional clump that moves due to gravity to the tip of the leave and hangs (Cisneros-Heredia & McDiarmid 2007: 28). Eggs of all four species have a greenish-tinted colouration (Kubicki 2007; pers. obs.), which is apparently produced by the accumulation of biliverdin in the eggs, and seems to be common to all members of this clade, probably a synapomorphy.

Teratohyla sornozai corresponds to the species mentioned as *Cochranella* sp. N11 by Yánez-Muñoz & Cisneros-Heredia (2008).

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Appendix I. Examined material

H = holotype; P = paratype.

Cochranella xanthocheridia: ICN 27758 (H); ICN 27757 (P); ICN 10643–6 (P). *Rulyrana adiazeta*: ICN 17919 (H). *Rulyrana orejuela*: KU 145081 (H); KU 145080 (P); DHMECN 04309; DHMECN 04551–2. *Rulyrana susatamai*: ICN 18641 (H); ICN 15801 (P). *Teratohyla amelie*: DHMECN 3066 (H); DHMECN 3591. *Teratohyla midas*: ICN 23755 (P); DFCH-USFQ D102; QCAZ 22876; QCAZ 20001-2; USNM 286702–05; USNM 286707; USNM 288437; USNM 342716. *Teratohyla pulverata*: USNM 342214–21; USNM 219379–87; DHMECN 2612, 3194–5; QCAZ 11367–8; DHMECN 2612; QCAZ 32224. *Teratohyla sornozai*: DHMECN 3522 (H); DHMECN 2634 (P); DHMECN 3521. *Teratohyla spinosa*: USNM 288443; USNM 286741–44; USNM 219388–94.