A NEW SPECIES OF COLLARED FROG (AMPHIBIA: ANURA: AROMOBATIDAE: MANNOPHYRyne) FROM THE ANDES OF TRUJILLO STATE, VENEZUELA

JÉSSICA Y. VARGAS GALARCE1,2 AND ENRIQUE LA MARCA2,3

1 Departamento de Biología, Facultad de Ciencias, Universidad de Los Andes, Mérida, Venezuela.
2 Laboratorio de Biogeografía, Escuela de Geografía, Facultad de Ciencias Forestales y Ambientales, Universidad de Los Andes, Mérida, Venezuela.

Abstract: We describe a new species of Mannophryne frog, coming from Trujillo State, in the Venezuelan Andes, which constitutes the first species of the genus described from that political unit. This new taxon is distinguished from its congeners by the following combination of characters: small size (SVL males 20.1–23.1 mm, females 23.3–27.5 mm); tympanum about ½ the horizontal length of eye; first finger almost equal, or slightly shorter than second; fingers with thick lateral fringes; tarsal fold conspicuous; foot-web formula: I.10–0.5II.1.0–1.0III.1.5–0.5IV0.5–2.0; toes with lateral flaps; short oblique pale inguinal band; collar moderately wide, solid, with small pale blotches; ventrolateral band absent. We provide data on coloration, in life and in preservative, of specimens of the type series, as well as a description of the larvae and ecological data for the species.

Key words: Mannophryne, Amphibia, Anura, Venezuela, Andes, taxonomy, natural history, conservation.

INTRODUCTION
The “collared frogs” (genus Mannophryne) constitute a monophyletic assemblage of neotropical amphibians, of which thirteen species are currently described (La Marca 1994, 1997; Mijares-Urrutia and Arends 1999a,b; Manzanilla et al. 2007). They are diurnal and terrestrial inhabitants of humid mountain forests in the Venezuelan Andes and Coastal Range, as well as in Trinidad and Tobago islands (La Marca 1995). Most of the environments where these frogs occur have undergone massive habitat destruction and their current distribution appears as highly patchy or fragmented. This is more evident in Trujillo State, where a long history of human occupation and land use, backing to the pre-Hispanic occupation (Claret 1985) and continuing up to date, have destroyed much of the original forest cover. Explorations in some of these forest remnants have unveiled populations of a collared frog that we regard as an undescribed species. The object of this paper is to describe this new taxon and to provide pertinent biological and ecological information.

MATERIAL AND METHODS
Terminology and methods for adult specimens follow La Marca et al. (2004). Measurements (in mm) were taken with a Helios® digital caliper (precision 0.01). Measurements taken for post-metamorphic specimens were snout-vent length (SVL); head length from posterior corner of mouth to tip of snout (HL); head width at level of angle of jaws (HW); eye-to-nostril distance from anterior corner of eye to center of naris (EN); internostril distance (IN); eye length from anterior to posterior corner (EYE); horizontal length of tympanum (T); hand length from proximal edge of palmar tubercle to tip of finger III (HAND); tibia length from outer edge of flexed knee to heel (TL); foot length from proximal edge of outer metatarsal tubercle to tip of toe IV (FOOT). Developmental staging of tadpoles follows Gosner (1960). Terminology for tadpoles follows Mijares-Urrutia (1998) with modifications. Abbreviations for tadpole measurements are: BL= body length, TL= tail length, BH= body height, END= eye-to-nostril distance,
M. trujillensis more closely resembles another wide-collar aromobatid frog: Mannophryne lamarcai Mijares-Urrutia and Arends, 1999. The new species can be distinguished from the former (characters of M. lamarcai within parentheses) by having a wider collar (narrower), less webbing between toes (more webbing, (1.0–2.0)-(0.5–1) (1.5–2.0)-(1.0–1.5) (1.5–2.0)-(1.0–1.5) (IV) (0.5–2.0)-(1.0–2.0) (V)). Furthermore, M. trujillensis lacks a cream canthal stripe surrounding the snout that is so distinctive in specimens of M. lamarcai, albeit some specimens of M. trujillensis may have heavily dark-stippled cream spots. Additionally, M. trujillensis lacks the cream stripe that is present below the tympanum in specimens of M. lamarcai.

From all other species in the genus having a wide collar, Mannophryne trujillensis is distinguished by the combination of characters in its definition. In some specific details, the new taxon is easily distinguished from the remaining wide-collar Mannophryne by having a unique foot-web formula between toes IV and V (i.e. IV 0.5-2.0V), and by having a larger tympanum in relation to the horizontal length of eye (1/2 versus 1/3 to 2/3) except from M. yustizi (La Marca, 1989) that is also 1/2. The later has less amount of webbing between the outermost toes (IV 0.5–1.0V versus the unique formula given above for M. trujillensis).

Additional characters to distinguish the new species from the other wide-collared Mannophryne frogs are as follows. Mannophryne trinitatis (Garman, 1887) has low lateral flaps on toes (well developed in M. trujillensis), and less amount of web between toes IV and V ((0.0–0.5)-(0.0–0.5) vs. 0.5-2.0 in M. trujillensis). Mannophryne riveroi (Donoso-Barros, 1965) is a much larger frog (SVL females 43.3 mm, males 35 mm; versus 25.4 mm in females and 21.6 mm in males of the new species) and lacks the oblique inguinal band present in M. trujillensis. Mannophryne obliterata (Rivero, 1984) is a much more foot-webbed frog (every pair of toes having webs reaching from two to three phalanges versus less than two in M. trujillensis). Mannophryne caquetio Mijares-Urrutia and Arends, 1999, M. collaris (Boulenger, 1912) and M. cordilleriana La Marca, 1994, among other characters, have smaller tympani (2/5 of the horizontal length of eye vs. ½ in M. trujillensis). Mannophryne herminia (Boettiger, 1983) has an internomostri distance 1.7 times eye-to-rostrum distance (1.5 times in M. trujillensis) and a more developed tarsal fold.

Of the Mannophryne with narrow collar, the new species is differentiated from M. olmonae (Hardy, 1983) and M. neblina (Test, 1956) by having a uniformly dark collar (with pale flecks in M. trujillensis); additionally, M. neblina is a larger frog, with entire pale immaculate lips (a unique character within the genus). The new taxon is distinguished from the recently described M. leonardoi Manzanilla et al., 2007, by having more webbed feet (rudimentary foot web in the later) and from an undescribed species, coming from Península de Pariá (Manzanilla et al., in press), among other characters, by having a wide collar, as opposed to narrow collar.

**Description of Holotype**

Head slightly wider than long. Interorbital area smooth, very slightly curved (almost flat); interorbital distance about 1/3 greater than upper eyelid width. Canthus rostralis not well-defined, between straight and...
slightly curved. Nares slightly elevated, directed laterally and slightly backwards; nares closer to tip-of-snout than to eye. Loreal region almost vertical, slightly concave, descending abruptly to lips. Snout sub-ovoid in dorsal view (cf. Fig. 1); tip of snout slightly rounded in both dorsal and lateral view. Horizontal length of eye about 1.7 times eye-to-nostril distance. Internostril distance about 1.5 times eye-to-nostril distance. Tympanum separated from eye about ½ its horizontal length; thick supratympanic fold, covering both lower and posterior upper parts of tympanum; tympanic ring well defined, with both anterior and ventral ridges slightly elevated. Mouth rictus with one to three tubercles. Tongue spatulate, wider and with an entire border in its posterior end; about twice longer than wide and its width about 1/3 mouth width; posterior ½ not adherent to floor of mouth. Lingual papillae absent. Choanae rounded with its anterior part concealed by palatal shelf of maxillary arch. Maxilla and premaxilla toothed; teeth short, not fang-like.

Dorsum smooth on anterior part, bearing small inconspicuous tubercles on lower back. Flanks with low, inconspicuous tubercles, look almost smooth. Throat, chest and venter smooth. Upper arm and forearm bearing inconspicuous tubercles; a small, inconspicuous tubercle on distal end of ventral surfaces of forearm; metacarpal tubercle not well-defined; palmar tubercle oval, almost rounded in outline, about 1.5 times the size of thenar; thenar tubercle oval, about twice longer than wide; no supernumerary tubercles; subarticular tubercles moderate-sized, flattened, rounded to oval in shape, largest on first finger; small pads on fingers, pads wider than long, largest pad on third finger, about 1/3 size of tympanum and about 1.8 times wider than adjacent phalanx. Fingers free, with thick lateral fringes; keel along outer edge of fourth finger, from base of pad to half of the hand, almost reaching to thenar. First finger almost equal, or slightly shorter than second (cf. Fig. 2); third finger in males, not enlarged; disks on fingers rounded, with two oval, well-defined dorsal scutes.

No tubercles on any surfaces of posterior extremities. Length of tibia about 47% snout-to-vent distance. Tarsal fold conspicuous, not ending in tubercle nor having a distal enlargement; inner metatarsal tubercle elongated; outer metatarsal tubercle oval, shorter than inner metatarsal tubercle; subarticular tubercles oval, flattened. Toes moderately webbed; foot web formula: I 1.0–0.5II 1.0–1.0III 1.5–0.5IV 0.5–2V; toes with lateral flaps; largest toe disk on second toe (cf. Fig. 3). Heels do not overlap when thighs are held at right angles to body axis.

**Coloration of holotype in preservative**

Dorsum pale brown with little dark dots and a relatively large irregular spot spread for all around dorsum; head paler than dorsum; numerous cream spots with smaller dark brown dots, from the medium part of tympanum to venter; lower lip paler than upper lip. Lower part of tympanic fold and lower eyelid are pale-cream; palpebral membrane transparent with a dark brown edge. Loreal region dark brown, alike the rim of nostril. There are cream spots distributed all around the arm. Phalanges begin with a transversal cream stripe followed by a dark brown stripe with small cream dots; both colour stripes being alternate. Discs on fingers II and IV dark brown and the discs III and I are cream. Flanks mostly as dark as dorsum. A discontinuous cream stripe extends from ingle to half of flank and continues in form of little pale brown spots, until insertion of arm.

There is a cream spot in the inguinal region that follows perpendicular to half of thigh. Ventral area between shank and thigh is brown, coloration that fades towards its posterior region. Thigh with cream spots of different sizes, mostly concentrated on its posterior surface. Tarsi, metatarsi and phalanges light brown with little cream spots that become more prominent toward the phalanges, where they form stripes that cover the subarticular tubercles. Discs on toes are dark brown.
**Coloration of type series in life**

The holotype possessed a marbled dorsum; black collar; yellow throat, with anterior part gray, posterior part yellow; white venter; yellow stripe in front of arms, reaching almost to corner of mouth; yellow inguinal stripe; yellow spots on flanks (E. La Marca, field notes 30 November 1984).

The coloration for the paratopotype series ULABG 1151 to 1157, from Trujillo city, is on records as follows: collar dark brown, blackish to almost black; or dusted with yellow on posterior part. Posterior part of throat intense-yellow with white lateral borders, anterior part whitish or gray (sometimes, a white coloration borders the yellow on the sides). Chest and venter are white or grayish-white. Yellow tinge or yellowish spots present on the border between flanks and venter.

Oblique inguinal band between pale yellow to intense yellow, reaching to mid-flank, where it turns to brown up to arm insertion. Undersides of thighs pale gray, lead-gray or with a pale-violet tinge. Posterior surfaces of thighs with yellowish-white minute dots. Dorsum almost uniformly brown, dark brown, dark-brown with pale spots, or ashy-brown. Cross-bars on thighs pale brown, inconspicuous (sometimes absent). Dermal scutes present on digit-tips, pale-blue. Base of tympanum pale-gray, while the iris is pale-brown (E. La Marca, field notes 29-30 November 1984).

The coloration for the paratype series ULABG 1198 to 1216, from Paragüita, near Flor de Patria, was recorded as follows: collar wide, blackish, without reticulations, reaching laterally to mandibles in males; with white stippling in females. The throat is gray to dark gray, sometimes with yellow in posterior part or with two yellow spots on chest at the level of the scapular girdle in males; intense yellow in females. Chest is uniformly intense yellow, or with anterior part gray, or uniformly gray, in females. Venter, in males, white or grayish, except on posterior part that is dirty white. Venter, in females, yellow or whitish, or gray with posterior part white. Inguinal yellow-greenish or pale green spots sometimes present in females. Inguinal oblique band is coppery or yellowish (sometimes with an infra-posterior yellow spot) in males; yellow or pale yellow in females. Undersides of thighs are uniformly gray in males; pale green in proximal or distal parts in females. Proximal ventral parts of shanks gray to greenish-yellow in males and females. Tubercle at rictus has a copperish tinge (E. La Marca, field notes 20 January 1985).

Adult female paratopotype ULABG 6846 (Fig. 4) had an intense yellow throat, with lateral and anterior parts gray (Fig. 5). The collar was solid black, with some gray markings on its posterior border. Chest and venter intense yellow, with some irregular white spots. Under parts of thighs grayish. Shanks, below, yellowish-gray. Palms and soles dark gray. Iris pale caramel. Yellow inguinal band ending as diffuse spots near insertion of arm. Upper parts of legs with dark wide bands that alternate with narrower grayish-cream bands. Top of head dark brown. Dorsum with large dark brown spots on a dark brown-greenish background. Some elongate pale brown markings on shoulders. Arm and forearms with dark brown bands. Base of arm yellowish-cream. Dark loreal band. Grayish band, bearing dark spots, on upper lip, crossing the lower half of tympanum and almost reaching the arm pit. Dermal scutes on digits pale-gray. Narrow pale-gray bands on fingers and toes. Tongue yellowish-cream. Two short cream bands on each side of cloacal opening. Upper part of thighs, marbled (E. La Marca, field notes 1 August 2006).

**Variation**

The yellow throat coloration in females becomes more intense as females grow larger. Old mature females have intense yellow vents, while subadult and young adult females have white vents (Fig. 5). The collar, in females, ranges from solid to reticulate, the later resembling some Mannophryne herminae from Rancho Grande (Aragua State). The yellow inguinal band can be short or extending to reach almost the base of arm. Base of forearm can be yellowish cream to pale brown. Dark bands on legs can be conspicuous or inconspicuous.
Variation in measurements of the type specimens is given in Table 1; data are arranged according to the places of origin of the populations.

In comparison to the holotype, toe-webbing could be more extensive between toes I and II (e.g. I 1½-1 II in ULABG 1157, 1206 and 1210; I:II in ULABG 1205), less or more between toes II and III (e.g. II1½-1III in ULABG 1157 and 1205-1206; II½-1III in ULABG 1202, 1210 and 1212), more between toes III and IV (e.g. III 2-1 IV in ULABG 1202 and 1212, III1½-1IV in ULABG 1210, III1½-1¼IV in ULABG 1157), and variable between toes IV and V (e.g. IV 1½-2 V in ULABG 1157, IV½-1½V in ULABG 1198, IV1-1½V in ULABG 1202, 1205-1206, 1210 and 1212).

**TABLE 1.** Measurements of metamorphosed Mannophryne trujillensis. Mean and standard deviation (above), with the range of variation (within parentheses). Abbreviations explained in materials and methods. F= females, M= males.

<table>
<thead>
<tr>
<th>LOCALITY</th>
<th>SEX</th>
<th>N</th>
<th>SVL (mm)</th>
<th>TL (mm)</th>
<th>HW (mm)</th>
<th>HL (mm)</th>
<th>T</th>
<th>EYE</th>
<th>EN (mm)</th>
<th>IN (mm)</th>
<th>HAND</th>
<th>FOOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paseo Los Ilustres</td>
<td>F</td>
<td>14</td>
<td>24.2±2.7 (20.1-27.5)</td>
<td>12.1±1.0 (10.1-13.3)</td>
<td>8.6±1.1 (7.1-10.3)</td>
<td>7.5±0.9 (6.1-9.0)</td>
<td>1.4±0.2 (1.2-1.7)</td>
<td>3.3±0.3 (2.6-3.9)</td>
<td>2.2±0.2 (1.9-2.7)</td>
<td>3.1±0.3 (2.5-3.6)</td>
<td>6.5±0.6 (5.6-7.5)</td>
<td>11.2±1.1 (8.7-12.6)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>6</td>
<td>20.5±3.0 (17.4-20.0)</td>
<td>10.5±1.4 (8.9-12.7)</td>
<td>7.6±1.5 (6.0-10.1)</td>
<td>6.3±0.7 (5.5-7.3)</td>
<td>1.3±0.2 (1.1-1.6)</td>
<td>2.6±0.3 (2.5-3.4)</td>
<td>2.0±0.3 (1.6-2.5)</td>
<td>2.7±0.4 (2.1-3.3)</td>
<td>5.6±0.9 (4.8-7.3)</td>
<td>9.9±1.9 (7.8-13.2)</td>
</tr>
<tr>
<td>Paragüita</td>
<td>F</td>
<td>9</td>
<td>22.7±2.4 (19.8-26.6)</td>
<td>11.7±1.1 (10.1-13.2)</td>
<td>8.8±1.1 (6.9-9.9)</td>
<td>7.2±0.8 (6.2-8.7)</td>
<td>1.5±0.3 (1.0-1.9)</td>
<td>3.1±0.2 (2.8-3.4)</td>
<td>2.0±0.2 (1.8-2.4)</td>
<td>3.0±0.2 (2.8-3.2)</td>
<td>5.9±0.5 (5.1-6.4)</td>
<td>10.6±1.1 (9.2-12.2)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>9</td>
<td>21.1±1.6 (18.6-23.1)</td>
<td>11.0±0.6 (10.3-12.2)</td>
<td>7.8±0.8 (6.8-8.9)</td>
<td>6.8±0.7 (6.0-8.3)</td>
<td>1.3±0.2 (1.0-1.6)</td>
<td>2.9±0.3 (2.4-3.2)</td>
<td>1.9±0.2 (1.7-2.3)</td>
<td>3.0±0.2 (2.7-3.2)</td>
<td>5.6±0.5 (4.8-6.2)</td>
<td>9.7±1.1 (8.2-11.2)</td>
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</table>

ULABG 1198 has the right hand with atrophied phalanges; ULABG 1204 has the right foot larger (about 1.8 mm larger) than the left foot; ULABG 1211 lacks the second finger on left hand, apparently a malformation; ULABG 1154 presents syndactyly in three toes except the first one, and a toe is missing through malformation; ULABG 1151 and 1216 have small skin lesions (unpigmented blotches, muscles sometimes can be seen through translucent skin).

**Tadpoles**

The following account describe specimens in developmental stages 30 and 31 (Gosner 1960), lot ULABG 1161, all coming from the type locality. They are assigned tentatively to the new species on the basis of resemblance to other Mannophryne tadpoles. No other amphibians are known from this locality.

Body elongate and oval in dorsal view, depressed (wider than deep); widest in the first 1/3 of body length; deepest at about half-length of body. Snout broadly rounded in dorsal view. Eyes directed...
Coloration in preservative: dorsum pale brown with dark brown fleckings; ventral fin translucent; dorsal fin translucent with numerous brown fleckings.

**Measurements of tadpoles**

Abbreviations as explained in the Material and Methods section. Measurements expressed as a mean, followed by standard deviation, and range within parentheses. BL= 10.3±0.7 (9.3-11.5), TL= 21.5±1.9 (19.1-24.0), BH= 4.4±0.4 (3.9-4.9), END= 2.2±0.2 (2.0-2.3), ESD= 2.5±0.1 (2.4-2.6), ED= 0.9±0.1 (0.8-1.1), SSD= 6.1±0.4 (5.4-6.6), SDD= 2.8±0.3 (2.3-3.1), CMH= 2.0±0.1 (1.8-2.2), DFH= 1.7±0.2 (1.5-1.9), VFH= 1.2±0.1 (1.0-1.4), ADW= 1.2±0.4 (0.8-2.0), PDW= 1.4±0.2 (1.2-1.6), ODW= 2.5±0.2 (2.2-2.7), BW= 5.6±0.3 (5.1-5.9), IOD= 1.9±0.2 (1.8-2.1), IND= 1.3±0.2 (1.1-1.6).

**Ecological notes**

*Mannophryne trujillensis* inhabits semi-deciduous forests in Trujillo State. It is possible that the species occurs in many of these herpetologically unexplored places in the Andes of northwestern Venezuela. Most of the original semideciduous forests have been destroyed or highly modified for agricultural purposes (mainly coffee plantations); they can be considered among the most threatened ecosystems in the Venezuelan Andes. *Mannophryne* populations still survive in some of these places, but we lack long-term monitoring studies to assess properly their conservation status.

The ecology of the species is largely unknown. However, there are scanty worth-noting ecological data. Most specimens in Parque Los Ilustres were found on rocks and vegetation (submersed roots) in a stream Quebrada Los Cedros that runs across this urban park in Trujillo city. Some frogs were collected under rocks. Some of the collecting places had solid waste (Fig. 8) and a water pH value of 5.75. The water in the stream reached a temperature of 24 °C at 14:45 hours.

One natural predator of the new species could be the colubrid snake *Liophis melanotus* Shaw, 1802; a specimen of the later (ULABG 1162) was collected at the type locality and feed on adult specimens of the new species while kept in captivity. Pseudotelphusidae fresh water crabs, also present at the type locality, could be potential predators of the larvae as inferred from observations on its feeding on tadpoles under captivity conditions. Specimens from Paraguita come from a stream in a hilly sector behind the small town of Flor de Patria, in
Trujillo State, close to the city of Trujillo. By the time of collection, the place was forested, with a more or less undisturbed cover of semi-deciduous trees. Since the last decade of the last century, the place has undergone a strong human transformation, due to urbanization (Fig. 9). The populations at the two only known places of occurrence for the species still survive in low numbers, but no conservation assessment can be forwarded at this moment due to the lack of monitoring studies.

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