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A NEW DIAGNOSIS AND DESCRIPTION OF VARIATION AMONG ADULT *RHINELLA CERATOPHRYS* (BOULENGER) (AMPHIBIA: BUFONIDAE), WITH NOTES ON ECOLOGY AND DISTRIBUTION

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ABSTRACT. Published accounts and descriptions of *Rhinella ceratophrys* Boulenger, 1882 were all based on juvenile specimens until 1994, thus it had generally been presumed to be a diminutive species. Based on examination of additional material, including adult specimens, as well as the holotype, we here report on variation in this large-sized bufonid toad and provide a new diagnosis for the species. Additionally, we present notes on the ecology and distribution of this species.

KEYWORDS. Bufonidae, *Rhinella*, South America, Taxonomy, Ecology.

INTRODUCTION

In 1882, Boulenger described *Bufo ceratophrys*, now *Rhinella ceratophrys* (*sensu* Chaparro *et al.*, 2007; Frost, 2011), from a juvenile specimen (BMNH 80.12.5.151.) obtained in Ecuador. Early collections included only juvenile individuals, with sizes ranging from 12-35 mm snout-vent length (SVL) (Boulenger, 1882; Cochran and Goin, 1970; Hoogmoed, 1977; Rivero, 1972). These collections led early workers – and indeed those working until nearly the end of 20th century – to characterize the species as a relatively diminutive species compared to most other South American species then referred to the genus *Bufo*. Complicating our understanding of the species is the fact that few specimens of *R. ceratophrys* have been found, and scant information has been published on its ecology. Based on observations in the field and evaluation of museum specimens, we present a description of adult specimens based mostly on a well preserved series from Vaupés, Colombia, as well as a new diagnosis for the species.

Gallardo (1962) included *Rhinella ceratophrys* in the *Bufo* (= *Rhinella*) *marinus* subgroup. Blair (1972) and Hoogmoed (1977) included the taxon in the “*Bufo typhonius*” group. Hoogmoed (1977) considered *Bufo* (= *Rhaebo*) *nasicus* to be the sister taxon to *Rhinella ceratophrys*. Both *Rhinella ceratophrys* and *Rhaebo nasicus* have a projecting flap of skin above each eye and similar dorsal patterns and colors. However, as Hoogmoed (1977) noted, the eyelid process is more developed in *Rhinella ceratophrys*

than in *Rhaebo nasicus*. Hoogmoed (1977) argued that *Rhinella ceratophrys* is the more derived of the two, with *Rhaebo nasicus* representing the “primitive condition.” He indicated then-evident differences including: (1) *Rhinella ceratophrys* not exceeding a snout-vent length (SVL) of 35 mm, (2) *Rhaebo nasicus* not having pointed flaps of skin at the corners of its mouth, (3) the parotoid glands in *Rhaebo nasicus* being less elongate and less pointed, and (4) the presence of paired swellings of skin present above the five anteriormost vertebrae in *Rhinella ceratophrys*, which are absent in *Rhaebo nasicus*. While Hoogmoed (1977) suggested that these two species were likely closely related, he emphasized that he believed they represented distinct species. He based this supposition primarily on differences in size (*Rhinella ceratophrys* reaching approximately 35 mm SVL; *Rhaebo nasicus* reaching nearly 67 mm SVL) and differential degree of development of the fleshy projection over the eyes (large in *Rhinella ceratophrys*; small in *Rhaebo nasicus*). However, Hoogmoed (1977) had available to him only a small number of juvenile specimens of *Rhinella ceratophrys*. Hoogmoed (1990:117) placed *R. ceratophrys* in “the so-called *B. ‘typhonius’* group” and explicitly stated that this decision was tentative, although he did not doubt the specific status of the taxon *ceratophrys* itself. Although its phylogenetic relationship among *Rhinella* species is unknown, Fouquet *et al.* (2007) explicitly removed it from the widespread *R. margaritifera* complex based on absence of morphological synapomorphies in *R. ceratophrys*.

The discovery of additional specimens in the field and in museums indicates that Hoogmoed's (1977) characterization of *Rhinella ceratophrys* must be modified to include variation among adult specimens. It is now evident that the original description by Boulenger (1882) was based on a juvenile specimen, as have been all other accounts prior to that presented by Rodríguez and Duellman (1994). Based on this history of inadequate accounts, we herein present a redescription of *Rhinella ceratophrys* (Boulenger, 1882).

MATERIALS AND METHODS

In order to determine the distribution of *R. ceratophrys*, we compiled a list of all museum records of which we were aware (Appendix I), as well as our own field observations of specimens not collected and reliable published records (Appendix II). The diagnosis and redescription presented are based on examination of well-preserved adult specimens from a wide range of localities. Museum acronyms used herein follow Leviton *et al.* (1985). The sex was determined by direct observation of the gonads and/or secondary sexual characters (*e.g.*, vocal slits in males); small specimens, lacking any secondary sexual characters, were assumed to represent juveniles.

With digital calipers, we took the following measurements of specimens: SVL from the tip of the snout to the vent (SVL); head width at the point of the widest dorsal view of the cranium; head length from angle of jaw to tip of snout; eye-nostril distance measured from the anterior edge of the eye to the center of the nostril; horizontal tympanum diameter from anterior to posterior edge of tympanic ring; hand length from proximal edge of the palmar tubercle to tip of the longest digit; tibia length measuring from tip of knee to base of tarsus on bent leg; foot length from proximal articulation of metatarsal tubercle to tip of the longest digit. Comments on coloration are based on observation of living specimens and photographs of same. Ecological notes are derived from field experience and examination of museum specimens.

Rhinella ceratophrys (Boulenger, 1882)

Bufo ceratophrys Boulenger 1882 – Holotype: BMNH 80.12.5.151; Type locality: “Ecuador”.

Bufo ceratophrys Boulenger, 1882; Gadow, 1901; Nieden, 1923; Gallardo, 1962; Gorham, 1963; Cochran and Goin, 1970; Blair, 1972; Hoogmoed,

1977; Frost, 1985; Coloma, 1991; La Marca, 1992; Rodríguez and Duellman, 1994; Ruíz-Carranza *et al.*, 1996.

Chaunus ceratophrys – Frost Grant, Faivovich, Bain, Haas, Haddad, de Sá, Channing, Wilkinson, Donnellan, Raxworthy, Campbell, Blotto, Moler, Drewes, Nussbaum, Lynch, Green, and Wheeler, 2006.

Rhinella ceratophrys – Chaparro, Pramuk, and Gluesenkamp, 2007; Frost, 2011.

Diagnosis

Rhinella ceratophrys differs from all other species of bufonid anurans in South America by having triangular dermal flaps projecting over the eyelids. Although *Rhinella ceratophrys* historically has been confused with *Rhaebo nasicus*, it is easily distinguished from the latter by having: 1) triangular projecting dermal flaps on the eyelids, 2) projecting dermal flaps at the corners of mouth, and 3) a larger adult size (105 mm SVL maximum known in *Rhinella ceratophrys* vs. 67 mm SVL in *Rhaebo nasicus*). The utility of other putative diagnostic characters, such as shape of parotoid glands and other dermal textures and structures, should await a more complete survey of variation in both species, when additional material becomes available.

Description

Body robust; head wider than long, approximately 33% of SVL in adult females, 35% of SVL in adult males. Head length in adult females is approximately 28% of SVL, and approximately 33% SVL in adult males. Snout pointed in dorsal view, moderately rounded in profile, rostral keel absent; canthus rostralis distinct; canthal, supraorbital, postorbital, supratympanic, and parietal crests absent; preorbital crest present, weakly developed, about 1/3 length of eye-nostril distance; skin on medial surfaces of canthal, supraorbital, postorbital, and lateral surfaces of head, smooth; ocular skin fold present, approximately equal in length to eye diameter, extending from top of head to the beginning of the supratympanic fold, occasionally forming an elevated knob posteromedial to the eye; nostril protuberant, directed laterally; loreal region concave; upper lip barely distinct, rounded; lower lip distinct; one large, triangular rictal tubercle present slightly posterior to the confluence of the upper and lower jaw, surrounded by several smaller tubercles; tympanum distinct, slightly ovoid,

approximately 60% of eye diameter in females, 55% of eye diameter in males; supratympanic fold distinct, terminating at posterior edge of parotoid gland. Forelimbs short, robust, outer edge of forearm bearing a row of ulnar tubercles; prominent, triangular tubercles present at insertion of arm and on anterior surfaces of arm and chest; hand broad, with long fingers, relative lengths of fingers $II < IV < III < I$; webbing absent between fingers I and II, webbing vestigial between fingers II and III and between fingers III and IV; all fingers bearing distinct lateral fringe; tips of fingers with slightly rounded tips, smooth dorsally; palmar tubercles prominent; subarticular tubercles distinct. Hind limbs robust, moderate in length, tibia approximately 48% SVL in females, 49% SVL in males; foot length approximately 39% SVL in females, 41% SVL

in males; tarsal fold absent; inner metatarsal tubercle prominent, ovoid; toes long, slender, relative lengths of toes $I < II < V < III < IV$; distinct lateral fringe on all toes; webbing thin, vestigial; tips of digits not enlarged, slightly rounded, smooth dorsally; subarticular tubercles prominent, raised, oblong in profile; supernumerary tubercles distinct; inner metatarsal tubercles prominent, ovoid; outer metatarsal tubercles prominent, rounded.

Skin on dorsum of body with irregularly spaced conical tubercles, many bearing keratinous apices; distinct dorsolateral ridge of large triangular tubercles extending from the posterior edge of parotoid gland to anterior edge of hindlimbs; parotoid glands larger than eyelids, distinctly raised, elongate in shape, color pattern of dorsolateral ridge splits the parotoid gland

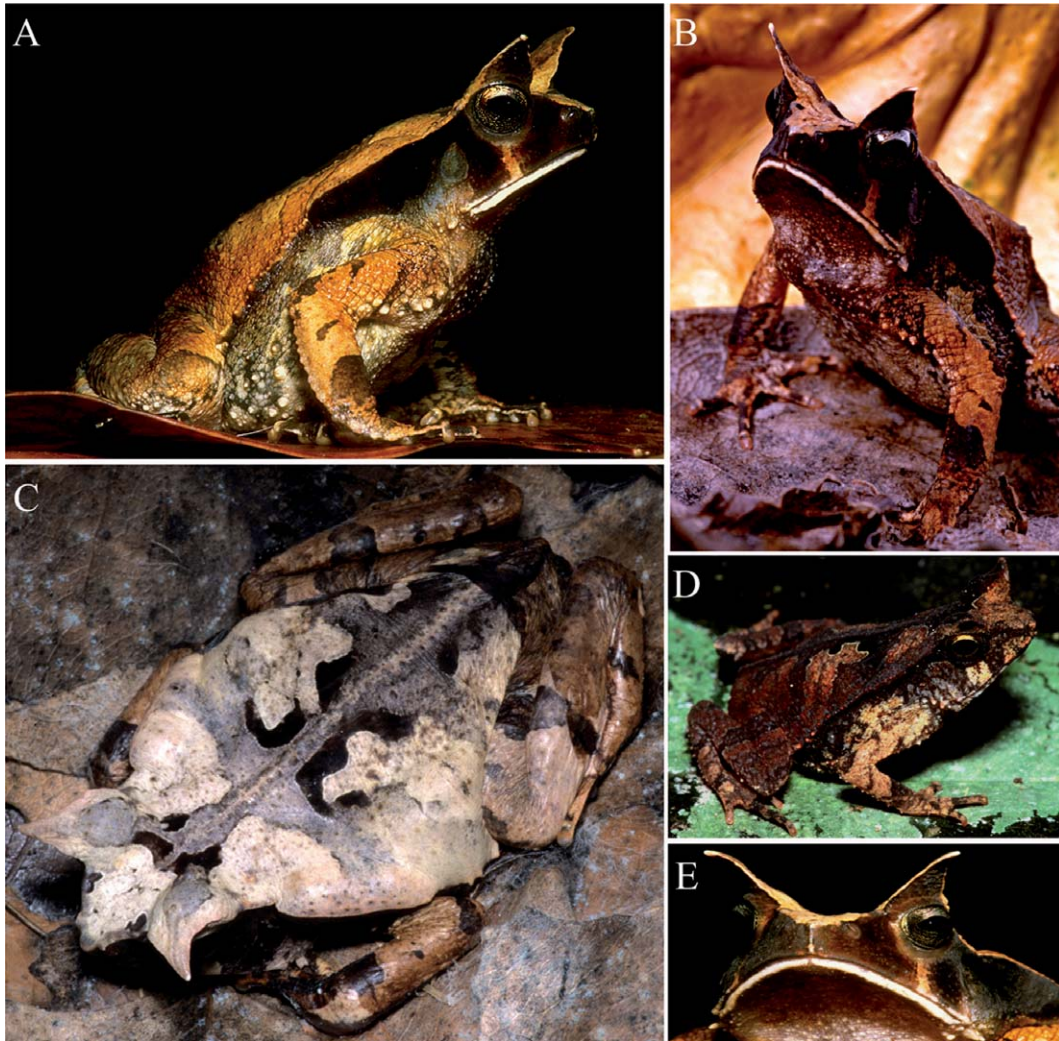


FIGURE 1. A-E. Living specimens of *Rhinella ceratophrys* (measurements not available) from Departamento Loreto, Peru. A, E. adult from Paraíso, middle Río Tigre (left bank), showing supraciliary processes. B. adult from Paraíso showing pale mandible and pronounced rictal tubercles. C. adult from Brillo Nuevo, Río Yaguayacu, showing pale ground color and cryptic pattern; darker color is unshed stratum corneum. D. juvenile from Supay Cocha, Río Apayacu, showing lateral countershading. All photos by D. B. Fenolio or W. W. Lamar.

evenly; texture of parotoid gland tuberculate dorsally, smooth laterally; dorsal surface of forelimbs tuberculate distally (*i.e.*, corresponding to the tibiofibula area), less tuberculate over humerus; dorsal surfaces of legs tuberculate; skin on chest with small, distinct tubercles, ventral surface with smaller conical tubercles. Nuptial excrescences small, poorly developed, appearing as simple fleshy thickenings on base of finger I, no evidence of keratinous spicules.

Choanae large, ovoid, widely spaced, clearly visible; teeth absent; tongue pear-shaped, free posteriorly. Vocal slits bilateral, approximately 1/3 length of tongue.

Coloration in life – The ground color is medium to dark brown dorsally, occasionally with gray to reddish tan or golden brown highlights (Fig. 1). A pale, thin, mid-dorsal line, extending from the tip of the snout to the vent may be evident. A pattern of diffuse darker brown bands beginning posterior to the parotoid glands and often continuing across the thighs and shanks is usually evident. The dorsal pattern may

include dark brown bars radiating from the mid-dorsal stripe to the tips of the supraocular processes. The snout, face, and flanks are primarily dark brown, with or without lighter brow to yellow markings beneath the eyes, tympanum, and in the paraventral region. The tympanum is usually medium brown to gray. The edge of the lower lip is usually cream colored. The forelimbs are pale brown with irregular darker markings. The overall effect is of a dead leaf and paler specimens also are counter shaded by dark lateral coloration. Ventral color ranges from uniformly pale to dark brown, with or without darker mottling. The chin in adult males is uniformly blackish. Some specimens are homogeneously dark dorsally. The iris is brownish bronze with gold highlights dorsally.

Distribution – The Upper Amazon Basin in Venezuela, Colombia, Peru, and Ecuador (Fig. 2). This species undoubtedly reaches its eastern limits in northwestern Brazil, but we are unaware of any records from that region. It would not be surprising if *R. ceratophrys* occurs further north in Colombia, perhaps

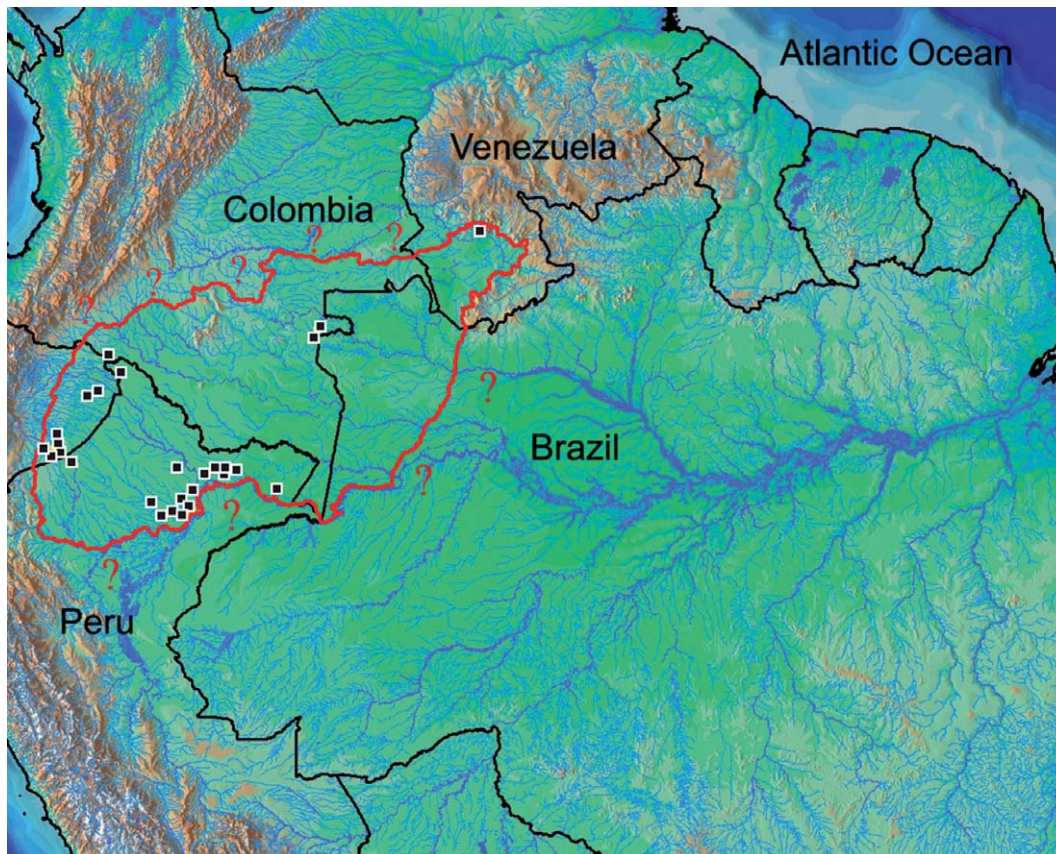


FIGURE 2. Distribution of *Rhinella ceratophrys* in South America. Red line indicates estimated range. Question marks highlight unknown borders; the limit shown here is an estimation. Black squares indicate confirmed locations represented by museum specimens or reliable sightings (see Appendix I).



FIGURE 3. The holotype of *Rhinella ceratophrys* (Boulenger, 1882), catalog number BMNH 1880.12.5.151, a juvenile of undetermined sex; SVL = 38 mm. This type agrees in all respects with other material discussed in this paper. Image was taken by Harry Taylor, and copyright remains with the Natural History Museum, UK.

passing the Río Inirida and extending into eastern Viçhada. The western and southern limits of the range in Ecuador and Peru have not been established. Notes on the distribution of this species in Venezuela were provided by Rivero (1972), La Marca (1992), and E. La Marca (*pers. comm.*). Distributional information from Colombia and Ecuador were presented by Cochran and Goin (1970), Ruíz-Carranza *et al.* (1996), and Coloma (1991). In Peru this species appears to be confined to the western and northern banks of the Marañón and Amazon rivers, respectively.

Ecological Notes – *Rhinella ceratophrys* inhabits leaf litter on the floor of humid primary forests. In north-eastern Peru, it appears to be restricted to non-flooded forest, although we have found specimens along riverbanks. Secondary areas close to undisturbed forest are also used. The species is both diurnal and nocturnal (L. Coloma, *pers. comm.*; W. W. Lamar, *pers. observ.*). We have also found sleeping individuals at night so nocturnal activity may be associated with breeding or some other seasonal cue. When disturbed or approached, this toad presses its body down into the leaf litter and remains motionless. During ecdysis the eyelid processes are alternately rotated forward and backward to pull loose skin toward the mouth where it is consumed. Stomach contents of specimens collected in Vaupés, Colombia, yielded termites of the genus *Nasutitermes*. A specimen from Orán, Loreto, Peru, was observed feeding on ants (*Dolichoderus*

bispinosus) (A. Giardinelli, *pers. comm.*). Captive specimens in our care fed readily on termites. Three females from the series at UTA contained 1000-1500 small (< 1 mm diameter), pigmented eggs. Other aspects of the reproduction, including behavior and advertisement call, are unknown; the tadpole has never been observed.

Comments – We examined the holotype (BMNH 1880.12.5.151) indirectly through good quality digital images (Fig. 3) sent to us by courtesy of the Natural History Museum, UK. The specimen is reasonably well preserved and intact, except for some superficial dissections of the ventral skin; sex of the specimen is undetermined. The holotype matches the specimens examined herein and the diagnostic characteristics provided in this paper. Based on its general appearance, small size (SVL = 38 mm), and agreement with juvenile specimens examined in this study, we consider the holotype to be a juvenile specimen. All records at BMNH indicate that this is, in fact, the type specimen used by Boulenger in his original description (B. Clarke, *pers. comm.*). Consequently, we are confident that the name *Rhinella ceratophrys* (Boulenger, 1882) is applicable to all of the specimens reported herein. However, as often is the case in widespread species such as this one, there always remains the possibility that genetic inquiry may identify additional cryptic species-level diversity that our assessment was not designed to detect.

TABLE 1. Morphometric variation in adults of *Rhinella ceratophrys*. Mean \pm 1 SD are presented above range (in parentheses); all measurements in mm.

Variable	Males n = 6	Females n = 9
Snout-vent length	56.5 \pm 12.5 (39.9 – 69.8)	93.9 \pm 15.5 (60.2 – 106.6)
Head width	20.0 \pm 3.8 (14.4 – 24.4)	31.1 \pm 4.6 (20.2 – 34.7)
Head length	18.4 \pm 3.6 (13.1 – 22.0)	26.8 \pm 3.1 (19.7 – 29.5)
Eye-nostril distance	4.3 \pm 0.9 (3.3 – 5.7)	7.0 \pm 1.3 (4.7 – 8.2)
Tympanum diameter	3.4 \pm 0.6 (5.7 – 6.6)	4.8 \pm 1.0 (2.8 – 5.8)
Hand length	14.7 \pm 3.6 (10.2 – 18.6)	23.0 \pm 3.2 (16.0 – 26.0)
Tibia length	27.8 \pm 6.0 (19.5 – 33.27)	44.8 \pm 7.5 (28.8 – 50.9)
Foot length	22.6 \pm 5.7 (16.1 – 28.4)	37.4 \pm 5.3 (26.0 – 41.9)

RESUMEN

Hasta 1994, los sumarios y descripciones publicadas de *Rhinella ceratophrys* Boulenger, 1882 se han basado en especímenes juveniles, por lo que en general se presumía que se trataba de una especie pequeña. Basados en la revisión de material adicional, incluidos especímenes adultos, así como el holotipo, reportamos la variación de este sapo bufónido de gran tamaño y proveemos una nueva diagnosis para la especie. Adicionalmente, presentamos notas sobre su ecología y distribución.

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APPENDIX I

Specimens Examined

Colombia: Nariño: La Guayacana, 400 m (KU 145061); Putumayo: Puesto de Bombeo Guamez [= Guamués] (KU 140332); Santa Rosa de los Kofanes, middle course of Río Guamés, tributary of upper Putumayo (CM 50609); Vaupés: Wacará (UTA 3852-3855, 4060-4062, 6137, 8526, 8365); Yapima (UTA 6138). Ecuador: eastern Ecuador (AMNH 53339); Pastaza River, Canelos to Marañón (MCZ 19601); Napo: Cuyabeno, along the Río Cuyabeno (UIMNH 59422-59424); Limón Cocha (UIMNH 93099); Pastaza: Andoas, Río Pastaza (AMNH 53335) [Authors' comment: this is actually in Loreto, Peru]; Río Capahuari, at point of confluence with Río Pastaza (USNM 196962) [Authors' comment: this should be the Río Copahuari, not to be confused with the Río Copahuari which joins the Río Pastaza at Andoas, a site in Loreto, Peru]; Río Rutuno, tributary of Río Bobonaza (USNM 196963-196965, 266104); Río Bufo, Bajo Bobonaza (USNM 196695, 266105-266106); Río Pindo (USNM 196966-196967); Peru: Loreto: Santa Luisa, Río Nanay, 160 m (FMNH 109824); Yagua Indian Village, headwaters of Río Loretoyacu [100+ km NW Leticia] (AMNH 96009-96010); Quebrada Orán, *ca.* 5 km N Río Amazonas, 85 km NE Iquitos, 110 m (KU 206135).

APPENDIX II

Additional Material in Collections and field observations (WWL)

Colombia: Putumayo: Puesto de Bombeo Guamez, 1000 m [= Guamués] (KU 140330-140331); Vaupés: Yapima (UTA 6138). Ecuador: Pastaza: upper Río Pastaza [= Pastaza] drainage (KU 154655); Río Pindo (USNM 196966); Andoas [= Andoas], Río Pastaza (AMNH 53337); Río Capaguaría (AMNH 53338); Amundai (Kapawi Lodge), 300 m, 02°52'S, 72°20'W (QCAZ 11114-11117); north of Jatún Molina (east of Sarayacu, between the rivers Bobonaza and Jatúnrutunoyacu, 01°48'S, 77°18'W (QCAZ 10638). Peru: Loreto: Quebrada Orán, *ca.* 5 km N Río Amazonas, 85 km NE of Iquitos, 110 m, KU 206134; Estirón, Río Ampiyacu, MZUSP 27368-27369; Aldeia dos Indios Borra [= Bora], 2 km da boca do Río Zumón, MZUSP 54140; San Joaquín de Omaguas, Río Amazonas (WWL); Pebas (WWL); Sabalillo, Río Apayacu (WWL); Supay Cocha, Río Apayacu (WWL); Nauta (WWL); lower Río Itaya (WWL); Brillo Nuevo, Río Yaguasyacu (WWL); Orán, Río Amazonas (WWL), ExplorNapo Lodge, Río Sucusari (WWL), Explorama Lodge, Quebrada Yanamono (WWL); Nueva Colonia, Río Zumón (WWL); between the Río Tacshacuraray and Río Mazan, 3 days walking distance (WWL); middle Río Nahuapa, tributary of the lower Río Tigre (WWL); El Paraíso, left bank of Río Tigre (WWL); Gueppi (P. Venegas, *pers. comm.*). Venezuela: Amazonas: Marahuaca (U.P.R. 253, cited by Rivero, 1972).