Zootaxa 3447: 22–40 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

A new Amazonian species of *Rhaebo (*Anura: Bufonidae) with comments on *Rhaebo glaberrimus* (Günther, 1869) and *Rhaebo guttatus* (Schneider, 1799)

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Abstract

We describe a new species of toad of the genus *Rhaebo* from the Amazonian lowlands of Colombia and Ecuador. The new species is characterized by have a large-size (SVL 156.7 mm in adult female, 92.8–127.0 mm in adult males), lacking a preocular ridge and most cephalic crests except for the low parietals crests; having the cloacal opening towards the middle level of thighs; rounded to slightly oval parotoids; and dark to cream brown groin. The new species was previously confused with *Rhaebo glaberrimus*, but the latter differs by having the cloacal opening at the ventral level of the thighs, small body size, skin texture mainly smooth, and a pink or yellowish color in the groin. The new species is also similar to *Rhaebo guttatus* that differs by having a preocular ridge and a different ventral coloration (throat, chest and belly with cream round spots). We also comment on the identity of *R. glaberrimus* and *R. guttatus*, correct some reports published in the literature, and present new information on their natural history and distribution.

Key words: Bufonidae, *Rhaebo*, new species, *Rhaebo glaberrimus*, *Rhaebo guttatus*, Amazonia

Resumen

Se describe una nueva especie de sapo del género *Rhaebo* de las tierras bajas amazónicas de Colombia y Ecuador. La nueva especie se caracteriza por tener un tamaño grande (LRC 156.7 mm en la hembra adulta, 92.8–127.0 mm en machos adultos), ausencia de pliegue preocular; ausencia de crestas cefálicas, excepto las crestas parietales; apertura cloacal al nivel medio de los muslos e ingle café a café crema. La nueva especie fue anteriormente confundida con *Rhaebo glaberrimus*, la cual difiere por tener la apertura cloacal al nivel ventral de los muslos, por tener un tamaño corporal pequeño, una textura de la piel mayormente lisa, y un distintivo patrón de coloración (ingle con manchas rosadas o amarillo). La nueva especie es similar a *Rhaebo guttatus*, la cual difiere por tener un pliegue preocular y un patrón de coloración diferente (garganta, pecho y vientre con manchas redondeadas crema). Nosotros comentamos sobre la identidad de *R. glaberrimus* y *R. guttatus*, corregimos algunos reportes publicados en la literatura y presentamos nueva información sobre su historia natural y distribución.

Palabras clave: Bufonidae, *Rhaebo*, new species, *Rhaebo glaberrimus*, *Rhaebo guttatus*, Amazonia

Introduction

The genus *Rhaebo* Cope, 1862 currently includes nine species of toads (Mueses-Cisneros 2009) distributed from Honduras to the Pacific lowlands of western Ecuador, northern Colombia, north-western Venezuela, the Guiana region, and the Amazonian lowlands of Venezuela, Colombia, Ecuador, Peru, Bolivia, and Brazil (Mueses-Cisne-

 Accepted by M. Vences: 29 Jun. 2012; published: 31 Aug. 2012

ros 2007; Frost 2011). *Rhaebo glaberrimus* (Günther) has been considered as a widely distributed species through the foothills of the Andes and Amazonian lowlands of Venezuela, Colombia, Ecuador, and Peru. However its distributional range is discontinuous and despite substantial survey efforts, the species remains known from two disjunct areas: (i) the Andean slopes of the Cordillera Oriental from southern Venezuela and northern Colombia; and, (ii) the Amazonian lowlands of Ecuador, Peru and probably Bolivia and Brazil. After its description by Günther (1869), almost no information was published about *R. glaberrimus* until the mid-20th century when Stebbins and Hendrickson (1959) and Rivero (1961) regarded it as a subspecies of *Rhaebo guttatus* (Schneider). However, other authors (e.g., Cochran and Goin 1970; Duellman 1978) treated it as a valid species.

Between 1998 and 2001, one of us (DFCH) conducted herpetological surveys in the Amazonian lowlands of Ecuador, particularly at the Tiputini Biodiversity Station (190–270 m a.s.l., province of Orellana), where he collected specimens preliminarily identified as *Bufo glaberrimus* (Cisneros-Heredia 2003). In 2002, when DFCH and RWM started to work together, RWM pointed out that the original description of *Bufo glaberrimus* showed a toad with a pink-coloured groin, a colour pattern never observed or reported in populations from Amazonian Ecuador or Peru (Rivero 1961; Schlüter 1981; Duellman 1978; pers. obs.) and know only in populations from the Andean slopes of Venezuela and Colombia. In 2004, after reviewing material assigned to *R. glaberrimus* in various museums (see Material and Methods), they concluded that the *Rhaebo* populations from Amazonian Ecuador were different from *R. glaberrimus* in aspects of morphology and colouration, and likely represented an undescribed species (Cisneros-Heredia 2006). As part of a systematic revision of the genus *Rhaebo* (Mueses-Cisneros 2008), among 2006–2008, JJM examined specimens of *Rhaebo glaberrimus* from the Andean slopes of Colombia and material assigned to *R. glaberrimus* from Ecuador and south-eastern Amazonian Colombia. He concluded that differences between these two populations were evident, and that populations assigned to *R. glaberrimus* from the western Amazonian lowlands of southern Colombia, Ecuador, and northern Peru, should be described as a new species.

We are pleased to collaborate in this article and describe this new species of *Rhaebo* that is phenetically similar to *Rhaebo guttatus* and *R. glaberrimus*.

Material and methods

Of the 839 specimens of *Rhaebo* that were examined (Mueses-Cisneros 2008), 158 are included in this study. Specimens are deposited at the following collections: Instituto Alexander von Humboldt, Villa de Leyva, Boyacá, Colombia (IAvH); Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá D.C., Colombia (ICN); Museo Ecuatoriano de Ciencias Naturales, División de Herpetología, Quito, Ecuador (DHMECN); Universidad San Francisco de Quito, Quito, Ecuador (DFCH-USFQ); Museo de Herpetología, Universidad de Antioquia, Medellín, Colombia (MHUA); Museo de Historia Natural, Colegio San José, Medellín, Colombia (MHNCSJ); Museo de Historia Natural, Pontificia Universidad Javeriana, Bogotá D.C., Colombia (MUJ); Museo de la Universidad de La Salle, Bogotá D.C., Colombia (MLS); Museo de Zoología, Pontificia Universidad Católica del Ecuador, Quito, Ecuador (QCAZ); Museu Nacional/UFRJ, Rio de Janeiro, Brazil (MNRJ); National Museum of Natural History, Smithsonian Institution, Washington, D.C., Estados Unidos de América (USNM). Some specimens not available for direct examination were studied through detailed dorsal, ventral, and lateral photographs. Sex and sexual maturity were determined by direct inspection of gonads. Conditions of the *omosternum*, pectoral girdle, and *musculus adductor longus* were determined by direct examination after incision of the breast and thigh. Measurements were taken with electronic digital callipers (0.05 mm accuracy, rounded to the nearest 0.1 mm). The following abbreviations are used in the text: SVL (snout-vent length); HW (head width at the corners of the mouth); HL (head length from the tip of the snout to the corners of the mouth); IOD (inter-orbital distance). Webbing formulae follow the method of Savage and Heyer (1967) as modified by Myers and Duellman (1982). When geographic coordinates were not indicated in field notes, these were georeferenced for the locality data using digital maps; in some cases elevations are approximated.

***Rhaebo ecuadorensis* sp. nov.**
(Figures 1, 2)

Bufo guttatus glaberrimus—Rivero. 1961. Bull. Mus. Comp. Zool. 126: 21–22 (in part).
Bufo glaberrimus— Duellman. 1978. Univ. Kans. Misc. Publ. No. 65:116–17; Schlüter. 1981. Stud. Neotrop. Fauna Environ. 16: 221; Lötters *et al*. 2000. Bonn. Zool. Beitr. 49:75–78; Cisneros-Heredia. 2003. Mem. I Cong. Ecología y Ambiente, Univ. San Francisco de Quito: 17; Schlüter *et al.* 2004. Salamandra. 40(2): 141–160; Pramuk. 2006. Zool. J. Linn. Soc. 146:407,443.
Rhaebo glaberrimus—Frost *et al*. 2006. Bull. Am. Mus. Nat. Hist., 297: 365; Pramuk *et al.* 2007. Global Ecol. Biogeogr. 2007: App.S1. Aguilar *et al*. 2010. Rev. Peru. Biol. 17(1): 005–028.

Holotype: QCAZ 32715(Figure 1), an adult female collected at km 38 of the YPF-Maxus road, Parque Nacional Yasuní, Provincia de Orellana, Ecuador (Figure 3), 00°40’16.7”S, 77°24’01.8”W, 250 m, on 12 June 2006 by Morley Read, Silvia Aldás Alarcón, and Aldo Sornoza.

Paratypes: ECUADOR: PROVINCIA DE SUCUMBÍOS: Reserva de Producción Faunística Cuyabeno, 00° 05' 02”S, 76° 12' 54” W, 280 m (DFCH-USFQ C320–21); PROVINCIA DE ORELLANA: Tiputini Biodiversity Station, Universidad San Francisco de Quito, 00°37’05” S, 76°10’19” W, 215–300 m (DFCH-USFQ T80–82); Estación Científica Yasuní, Pontificia Universidad Católica del Ecuador, 00°40’16.7”S, 77°24’01.8”W, 250 m (QCAZ 23887) ; PROVINCIA DE MORONA SANTIAGO: Quebrada del Río Napinaza, 6.6 km N of Limón, on road to Macas, 02°55’05”S, 78°24’25.2”W, 1013 m, General Leonidas Plaza Gutiérrez, (QCAZ 26558, 38113); PROVINCIA DE PASTAZA: Bobonaza, vía a Taculí, aprox. 01°29’53.2”S 77°52’45.5” W, 900 m (QCAZ 38325); Conambo, aprox.01°52’21”S 76° 53’53” W, 256–393 m (DHMECN 4667); Reserva de Bosque Tropical Hola Vida, camino a las cascadas, 01° 37' S, 77° 54' W, 831 m (QCAZ 36767; Figure 3).

Referred specimens: (Juveniles). COLOMBIA: DEPARTAMENTO DE AMAZONAS: Leticia, aprox. 04°12’S 69°56’W (IAvH 4524); ECUADOR: PROVINCIA DE NAPO: Estrellayacu (QCAZ 4497–8); Napo-Galeras, Río Pusuno, aprox 01°01’25”S 77°35’06”W, 1100 m, (QCAZ 14055); Tena, junto al Río Misahuallí (QCAZ 3895); PROVINCIA DE ORELLANA: Tiputini Biodiversity Station, Universidad San Francisco de Quito, 00°37’05” S, 76°10’19” W, 215–300 m (DFCH-USFQ T83–84); Coca, Puerto Francisco de Orellana (QCAZ 12); Estación Científica Yasuní, Pontificia Universidad Católica del Ecuador, 00°40’16.7”S, 77°24’01.8”W, 250 m (QCAZ 23896, 24577); Carretera NPF a Tivacuno, aprox. 0°42’26”S 76°28’19”W (QCAZ 30900); Bloque Shiripuno, SW border of the buffer zone of the Parque Nacional Yasuní, aprox. 0°43’33”S 76°43’33”W, 220 m (QCAZ 8973); Loreto, Ávila Viejo, aprox. 0°38’11”S 77°25’58”W, 748 m (QCAZ 10722); PROVINCIA DE PASTAZA: Cononaco, Bataburo Lodge, al sur de la carretera desde Cononaco, 01° 12’S, 76°42’W, 220 m (QCAZ 39417); Pablo López de Oglán, aprox. 1°18’00”S 77°42’24”W, 800 m (DHMECN 3067); Río Pucayacu, finca km 6 vía San Ramón–El Triunfo, Parroquia Teniente Hugo Ortiz, aprox. 01°22’22”S 77°51’36”W, 950 m (QCAZ 33237); Plataforma K 10 de la empresa de explotación Petrolera AGIP en el bloque 10, Cerca a 10 de Agosto, 01°28’28”S, 77°31’54”W, 498 m (QCAZ 39287; Figure 3).

Diagnosis. A bufonid of genus *Rhaebo* (diagnosed on the basis of their lack of cephalic crests (except for the low parietals crests), their yellowish-orange skin secretions, presence of an *omosternum* and hypertrophied testes), of large-sized (SVL 156.7 mm in adult female, 92.8–127.0 mm in adult males) lacking a preocular ridge (Figure 1); having the cloacal opening near the middle level of thighs (Figure 4C), rounded to slightly oval parotoids, and dark to cream brown groin (Figures 1, 2).

Comparisons with other species: *Rhaebo ecuadorensis* is phenetically similar to *R. glaberrimus* and *R. guttatus*, and juveniles may be confused with *R. blombergi* (Myers and Funkhouser). *Rhaebo glaberrimus* (Figures 5, 6) differs by having the cloacal opening situated towards the ventral level of the thighs (Figures 4A–B) [cloacal opening towards the middle level of thighs in *R. ecuadorensis*], smaller body size (49.6–64.6 mm SVL in adult males) [large body size (92.8–127.0 mm in adult males) in *R. ecuadorensis*], mainly smooth dorsal skin [dorsal skin warty, spiculae and coni in *R. ecuadorensis*], enlarged parotoid glands [rounded parotoid glands in *R. ecuadorensis*], and pink and yellow groin (Figure 6A) [groin without pink or yellow coloration in *R. ecuadorensis*]. *Rhaebo guttatus* (Figure 7) differs by having a preocular ridge (Figure 8) [absent in *R. ecuadorensis*], and ventral colouration pattern with rounded light spots on a dark background (Figure 7C) [ventral colouration without circular light spots in *R. ecuadorensis* (Figure 2)]. Juveniles of *R. blombergi* have more foot webbing that *R. ecuadorensis*, parotoids more rounded and snout truncated in lateral profile [weakly truncated to round in *R. ecuadorensis*].

Further *R. blombergi* inhabits the Pacific lowlands and western Andean foothills from central Colombia (departments of Chocó, Valle del Cauca, Cauca, and Nariño) to northern Ecuador (provinces of Esmeraldas, Carchi, Imbabura and Pichincha, Mueses-Cisneros 2008), while *R. ecuadorensis* occurs on the Amazonian lowlands of Colombia, Ecuador, Peru, Bolivia and Brazil.

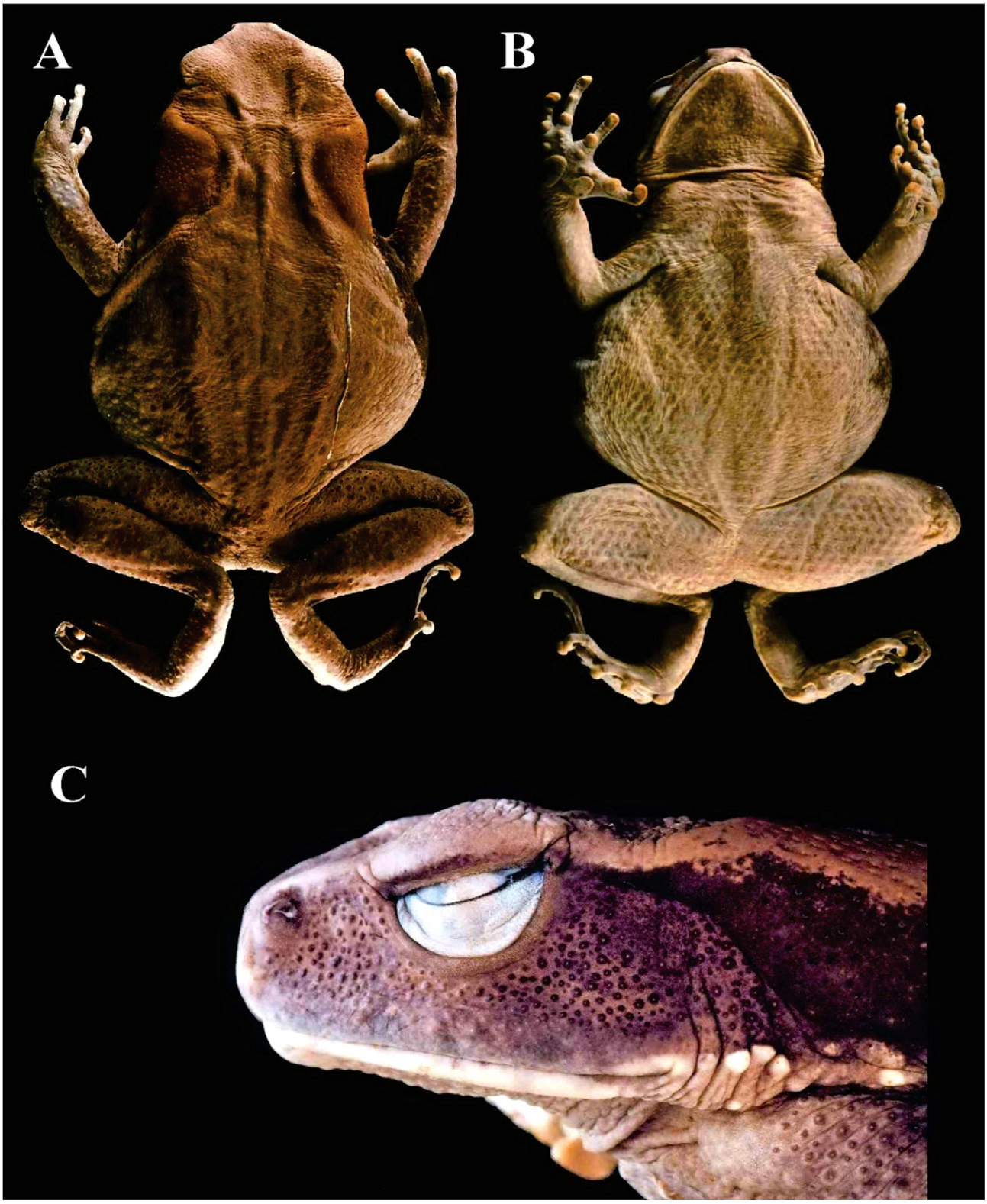

FIGURE 1. Holotype of *Rhaebo ecuadorensis* **sp. nov.** Dorsal (**A)**, ventral (**B**) and lateral (**C**) views, QCAZ 32715, adult female, 156.7mm. SVL. Photos by Luis A. Coloma.

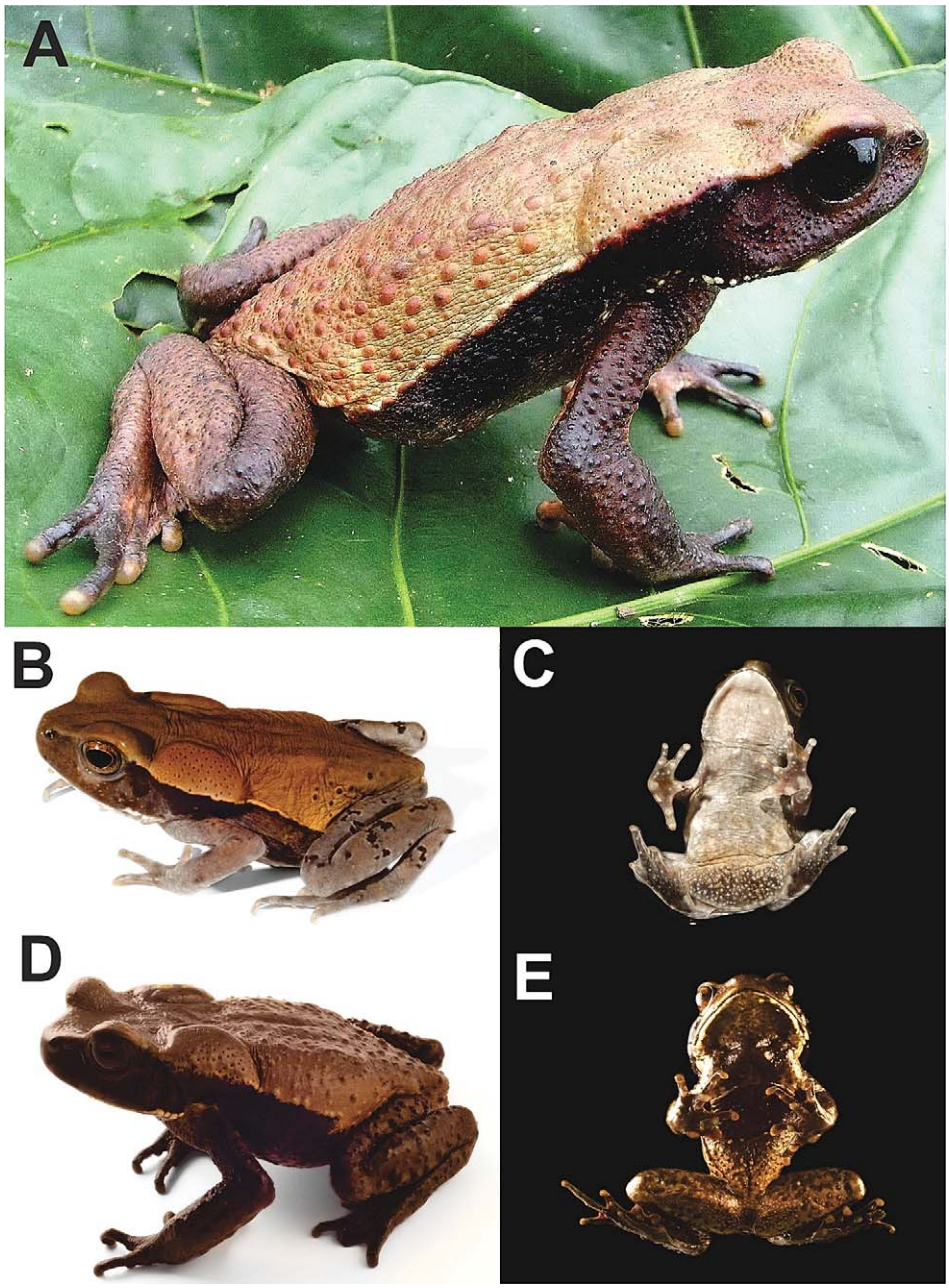

FIGURE 2. *Rhaebo ecuadorensis* **sp. nov.** in situ. (**A)** Dorsolateral view of Paratype, DHMECN 4667, adult male, 127.0mm SVL. Photo by Mauricio Ortega; (**B)** dorsolateral and (**C**) ventral view of QCAZ 33237 from Pucayacu, Provincia de Pastaza, Ecuador (female juvenile 68.9 mm SVL); (**D)** dorsolateral and (**E**) ventral view of QCAZ 38113 from Napinaza, Provincia de Morona Santiago, Ecuador (adult male of 92.8 mm. SVL). Photos B–E by Luis A. Coloma.

Description: Based on one adult female and six adult males; large-sized toad (female = 156.7 mm SVL, males = 92.8–127.0 mm, $\bar{x}$ = 105.6 ± 14.9 SVL); head narrower than body width, slightly wider than long. Head width slightly wider than at level of tympanum (female: HW/HL = 1.18; HW/SVL = 0.38; HL/SVL = 0.32; males: HW/HL = 1.13–1.17, $\bar{x}$ = 1.15 ± 0.15; HW/SVL = 0.37–0.39, $\bar{x}$ = 0.38 ± 0.08; HL/SVL = 0.32–0.34, $\bar{x}$ = 0.33 ± 0.10). Head subacuminate in dorsal view; snout slightly rounded to truncate dorsally, weakly rounded to truncate in lateral view. Tip of snout without fleshy vertical ridge. Distance between nostril and tip of snout/distance between nostril and eye = 0.12 in female, 0.21–0.31 ($\bar{x}$ = 0.26 ± 0.38) in males. Nostrils open posterior to anterior rim of mouth, below *canthus rostralis* in slightly swollen area. Nostrils oblique, oval, directed laterally. Dorsal edge of nostril rounded, ventral edge straight to concave. Distance between nostrils/distance between nostril and eye = 1.10 in female, 1.15–1.22 ($\bar{x}$ = 1.18 ± 0.28) in males. Internarial area flat to weakly concave. Top of head from snout to anterior corners of eyelids flat. Interorbital and occipital region flat, with some low and slender tubercles near

parotoids. Upper eyelid narrower than interorbital area, with low, slender tubercles. Upper eyelid width/IOD = 0.74 in female, 0.73–0.79 ($\bar{x}$ = 0.76 ± 0.24) in males. Inner and outer rim of upper eyelid not delineated by tubercles. Outer rim of upper eyelid not projecting beyond eye. Cephalic crests absent with exception of parietal crests, which are low in adult males, some pronounced in female holotype. *Canthus rostralis* straight, weakly fleshy in the males, fleshy in the holotype; projecting over loreal region. Loreal region weakly concave to flat, with some small, regularly distributed spiculae and coni, extending to the post-tympanic region. Lips not flared. Eyes with horizontally oval pupil. Preorbital ridge absent. Tympanum oval, 51.3% of eye length in the female, 44.2–53.0% ($\bar{x}$ = 48.3 ± 3.5) in the males; anterior 3/5 (or all) of tympanum visible. Supratympanic ridge present, fleshly. Parotoids large, distinct, rounded to slightly oval. Parotoid width 52.7% of parotoid length and 62.6% of inter-parotoid distance in the female, 53.1–61.9% ($\bar{x}$ = 56.1 ± 3.1) of parotoid length and 59.2–69.9% ($\bar{x}$ = 63.3 ± 3.7) of inter-parotoid distance in the males. Parotoids smooth, with nearly regularly distributed pores. Outer margin of parotoids without indentations. Inter-parotoidal region without evident crests (except in holotype). Skin of dorsum of body smooth, bearing some slender and low tubercles in sacral region and small rounded and prominent warts on postsacral region. Continuous lateral oblique row of round and oval, low and little evident o conspicuous warts, from parotoids to ⅔ of parotoid-groin distance. Ventral skin smooth, with some low tubercles mainly on throat and chest.

Forelimbs long, forearms somewhat robust in adult males, with warts, spiculae and coni on upper surface and flanks. Hand length 23.9% of SVL in the female, 24.8–29.2% ($\bar{x}$ = 26.6 ± 1.6) in males. Fingers without webs; with fleshy and bulbous tips. Finger **I** longer than **II**. Super-numerary palmar tubercles few, rounded and low. Subarticular tubercles rounded and evident. Palmar tubercle large, rounded, 1.2–1.5 times the size of rounded thenar tubercle. Ulnar tubercles and ulnar fold absent. Metacarpal fold absent (Figure 9D).

Hind limbs long. Thighs somewhat robust. Upper surface with some warts, spiculae and coni extending up the thighs. Inner tarsal fold evident and fleshy, 1/2– 2/3 of the tarsal length. Tubercles on outer edge of tarsus absent. Foot and tibia lengths 37.7% and 43.9% of SVL in the female, 35.9–41.8% ($\bar{x}$ = 38.8 ± 2.4) and 36.5–43.4% ($\bar{x}$ = 40.8 ± 2.6) of SVL in the males. Toes with fleshy, bulbous tips. Toes basally webbed. Foot-webbing formula **I**(1–1.5)–(1.5–2^{+})**II**(1–1.5)–(3–3^{+})**III**(1.5–2^{-})–(3⅓–3⅔)**IV**(3⅓–3⅔)–(1–2^{+})**V**. Supernumerary plantar tubercles low, round, scarce. Metatarsal inner tubercle elongate to oval, 1.2–1.3 times size of oval to round outer tubercle. Metatarsal fold absent (Figure 9). *Musculus adductor longus* present. *Omosternum* present.

Tongue rounded, not notched posteriorly, 2/3 of its extension adherent to floor of mouth. Choanae rounded to oval, large, not concealed by palatal shelf of maxillary arch. Males with small, subgular vocal sac; vocal slits long, lateral and posterior to tongue. Nuptial pads dark brown or cream on fingers **I** and **II**. Cloacal opening towards the middle level of thighs (Figure 4C).

Colouration in life. (Based on DFC´s filed notes and color slides). Dorsal background colouration varying from pale to dark brown, orange-brown or olive-brown. Most specimens have low, dark brown to black warts scattered on dorsal surfaces. Parotoid glands slightly paler than dorsal colouration in most specimens. Background colouration on the sides of the head, tympanic area, arms, legs, flank, and groin dark brown to black (no flash colours in the groin) usually with pale low warts, especially on the posterior flanks and upper lip. Postrictal warts white to creamish. If legs are pale brown, they usually have dark spots sometimes forming indistinct bands. Background colour of the throat and chest varies from dark brown to black, marbled with cream or white; that on the venter varies from tan-cream to dark brown. White post-cloacal warts. Iris black with abundant bronze to golden punctuations especially concentrated around the golden circumpupillary ring (Figure 2).

Colouration in preservative (70% ethanol). Dorsum light to dark brown. Parotoids yellowish-brown dorsally and dark brown to black laterally in most specimens (some juveniles have the same dorsal colouration throughout). Sides of head light brown. Body flanks dark brown; dorsal and flank colour sharply-separated. Arms and legs black or dark brown with or without dark to black warts; sometimes with indistinct dark bands. Throat and chest dark brown to grey, marbled with cream. Venter cream to dark brown or dark brown with some irregular creamish stain. (Figure 1).

Measurements of female holotype (in mm). SVL: 156.7, HL: 50.3, HW: 59.6, IOD: 19.0, Upper eyelid width: 14.0, Internarial distance: 13.0, Parotoid length: 36.8, Parotoid width: 19.4, Inter-parotoid distance: 31.0, Tympanum diameter: 7.7, Eye diameter: 15.0, Eye-nostril distance: 11.8, Nostril-snout distance: 1.4, Tibia length: 68.8, Foot length: 59.1, Hand length: 37.5.

Measurements of the type series. The measurements of the type series are presented in Table 1.

TABLE 1. Measurement (in millimeters) of the type series of *Rhaebo ecuadorensis* sp. nov.

	QCAZ 32715	QCAZ 38325	QCAZ 26558	QCAZ 23887	QCAZ 38113	QCAZ 36767	DHMECN 4667
SEX	Female	Male	Male	Male	Male	Male	Male
SVL	156.7	95.5	95.8	122.0	92.8	100.4	127.0
HL	50.3	31.8	32.5	38.4	31.0	31.7	41.8
HW	59.6	36.5	36.8	45.0	35.7	36.7	47.3
IOD	19.0	12.2	12.8	14.2	12.1	12.6	17.8
Upper eyelid width	14.0	9.5	9.8	10.6	9.6	9.5	12.9
Eye-nostril distance	11.8	7.1	6.4	9.1	6.6	7.1	8.8
Eye diameter	15.0	12.6	9.5	11.5	10.0	11.1	12.4
Nostril-snout distance	1.4	1.8	1.9	2.1	1.4	2.2	2.2
Internarial distance	13.0	8.6	7.8	10.5	7.8	8.4	10.1
Tympanum diameter	7.7	5.9	4.2	6.1	4.5	5.7	6.1
Parotoid length	36.8	24.3	23.1	28.3	22.8	24.7	24.4
Parotoid width	19.4	12.9	12.8	15.3	12.6	14.0	15.1
Inter-parotoid distance	31.0	21.8	20.5	21.9	20.3	21.5	24.6
Tibia length	68.8	34.9	39.1	52.9	39.1	39.3	54.3
Foot length	59.1	34.3	39.7	47.0	38.8	36.7	49.1
Hand length	37.5	23.7	26.4	30.6	27.1	26.2	33.7

Natural history. Most specimens have been found on the leaf litter, especially after heavy rains. At the Tiputini Biodiversity Station, Province of Orellana, Ecuador, *Rhaebo ecuadorensis* was usually found in Lowland Evergreen Non-Flooded forests (= terra firme forests) amidst the leaf litter in the vicinities of small creeks during the late afternoon and early evening. QCAZ 32715 and QCAZ 23887 were collected on a paved road in an area of Terra firme forest. QCAZ 38325 was collected at the margin of a stream (about 3 m width). This specimen exuded a yellow excretion from the parotoid glands. QCAZ 36767 was collected on leaf litter. Other specimens have been found under trunks or among stones in the river banks.

Etymology. The specific name of this new species is proposed to honour the Republic of Ecuador, as a tribute to its people and natural diversity. Despite being one of the smallest countries on the continent of South America, Ecuador is one of the 10 megadiverse countries of the world. The examination of Ecuadorian material allowed us to determine the existence of this undescribed species of *Rhaebo* previously confused with *R. glaberrimus* and *R. guttatus*.

Conservation status. Unfortunately the information available on the current state of *Rhaebo ecuadorensis* populations, and the current state of their habitat is limited, so we suggest categorize *Rhaebo ecuadorensis* as Data Deficient (DD).

Distribution. *Rhaebo ecuadoriensis* is distributed across the Amazonian regions of southeastern Colombia, Ecuador, and northern Peru, at elevations between 215–1100 m a.s.l. (Figure 3). Although we do not examine directly the specimens reported by Lötters *et al.* (2000), according to their comments and personal observations of JJM (see Remarks) we conclude that *Rhaebo ecuadorensis* also is distributed from Central Amazon of Brazil and Bolivia.

Remarks. Recently we found a specimen of *Rhaebo* (QCAZ 3812), collected in Taisha, Provincia de Morona Santiago, Ecuador, ca. 2°20'26”S 77°27'34"W (Figure 3), phenetically similar to *R. ecuadorensis*. The specimen is an adult female with numerous eggs and well convoluted oviducts, of 94.0 mm SVL (versus 156.7mm in the holotype of *R. ecuadorensis*). Externally we do not find marked differences other than SVL, to recognize this specimen as another different species, for this reason we refer this specimen to *R. ecuadorensis*, until more specimens are collected and studied.

Aguilar *et al.* (2010) reported "*Rhaebo glaberrimus*" from Peru, between 300-1400 m a.s.l.; however, although we did not examine directly specimens from Peruvian Amazon, we confirmed the report of *Rhaebo ecuadorensis* to

Peru from the picture provided by Schlüter (1981) of a specimen of Panguana (Figure 3), a tributary of the Rio Pachitea (at 9 °37'S 74°56'W, ca. 260 m a.s.l.), clearly without preocular ridge. Rodriguez & Duellman (1994) reported a photograph of "*R. glaberrimus*" of a specimen from Iquitos region, but the photo quality is not very good, and it is not possible to distinguish with certainty whether this specimen corresponds to *R. ecuadorensis* or to a juvenile of *Rhaebo guttatus*, therefore the identity of this specimen is in doubt and must be confirmed by direct examination.

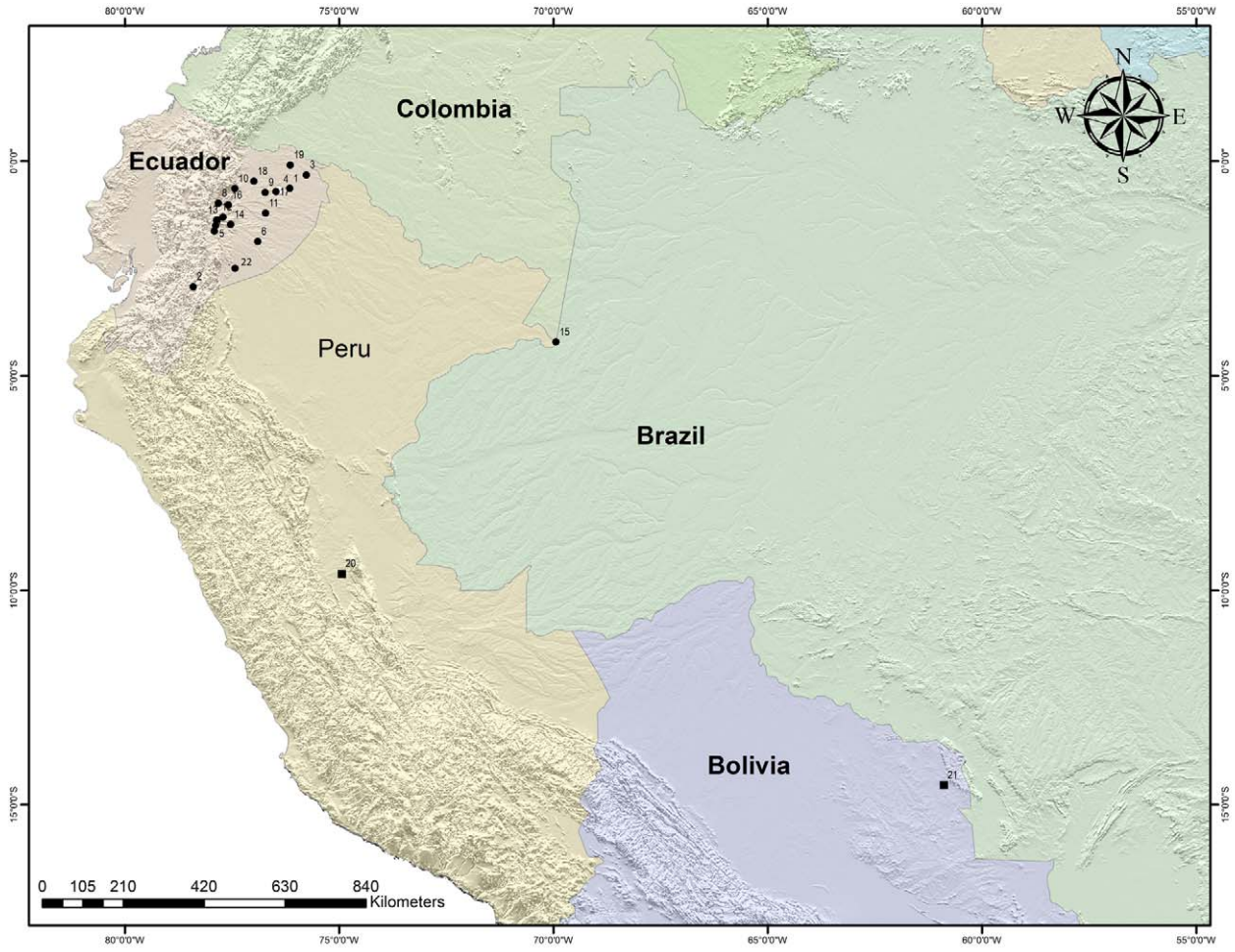

FIGURE 3. Geographic distribution of *Rhaebo ecuadorensis* sp. nov. 1. Estación Biológica Tiputini; 2. Quebrada Napinaza; 3. Cuyabeno; 4. Type locality (white circle): Parque Nacional Yasuní; 5. Bobonaza; 6. Conambo; 7. El Porvenir; 8. Río Misahuallí; 9. Bloque Shiripuno; 10. Ávila Viejo; 11. Cononaco; 12. Pablo López de Oglán; 13. Río Pucayacu; 14. Diez de Agosto; 15. Leticia; 16. Pusuno; 17. Tivacuno; 18. Coca; 19. Puerto Bolivar; 20.Panguana; 21.Parque Nacional Noel Kempff; 22. Taisha. Squares represent literature records from Schlüter (1981) and Lötters *et al.* (2000).

Lötters *et al.* (2000) examined three specimens of *Rhaebo ecuadorensis* (as *R. glaberrimus*) from Ecuador, adult specimens of *Rhaebo guttatus* from French Guyana and subadults from the Central Amazon of Brazil, and four specimens *of Rhaebo guttatus* from Bolivia. From his observations we can distinguish that one of the specimens of the Central Amazon of Brazil, and a specimen from Bolivia, do not present preocular ridge and ventrally differ from the general coloration of *R. guttatus*. JJM noted that the condition of the preocular ridge in *Rhaebo guttatus*, can be seen externally in juveniles from 25.5 mm SVL, so that the specimen reported by Lötters *et al.* (2000) from Brazilian Central Amazon (with 32.2 mm SVL) without preocular ridge may be referred to *R. ecuadorensis*. Meanwhile, the exemplar of Bolivia (CBF 3345), from Parque Nacional Noel Kempff, Provincia Velasco, Departamento Santa Cruz (Figure 3), although it is a little smaller than the observed by JJM (20.0 mm SVL), can also be referred to *Rhaebo ecuadorensis*, confirming the presence of *R. ecuadorensis* in Brazil and Bolivia. Finally, JJM, in search of additional records of *Rhaebo ecuadorensis* in the Central Amazon of Brazil, examined photographs of

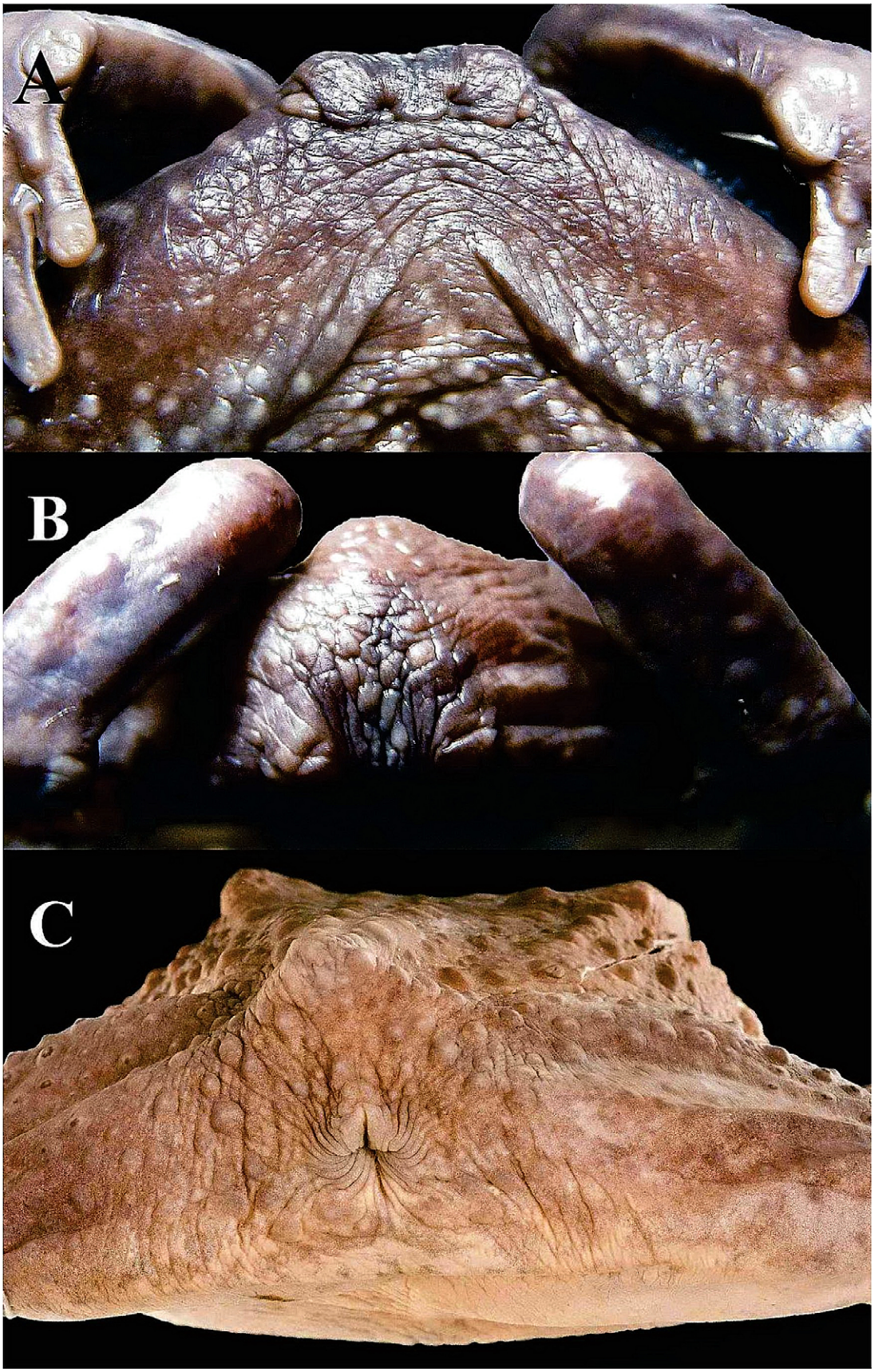

FIGURE 4. Cloacal opening: Towards the ventral level of the thighs in *Rhaebo glaberrimus* (**A**–**B**), ICN 04969, adult male, 59.9mm SVL. Photos by Jonh Jairo Mueses-Cisneros. Towards the middle level of the thighs in *Rhaebo ecuadorensis* (**C**), QCAZ 23887, adult female, 122.0 mm. SVL. Photo by Luis A. Coloma.

two specimens deposited at Coleção de Vertebrados da Universidade Federal de Mato Grosso (UFMT), kindly provided by Dr. Robson Avila; however, both specimens [UFMT 5485 from Aripuanã municipality (59º 27'W, 10º 9'S), Northern Mato Grosso State, Brazil, and UFMT 5850 from Araputanga (15°08'S 58°54'W), western Mato Grosso State, Brazil] are *Rhaebo guttatus*.

Species of *Rhaebo* phenetically similar to *Rhaebo ecuadorensis*

***Rhaebo glaberrimus*— (Figures 5, 6).** This species is distinguished from other known species of *Rhaebo* by having the cloacal opening near the inferior part of the thighs in females or ventrally in males (Figure 4A–B); most specimens also show flash-colours in the groin (pink and/or yellow). It is phenetically similar to *R. guttatus* from which it differs by body size (121.3–146.9 mm SVL in males of *R. guttatus* vs. 49.6–64.6 mm SVL in males of *R. glaberrimus*), by the absence of the preocular ridge (present in *R. guttatus*) and by the colouration pattern (Figure 5).

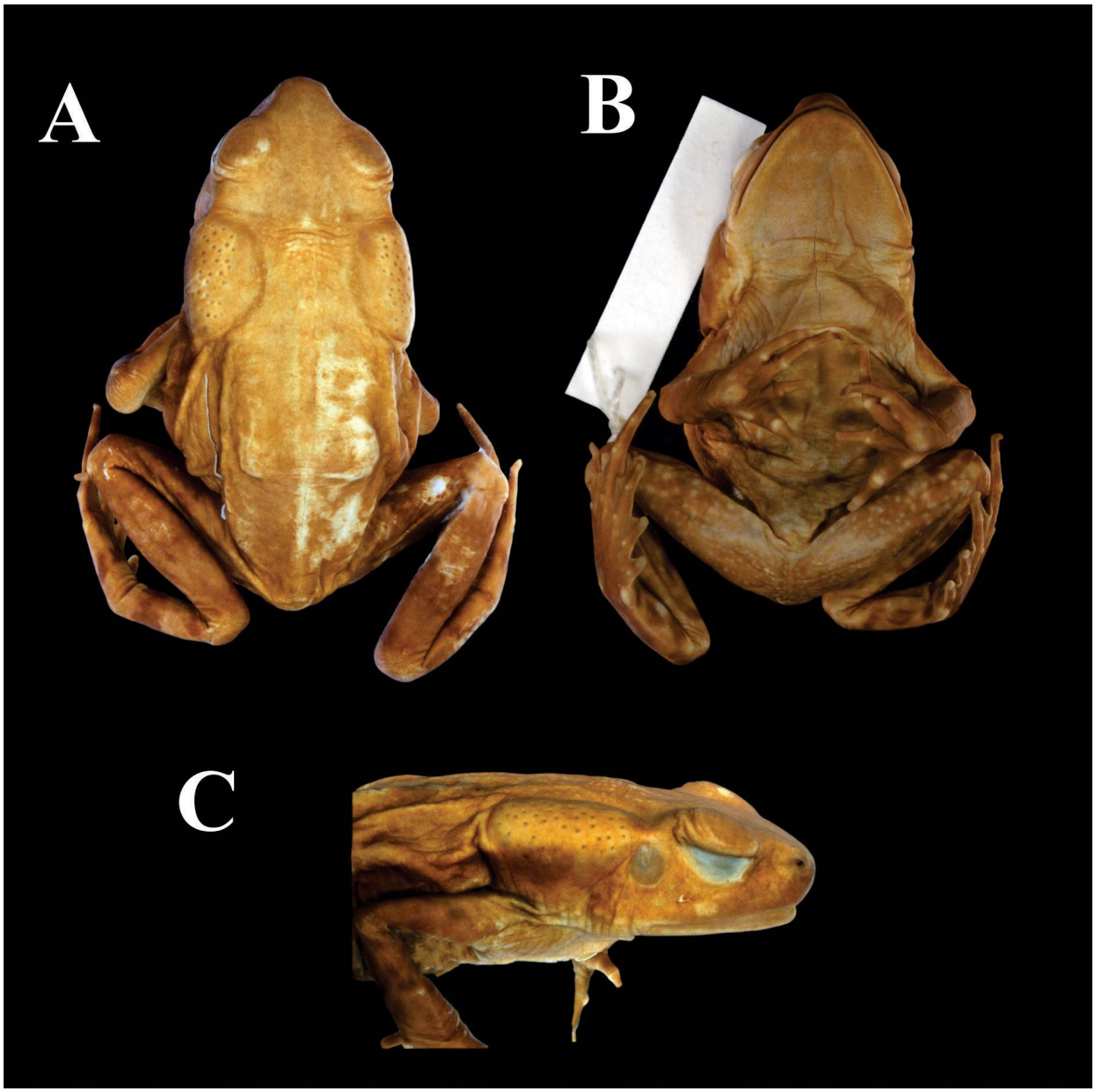

FIGURE 5. Holotype of *Bufo glaberrimus*. BM 1947.2.20.56. Dorsal (**A**), ventral (**B**) and lateral (**C**) views. © The Natural History Museum, London (2010). All rights reserved. Photos by Martín Bustamante.

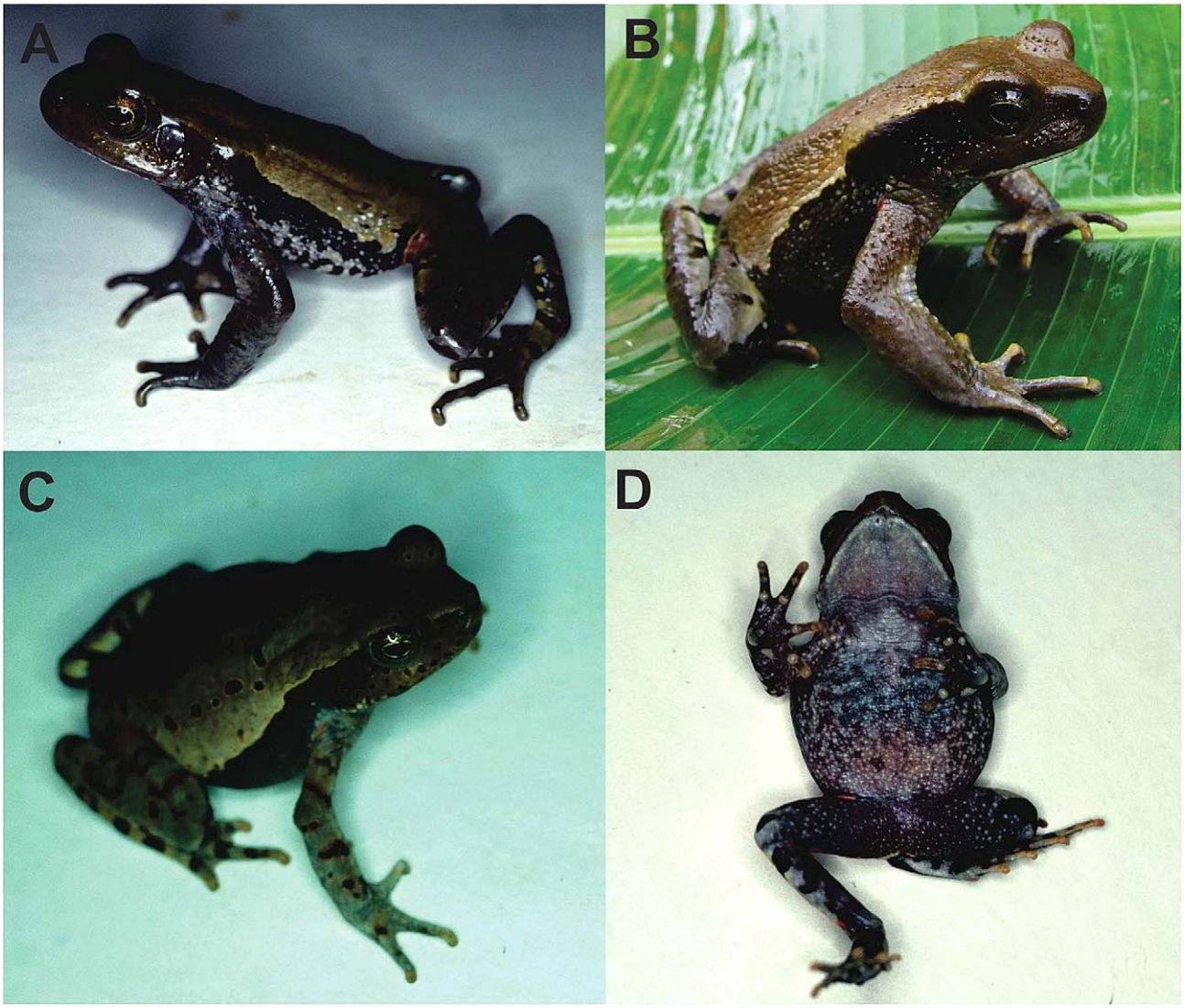

FIGURE 6. *Rhaebo glaberrimus* in situ. Dorsolateral (**A-C)** and ventral (**D**) views. **A**: adult male, 63.9 mm. SVL, ICN 4774. Photo by J.D. Lynch; **B**. adult, JJM 2229, from Villavicencio, Meta. Photo by J. J. Mueses-Cisneros, **C-D:** juvenile female, 31.9 mm. SVL, ICN 4775. Photos by J.D. Lynch.

Distribution. *R. glaberrimus* is distributed in Colombia along the eastern flank of the Cordillera Oriental, in the departments of Boyacá, Casanare, Cundinamarca, and Meta between 520–1470 m a.s.l. (although Ruiz-Carranza *et al* (1996) reported its distribution between 300 and 1240 m a.s.l.), and in Venezuela in the state of Táchira between 300–1400 m a.s.l. (Chacón *et al* 2002 "2000").

Colouration in life. (Figure 6). "Orange-brown dorsally, cream-bordered dark brown flanks; coppery-golden iris with black punctuations; forelimbs gray with greenish shadows; dark gray throat with a light gray line on the mandible; venter dark gray with cream spots; anterior part of hind limbs with pale yellow marks; groin, axilla, and posterior part of hind limbs mottled with pale reddish" (John D. Lynch, field notes, 26 July 1986). "Golden parotoid glands; yellowish brown dorsum with olive-green shadows, flanks and sides of head brown; lower parts of the glands reddish-brown; groin and hidden parts of hind legs orange-brown; brown iris with golden punctuations" (John D. Lynch, field notes, June 1989).

Colouration in preservative. (Figure 5). Light or dark brown or cream dorsum, with or without rounded or irregular light-bordered dark brown marks; hind limbs with dark brown bars and cream or light to dark brown background; bicoloured flanks (dorsally light/ventrally dark brown) or not; venter cream or light to dark brown with dark brown reticulation; pink or yellowish groin; anterior and posterior parts of hind limbs with irregular dark brown marks.

Natural history. A calling male was found on a rock next to a waterfall; the call was a series of short soft

whistles (J. D. Lynch, field notes, June 1989). Specimens have been found under stones next to roads or amidst leaf litter in primary and secondary Terra Firme forests.

Measurements. Measurements of 20 adult examined specimens are presented in Table 2.

TABLE 2. Measurements (in millimeters) of *Rhaebo glaberrimus* and *Rhaebo guttatus.* Range of measurements (mean ± standard deviation).

Measurement	*R. glaberrimus*		*R. guttatus*	
	Males (n=16)	Females (n=4)	Males (n=4)	Female (n=1)
SVL	49.6–64.6 (57.1±4.4)	58.8–71.5 (66.4±5.5)	121.3–146.9 (129.2±12.0)	174.3
HL	17.8–21.1 (19.2±1.0)	20.0–22.5 (21.6±1.3)	35.0–47.0 (39.3±5.4)	53.5
HW	18.7–21.7 (20.1±1.0)	20.9–23.1 (22.3±1.3)	41.1–54.7 (46.0±6.2)	63.6
IOD	5.6–7.7 (6.5±0.6)	6.4–7.4 (7.0±0.6)	15.5–19.9 (17.0±2.1)	21.7
Upper eyelid width	5.1–6.1 (5.7±0.3)	5.7–6.5 (6.0±0.4)	8.0–15.5 (10.4±3.5)	14.8
Internarial distance	4.2–5.7 (5.0±0.5)	5.7–6.2 (5.9±0.3)	9.7–13.2 (11.0±1.6)	16.4
Eye diameter	5.6–7.1 (6.4±0.5)	6.3–7.2 (6.6±0.5)	10.3–13.6 (11.7±1.6)	15.5
Eye-nostril distance	3.7–5.7 (4.3±0.6)	4.7–5.0 (4.8±0.2)	8.0–12.0 (9.7±1.7)	14.0
Nostril-snout distance	1.0–2.9 (1.7±0.5)	1.8–3.0 (2.3±0.7)	1.0–2.9 (1.7±0.9)	1.9
Tibia length	22.3–26.9 (24.0±1.6)	24.5–27.8 (26.2±1.6)	41.8–53.4 (46.6±4.9)	65.7
Tympanum diameter	2.8–4.1 (3.5±0.4)	3.0–3.9 (3.4±0.5)	4.9–7.2 (6.0±1.1)	8.1
Foot length	22.6–27.1 (24.1±1.4)	28.0–29.1 (28.5±0.5)	39.1–52.6 (43.7±6.1)	55.7
Hand length	14.8–19.5 (16.1±1.4)	16.8–19.0 (17.9±1.1)	25.4–34.5 (28.8±4.1)	40.5
Parotoid length	11.7–18.2 (12.7±2.0)	9.2–16.0 (13.2±3.5)	23.7–30.0 (28.1±3.0)	41.2
Parotoid width	5.2–8.9 (7.0±1.2)	7.2–8.4 (7.8±0.6)	16.2–28.2 (20.2±5.6)	19.2
Inter-parotoid distance	10.6–16.8 (12.7±1.8)	12.9–13.5 (13.3±0.3)	19.6–27.6 (22.5±3.7)	33.5

Variation. The dorsal colouration in life is variable (Figure 6), from greenish brown to dark brown, with or without dark marks. Ventral colour may vary from dark brown with cream spots to cream with dark marks. Some specimens have a pink groin while others have it yellow-coloured, but five specimens have both yellow and pink. In lateral profile the snout shape has some slight variations.

Remarks. JJM examines two specimens of *R. glaberrimus* deposited in the Museo San José de Medellin (MHNCSJ 153–4), collected apparently in Albán Cundinamarca (western flank of the Cordillera Oriental of Colombia), however because these are the only two specimens purportedly collected on the western side of the Cordillera, it is very probable that the locality is in error. This place has also been visited on several occasions by J. D. Lynch and some experienced collectors, but none of them found a specimen of this species. Consequently and until more specimens of *R. glaberrimus* are collected on this flank of the Cordillera or in nearby localities, we consider these records doubtful.

Likewise, is very probable that the locality "Bogotá, Cundinamarca", recognized as the type locality of the species (Frost 2011) is also an error. Günther 1869, in his description of *Bufo glaberrimus* wrote: "We have received a single example from Bogotá…", however, this does not indicate that this specimen was actually collected in Bogotá. We believe that this locality is an error, because Bogotá is located at 2600 m a.s.l. (the range of distribution of the species does not exceed 1500 m), the habitats present in Bogotá are very different from the habitats where *Rhaebo glaberrimus* is distributed, and none of the studies in Bogotá and its surroundings (Lynch and Rengifo 2001) have detected the presence of *R. glaberrimus* in this region.

Cochran and Goin (1970) reported three specimens (FMNH [CNHM] 61767–9) as *R. glaberrimus* from Alto de Quimarí, Bolívar, Colombia; after careful examination of dorsal and ventral photographs of these specimens, it is clear to us that they are juvenile *R. blombergi* (Figure 10A). Further, they were not collected in the Department of Bolívar, but in the Department of Nariño (Alan Resetar pers. comm.). Cochran and Goin (1970) also reported two specimens (USNM 144569–70) of *Rhaebo glaberrimus* from Amanavén, Department of Vichada, but photographs revealed the presence of a preocular ridge (Figure 10B) and a distinctive ventral pattern with rounded light spots;

thus we refer them to *Rhaebo guttatus*. The specimens reported by Cochran and Goin (1970) from Buenaventura (Department of Valle del Cauca) are probably in error too, since *R. glaberrimus* is distributed in Colombia in the eastern flank of the Cordillera Oriental, not in the Pacific Region. Duellman and Salas (1991) and Parmelee (1999) reported specimens of *R. glaberrimus* from southern Peru; later Duellman (2005) changed these identifications to *Rhaebo guttatus*. Even though we have not examined those specimens, we agree with his reidentification. Chacón *et al.* (2002 "2000") reported *R. glaberrimus* from Venezuela and provided a brief description.

Almendáriz (1987) provided data on distribution, natural history, stomach contents and an illustration (under the name "*R. glaberrimus"*) based on individuals from Amazonia Central-Eastern Ecuador; however, DFCH examined these specimens and concluded that they are *Rhaebo guttatus*.

***Rhaebo guttatus*— (Figures 7, 8).**This species is known from Bolivia, Brazil, Colombia, Ecuador, Venezuela, and the Guianas, mainly from the Amazonian region. It is easily diagnosed by having a prominent preocular ridge, present even in juveniles. The preocular ridge is actually a bony projection of the posterior lateral edge of the nasal (Figure 8B) that appears as a fleshy lateral projection (Figure 8A) interrupting the *canthus rostralis* in front of the anterior edge of the superior eyelid.

Colouration in life. (Figure 7A–B)"Brown dorsum with darker grayish brown spots, border between the dorsum and the flanks with a thin yellow line down to the groin; dark brown flanks; dark brown legs with black spots; dark gray venter with yellowish-cream spots; bronze iris" (Claudia Vélez, field notes). "Reddish brown dorsum, terracotta-red warts; chocolate brown venter" (Juan Manuel Renjifo, field notes).

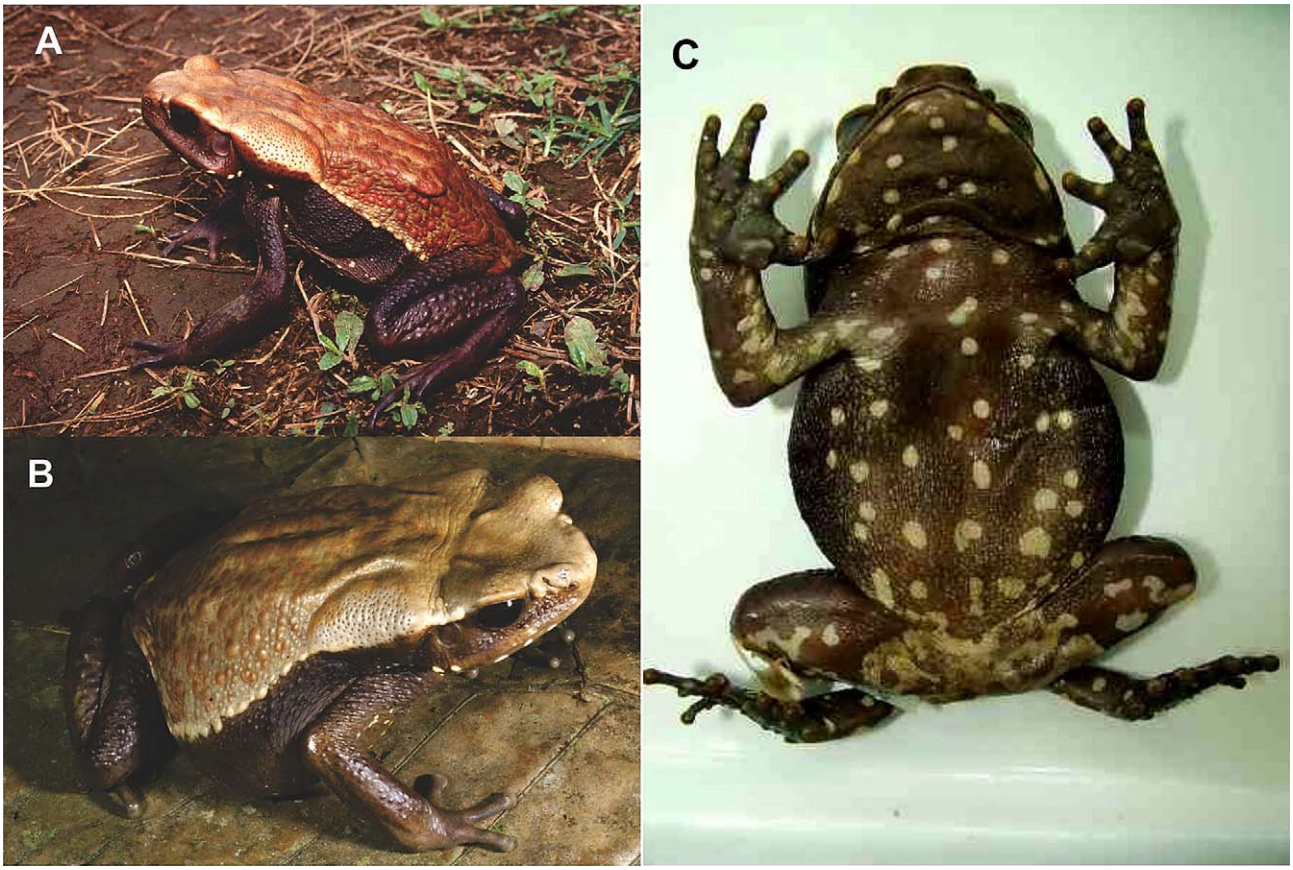

FIGURE 7. *Rhaebo guttatus* in situ (**A–B**) from Ecuador. Photos by Martín Bustamante, and ventral view in preservative (**C**), ICN 51939, adult male, 126.6mm SVL. Photo by Francisco López-López.

Colouration in ethanol. (Figure 7C). Light brown dorsally, parotoid glands orange-brown to dark brown; flanks and legs dark to gray brown; dark brown or gray ventrally with irregularly-sized rounded creamish spots.

Natural History. Duellman (2005) presented information on this species in southern Peru and included an analysis of the advertisement call and a description of the tadpole. Rivero (1961) mentioned *R. guttatus* preferring soils covered by leaf litter in humid regions, despite specimens cited by Ardila-Robayo and Ruiz-Carranza (1997)

collected at the hospital at Vaupés. Lötters *et al.* (2000) presented information on collecting localities in Bolivia, mentioning that when manipulated, specimens produced a yellowish substance from its parotoid glands. Juvenile males have enlarged thin testes, without convolutions seen in adult males.

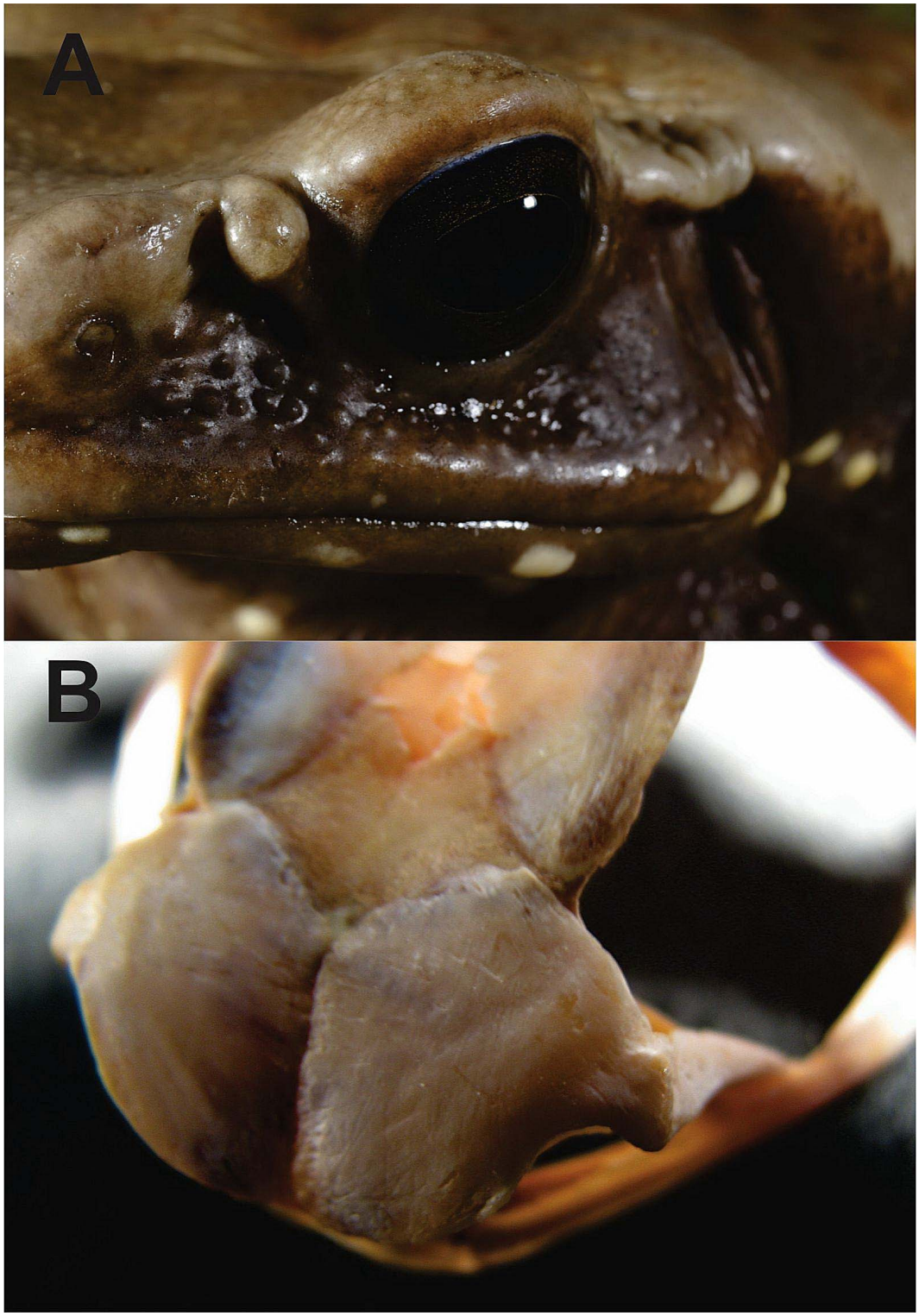

FIGURE 8. Preocular ridge **(A)** or bony projection of the posterior lateral edge of the nasal **(B)** in *Rhaebo guttatus*. **A:** photo by Martín Bustamante. **B:** ICN 54716, adult male, 122.2mm SVL. Photo by J. J. Mueses-Cisneros.

Measurements. For adult specimens provided on Table 2.

Remarks. Rivero (1961) reported specimens from Venezuela, briefly described the species, and included information on coloration and natural history. Rivero also pointed out that the type-locality of *R. guttatus* ("India

orientali") is in error, and that it was actually collected in Surinam by Bloch. Ruiz-Carranza *et al.* (1996) reported juveniles [as *Bufo anderssoni*] from the lower Vaupés and lower Vichada drainages and published a photograph of a juvenile female. Barrio-Amorós (1999 "1998") presented records of the species from southern Venezuela and mentioned that specimens collected in the Andean foothills of the state of Táchira, are either *R. anderssoni* or *R. glaberrimus*. Lötters *et al.* (2000) reported the *R. guttatus* from Bolivia and pointed out some characters that differentiate it from *R. ecuadorensis* [as *Bufo glaberrimus*], remarking that *R. guttatus* has a preocular ridge. De la Riva *et al.* (2000) mentioned records from Bolivia and included a photograph. Barrio-Amorós *et al.* (2001) reported it from Santa María del Orinoco in Estado Apure, Venezuela, and Bustamante *et al.* (2005) published the first vouchered records of this species from the provinces of Orellana and Sucumbíos, Ecuador. Mueses-Cisneros (2007) and Barrio-Amorós and Castroviejo-Fisher (2008) synonymized *Rhaebo anderssoni* with *R. guttatus* as suggested by Rivero (1961) and Hoogmoed (1990). Pramuk (2006) and Pramuk *et al.* (2007) hypothesized that *R. guttatus* was the sister taxon of *R. ecuadorensis* (as *Rhaebo glaberrimus*).

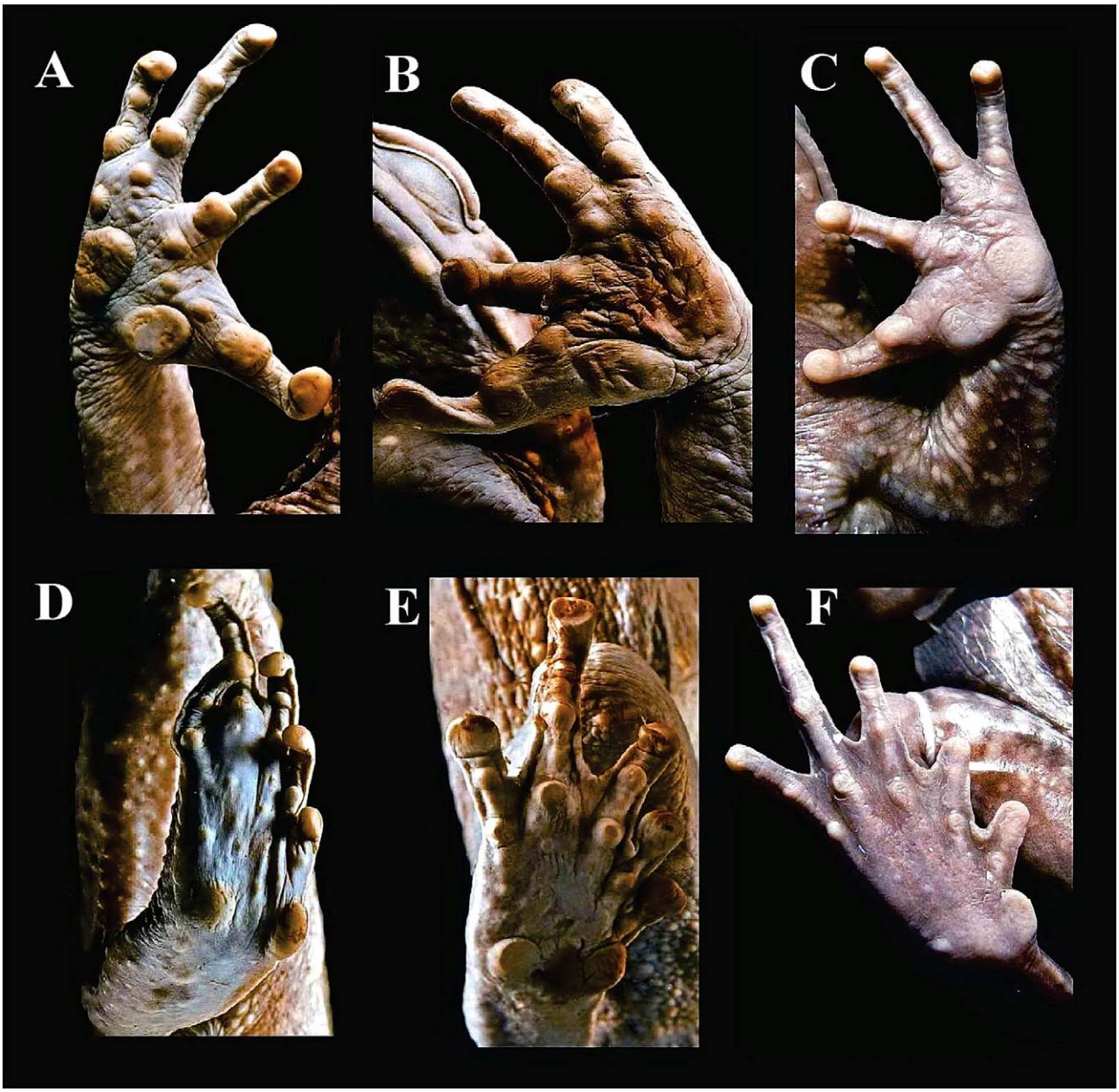

FIGURE 9. Hands and feet in: *Rhaebo ecuadorensis* (A and D), holotype, QCAZ 32715, adult female, 156.7mm. SVL; *Rhaebo guttatus* (B and E), QCAZ 26414, adult female, 174.3mm SVL. Photos by Luis Coloma; and *Rhaebo glaberrimus* (C and F), ICN 04969, adult male, 59.9mm SVL. Photos by J. J. Mueses-Cisneros.

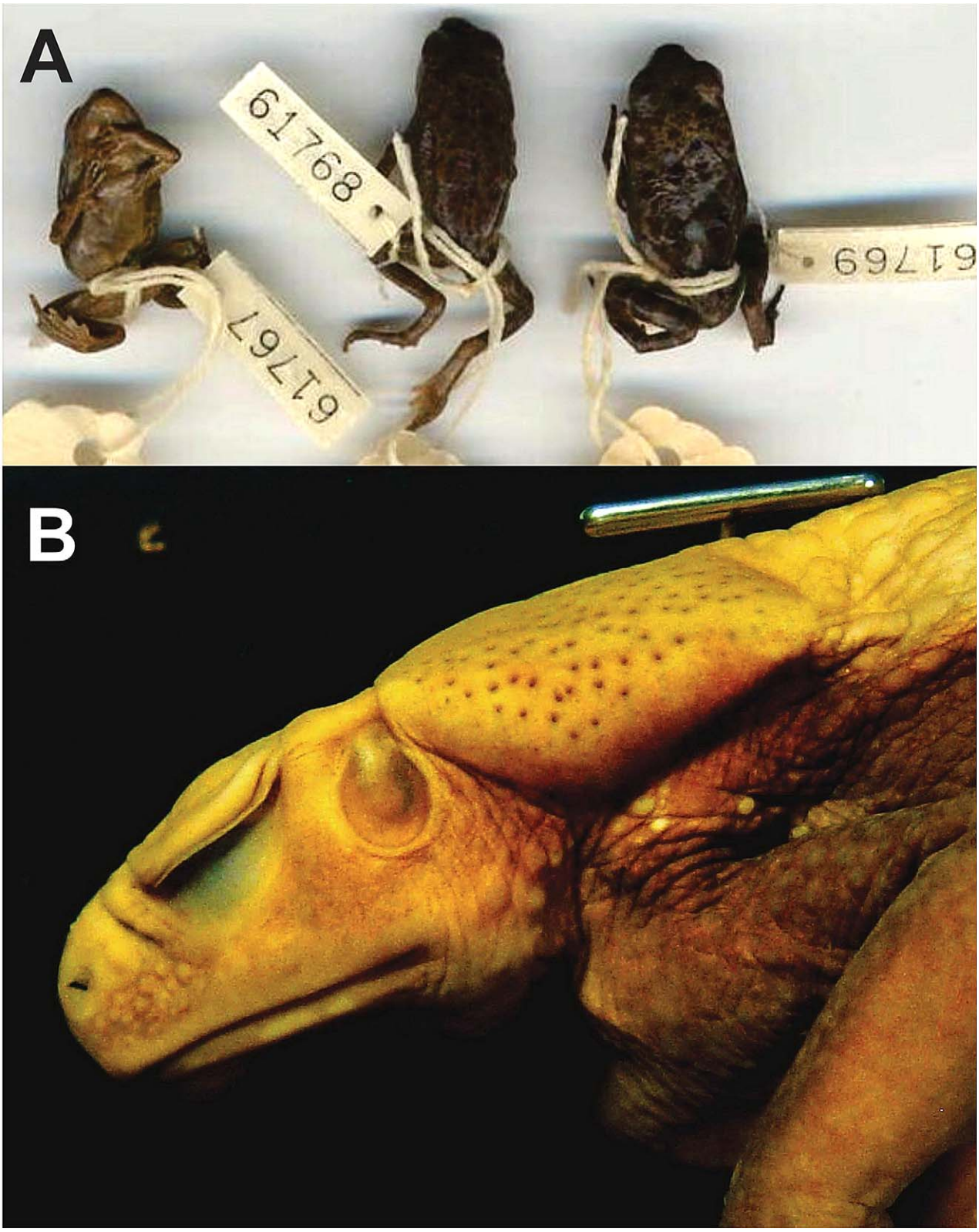

FIGURE 10. Misidentified specimens of *Rhaebo* species reported by Cochran and Goin (1970). (**A**). *Rhaebo blombergi* erroneously reported as *R. glaberrimus*, juveniles FMNH [CNHM] 61767–9. Photo by Alan Resetar. (**B**). *Rhaebo guttatus* erroneously reported as *R. glaberrimus*. USNM 144569. Photo by Felipe Franco Curcio.

Discussion

The description of *Rhaebo ecuadorensis* increases the number of described species of this genus to ten, clarifying the identity and geographic distribution of *Rhaebo glaberrimus* and *Rhaebo guttatus*. The new species is the sixth of the genus *Rhaebo* occurring in Ecuador (*Rhaebo andinophrynoides*, *Rhaebo blombergi*, *Rhaebo caeruleostictus*, *Rhaebo ecuadorensis*, *Rhaebo guttatus* and *Rhaebo haematiticus*). Unfortunately we could not directly examine specimens from the Peruvian Amazon, Bolivia and Brazil; therefore we recommend a careful revision of all specimens previously identified as *Rhaebo guttatus* and "*Rhaebo glaberrimus*" in collection from central and southern Peru, Bolivia, and Brazil to verify their identity.

Acknowledgments

We are thankful to the following people who granted access to collections under their care or loaned us specimens: José Pombal Jr. (MNRJ); Andrés Acosta (MUJ); Santiago Ayerbe, María del Pilar Rivas, and Jimmy Guerrero (MHNUC); Belisario Cepeda (PSO-CZ); Hermano Roque Casallas and Arturo Rodríguez (MLS); Fernando Castro and Angela María Cortés (UV-C); John D. Lynch (ICN); Afranio Ortiz Castellanos (MHNCSJ); Vivian Páez and Lucas Barrientos (MHUA); Diego Perico (IAvH); Ana Almendáriz (EPN); Luis A. Coloma (QCAZ) and Mario H. Yánez-Muñoz (DHMECN). We also are grateful to Luis A. Coloma, Mauricio Ortega, Felipe Franco Curcio, Martin Bustamante, J. D. Lynch, Alan Resetar, The Natural History Museum, London and Francisco López-López for allowing the use of their photographs. To Felipe Franco Curcio (Universidade de Sao Paulo, Brazil), Maureen Kearney and Alan Resetar (Field Museum of Natural History), David Gower, Mark Wilkinson, Barry Clarke, and Colin McCarthy (The Natural History Museum, London), William E. Duellman (KU), Caroline Pepermans and Egmond, J. van (National Museum of Natural History Naturalis, Leiden), Ned Gilmore (The Academy of Natural Sciences, Philadelphia), Goran Nilson (Goteborg Natural History Museum), and Mario Humberto Yañez-Muñoz (DHMECN) for the photographs of specimens deposited in their collections. To Mauricio Ortega (Fundación Ecociencia, Ecuador) and Gustavo Torres (Corpoamazonia) for the elaboration of the distribution map (Figure 3) and for providing some geographic coordinates. To Belisario Cepeda-Quilindo, Marvin Anganoy-Criollo, and Giuseppe Gagliardo, for their help in providing literature. DFCH's research was supported by M. E. Heredia and L. Heredia, the Smithsonian Women's Committee, the 2002 Research Training Program at the National Museum of Natural History - Smithsonian Institution, King's College London, Universidad San Francisco de Quito, Conservation International, the Russel E. Train Education for Nature Program of the Word Wildlife Fund WWF, and the "Fernando Ortíz-Crespo" Endangered Species Program managed by EcoCiencia and Conservation International. In June 2010 this project was suspended due to loss of the information because, unfortunately, seven of our computers were stolen while developing fieldwork in Andalucía, Valle del Cauca, Colombia. We have made an enormous effort to reconstruct the manuscript, collect images and check the corrections made by the evaluators. For this reason, we thank the Editorial Board of Zootaxa, especially Dr. Miguel Vences, for allowing us to reconsider publishing this work two years after submission to this journal. We thank the reviewers Luis A. Coloma and Robson Avila for their comments on this manuscript. The final phase of this project was funded by CI-Colombia, Fundación Omacha and Fondo Para la Acción Ambiental (Programa de Becas para la Iniciativa de Especies Amenazadas EIA, convenio 19 de 2011). Gently, Dr. Darrel Frost and Dra. Marilyn Faris have supported the work of JJM and investigations of his team (Fundación para la Investigación en Biodiversidad Amazónica-FIBA) donating equipment and stereoscopes, that strongly advances our understanding of the herpetofauna of southern Colombia.

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APPENDIX I. Specimens examined.

***RHAEBO GLABERRIMUS* (103).** COLOMBIA: **Boyacá,** Macanal, Santa María, Río Garagoa (MLS 551); San Luis de Gaceno; Vereda Arrayanes, 520 m (IAvH 38); Embalse Chivor (ICN 53394); **Casanare**, Nunchía, Vereda Vega del Tabaré, Finca La Esperanza, vega del Río Tocaría (IAvH 6710); **Cundinamarca**, Guayabetal (ICN 2613); Guayabetal, Vereda Chirajaro, Quebrada Curajuara (ICN 13104); Guayabetal, Portachuelo (ICN 12901); Guayabetal, carretera central Bogotá-Villavicencio-Portachuelo, Quebrada El Estado (ICN 26973–4); carretera Bogotá-Villavicencio, abajo de Guayabetal (ICN 4055–6); Medina (MLS 63b–e, 485); Medina, Vereda Choapal, ca. 9 km NNW de Medina, 660 m (ICN 14643–4); Medina, Caño Humea, Sur de Medina (ICN 34583); Ubalá, Mámbita, 700m (MLS 1250); Ubalá, Mámbita, Vereda Boca del Monte, Quebrada La Seca, 1000 m (ICN 40804); Ubalá, Mámbita, margen izquierda Río Sucio, 1300 m (ICN 40805); Paratebueno, Guaicaramo (MLS 63f); **Meta**, Acacías, Vereda Santa Juanía, "Río Cola de Pato", 850 m (ICN 14142–8); Acacías, Portachuelo, 1400 m (ICN 4968); Cubarral, Vereda Las Palomas, Puerto Angostura, 750 m (ICN 53391); Cubarral, Vereda Las Palomas, Puerto Angostura, Río Ariari, 850 m (ICN 53392); Cumaral, Vereda Balastrera, Hacienda Altamira, Caño Atascosa (ICN 36347); Restrepo, Alto Canay, 11 kilómetros arriba de la estación, 1000–1040 m (ICN 21221); Restrepo, Salinas del Alto de Upín (ICN 2873–80, 4774–5, 4840, 4854–5, 4943, 4965–7, 4992, 4994–5004); Restrepo, Salinas de Upín; Quebrada Blanca, antes de la desembocadura del Río Upín (ICN 17299–17300); Restrepo, Salinas de Upín, Quebrada Salinas, 750–760m. (ICN 21222); Restrepo, Salinas de Upín, 720 m (ICN 4969); Restrepo, cerca del Río Caney, 740 m (ICN 5093); Km 12 carretera Guayabetal-Manzanares, 1470 m (ICN 9732–7); Restrepo, Caño Caybe (ICN 36348); Restrepo, Vereda Santa Lucía, Quebrada del Ortez, 920–980 m (ICN 36349–51); Villavicencio (MLS 63, 63a, MHNCSJ 567–8, ICN 53393); Villavicencio, Vereda Buenavista, Caño Blanco, 1300 m (ICN 38792); Villavicencio, Guapi (ICN 2798–9); Villavicencio, parte alta del Caño Maizaro (ICN 26946, 38790–1, 53383–4); salida del Caño Maizaro (ICN 53390); Villavicencio, km13 carretera Villavicencio-Acacías, Hacienda Las Brisas (ICN 20524–7); Villavicencio, carretera Villavicencio-Pipiral (MLS 497); Villavicencio, Pozo Azul (ICN 53385–89).

RHAEBO GUTTATUS (19). BRAZIL: Vila Surumu, Mun. Pacaraima, RR (MNURJ 25168); Acampamento base, Barcelos, AM (MNURJ 36239); Tucuruí, PA (MNURJ 42823). COLOMBIA: **Amazonas,** Araracuara, sobre Río Caquetá y Quebrada Menta, frente a la casa de Luís Trujillo (ICN 52079); Puerto Rastrojo, Río Mitú-Paraná (IAvH 2502); Corregimiento de Santander, comunidad Peña Roja, Río Caquetá (ICN 51939); **Caquetá**, Puerto Abeja, Río Mesay, 240 m (ICN 37153); **Meta**, La Macarena, desembocadura Caño La Cabra (IAvH 2380); **Vaupés**, Mitú: Villa Fátima, Centro Educativo Santa Cruz (ICN 34808); Hospital (ICN 3278); **Vichada**, San José de Ocuré, Cunaibo, Comunidad Pilón, 120 m (ICN 37154–5); Territorio Faunístico El Tuparro, Río Tomo, 30 km al oeste de la boca sobre el Río Orinoco (IAvH 316); two adult specimens without locality. ECUADOR: Provincia del Napo, Estación Biológica Tiputini, Universidad San Francisco de Quito (USFQ), 250 m (QCAZ 10211); Provincia de Orellana, Estación Científica Yasuní, Pontificia Universidad Católica del Ecuador (QCAZ 19247); Provincia de Sucumbíos, Puerto Bolívar, 0°05'19.0"S 76°08'31.3"W, 240m. (QCAZ 26014, 26414).